Scheme and Syllabi of Courses
B.Tech. Third & Fourth Year
2019 batch

National Institute Of Technology Srinagar

Scheme of Courses for B.Tech. Chemical Engineering (3rd to 8th Semester) [2019 Batch onwards]

3rd Semester

S. No.	Course No.	Subjects	L	T	P	Credits
1.	CET-201	Introduction to Chemical Engineering	3	1	0	4
2.	CET-202	Material and Energy Balance	3	1	0	4
3.	CET-203	Process Fluid Mechanics	3	1	0	4
4.	CET-204	Thermodynamics and Chemical Kinetics	3	1	0	4
5.	ECT-205	Basic Electronics Engineering	2	1	0	3
6.	HST-201	Ethics & Self Awareness	2	0	0	2
7	MAT-201	Chemical Engineering Mathematics-I	3	1	0	4
		TOTAL = 19 + 6 + 0 = 25	**19**	**6**	**0**	**25**

4th Semester

S. No.	Course No.	Subjects	L	T	P	Credits
1.	CET-250	Chemical Engineering Thermodynamics	2	1	0	3
2.	CET-251	Heat Transfer	3	1	0	4
3.	CET-252	Mechanical Operations	3	1	0	4
4.	CET-253	Material Science &Technology	3	1	0	4
5.	CET-254	Process Instrumentation	3	0	0	3
6.	MAT-250	Chemical Engineering Mathematics –II	3	1	0	4
7.	CEL-255	Fluid Mechanics &Mechanical Operations Lab.	0	0	4	2
8.	ECL-256	Basic Electronics Engineering Lab.	0	0	2	1
		TOTAL = 17 + 5 +6 = 28	**17**	**5**	**6**	**25**

5th Semester

S. No.	Course No.	Subjects	L	T	P	Credits
1.	CET-305	Process Equipment Design– I	3	1	0	4
2.	CET-306	Chemical Reaction Engineering	3	2	0	5
3.	CET-307	Mass Transfer-I	3	1	0	4
4.	CET-308	Chemical Technology – I	3	0	0	3
5.	HST-309	Basic Management Principles	3	0	0	3
6.	MAT-310	Numerical Methods	3	1	0	4
7.	CEL-311	Heat Transfer Lab	0	0	2	1
8.	CEL-312	Computer Simulation Lab	0	0	2	1
		TOTAL = 18 +5 + 4 = 27	**18**	**5**	**4**	**25**

6th Semester

S. No.	Course No.	Subjects	L	T	P	Credits
1.	CET-355	Process Equipment Design -II	3	1	0	4
2.	CET-356	Mass Transfer – II	3	1	0	4
3.	CET-357	Chemical Technology – II	3	0	0	3
4.	CET-358	Energy Technology	3	0	0	4
5.	CET-359	Chemical Process Safety	3	0	0	3
6.	CET-360	Transport Phenomena	3	1	0	4
7.	CEL-361	Energy Technology Lab	0	0	2	1
8.	CEL-362	Thermodynamics & Reaction Engineering Lab	0	0	2	1
9.	CEI-363	Industrial Training & Presentation	0	0	2	1
		TOTAL = 18 +3+8 = 29	**18**	**3**	**8**	**25**

7th Semester						
S. No.	**Course No.**	**Subjects**	**L**	**T**	**P**	**Credits**
1.	CEP-413	Pre-project work	0	0	4	2
2.	CES-414	Seminar	0	0	2	1
3.	CET-415	Process Dynamics & Control	3	1	0	4
4.	CET-416	Process Economics & Plant Design	3	1	0	4
5.	CET-417	Biochemical Engineering	3	1	0	4
6.	CEL-418	Process Dynamics & Control Lab	0	0	2	1
7.	CEL-419	Mass Transfer Lab	0	0	4	2
8.	CET-020-24	Elective – I (Departmental Elective/Swayam)	3	0	0	3
9.	CET-025-29	Elective – II (Departmental Elective/Swayam)	3	0	0	3
		TOTAL = 15 + 3 + 14 = 32	**15**	**3**	**14**	**25**

8th Semester						
S. No.	**Course No.**	**Subjects**	**L**	**T**	**P**	**Credits**
1.	CEP-464	Project Work	0	0	16	8
2.	CET-465	Bioresource Technology	3	0	0	3
3.	CEL-466	Biochemical Engineering Lab	0	0	4	2
4.	CET-467	Modeling & Simulation of Chemical Process Systems	3	0	0	3
5.	CET-468	Industrial Pollution Abatement	3	0	0	3
7.	CET-069-72	Elective – III (Departmental Elective/Swayam)	3	0	0	3
8.	CET-073-76	Elective – IV (Departmental Elective/Swayam)	3	0	0	3
		TOTAL = 15 + 0 + 20 = 35	**15**	**0**	**20**	**25**

E-I: Any one of the following electives

S. No.	**E-1**	**Elective courses**	L	T	P	Credit
1.	CET-020	Polymer Science and Engineering	3	0	0	3
2.	HST-021	Managerial Economics for Engineers	3	0	0	3
3.	CET-022	Advanced Separation Processes	3	0	0	3
4.	MAT-023	Operations Research	3	0	0	3
5.	CET-024	Process Heat Integration	3	0	0	3

E-II: Any one of the following electives

S.No.	**E-II**	**Elective courses**	L	T	P	Credit
1.	CET-025	Cement Technology	3	0	0	3
2.	CET-026	Computational Fluid Dynamics	3	0	0	3
3.	CET-027	Multi-component Distillation	3	0	0	3
4.	CET-028	Optimization Techniques in Chemical Engineering	3	0	0	3
5.	CET-029	Heterogeneous Catalysis & Catalytic Processes	3	0	0	3

E-III: Any one of the following online electives

S. No.	**E-III**	**Elective courses**	L	T	P	Credit
1.	CET-069	SWAYAM Online course	3	0	0	3
2.	CET-070	SWAYAM Online course	3	0	0	3
3.	CET-071	SWAYAM Online course	3	0	0	3
4.	CET-072	SWAYAM Online course	3	0	0	3

E-IV: Any one of the following online electives

S. No.	**E-IV**	**Elective Courses**	L	T	P	Credit

1.	CET-073	SWAYAM Online course	3	0	0	3
2.	CET-074	SWAYAM Online course	3	0	0	3
3.	CET-075	SWAYAM Online course	3	0	0	3
4.	CET-076	SWAYAM Online course	3	0	0	3

Nomenclature

CE	Chemical Engineering
MT	Mathematics Department subject
HS	Humanities and Social Sciences Department subject
EC	Electronics and Communication Engineering Department subject
T	Theory
L	Lab. course
P	Project/Dissertation
S	Seminar
I	Industrial Training & Presentation
First Numeral	Year of course, Except for Elective courses assigned as “0”.
2^{nd}& 3^{rd} Num.	Unique Course Number

***SWAYAM online courses will be floated before the start of semester to be managed by a faculty mentor.**

5th Semester

Process Equipment Design-I (CET-305)

<table>
<tr><td rowspan="3">Subject: Process Equipment Design-I (CET-305)</td><td rowspan="3" colspan="2">Year & Semester: B.Tech. Chemical Engineering 3rd year & 5th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term
(30 Marks)</td><td>Class Assessment
(10 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Objective:

The objective of the course is to provide basic knowledge of design parameters and their applications in the design of the equipments such as pressure vessels, storage tanks and tall towers used in the process industries along with the flanges and supports.

Course Outcomes (COs)

CO1.	Getting basic idea about the mechanics of materials.
CO2.	Understanding of mechanical design of storage tank, pressure vessel and tall tower.
CO3.	Acquiring knowledge of flanges and supports with respect to design and applications.

Details of the Syllabus

Unit-I	Mechanics of Materials: Stress, strain, biaxial stress, stress-strain relationship for elastic bodies, theories of failure, thermal stresses, membrane stresses in shells of revolution, thin and thick cylinder.
Unit-II	Pressure Vessel: Selection of type of vessels, material of construction selection and design considerations. Introduction of codes for pressure vessel design, classification of pressure vessels as per codes. Design of cylindrical and spherical shells under internal and external pressure; Pipe thickness calculation under internal and external pressure; Selection and design of closures and heads, design of jacketed portion of vessels. Compensation of openings. Design of high pressure monoblock and multilayer vessels. Inspection and testing of pressure vessels
Unit-III	Flanges: Selection of gaskets, selection of standard flanges, optimum selection of bolts for flanges, design of flanges.
Unit-IV	Tall Tower Design: Design of shell, skirt, bearing-plate and anchor bolts for tall tower used at high wind and seismic conditions.
Unit-V	Supports: Design of lug and leg supports. Design of saddle supports including bearing plates and anchor bolts.
Unit-VI	Storage Tanks: Introduction to Indian standards codes, filling and breathing losses; classification of storage tanks; optimum length to diameter ratio, design of liquid and gas storage tanks with and without floating roof

Books Recommended

Text Books	1.	Brownell, L. E., Young, H. E., "Process Equipment Design", John Wiley (2004). 4. 6.
	2.	Bhattacharya, B. C., "Introduction of Chemical Equipment Design", CBS Publisher (2003).
	3.	I.S.:2825-1969, "Code for Unfired Pressure Vessels", (1969).
	4.	I.S.:803-1974, "Code of Practice for Design, Fabrication and Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks", (1984).
Reference Books	1.	Moss, D. R., "Pressure Vessel Design Manual", 3rd Edn., Gulf (2004).
	2.	Megyesy, E. F., "Pressure Vessel Handbook", 12th Edn., Pressure Vessel Publishing (2001

Chemical Reaction Engineering (CET-306)

Subject: Chemical Reaction Engineering (CET-306)	Year & Semester: B. Tech Chemical Engineering 3rd Year & 5th Semester		Total Course Credit: 5		
			L	T	P
			3	2	0
Evaluation Policy	Mid-Term (30 Marks)	Continuous Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objectives

The aim of the course is to impart basic knowledge of ideal reactor design for single and multiple reactions, the non-ideal flow, non-isothermal operations and stability of reactors, and understanding about the solid catalyzed and non-catalytic systems.

Course outcomes (COs): Upon successful completion of the course, students will be able to:

CO1	Explain the different types of reactors, their behaviour and performance for single reaction.
CO2	Design of batch, plug-flow and mixed flow reactors for multiple reactions
CO3	Analyze and size the reactors while accounting the non-isothermal conditions and non-ideal flow patterns.
CO4	Design reactors for the homogenous and heterogeneous catalyzed reactions, and understand their effect on performance equations of catalytic reactors.

Details of the Syllabus

Unit-I	**Introduction to Reactor Design:** Classification of rector types, material and energy balance for an element of volume of the reactor, basic performance equation, symbols and relationship between concentration and conversion. **Ideal Reactors:** Design equations for ideal reactors-batch, CSTR and plug Flow
Unit-II	**Design for Single Reaction**: Design equation for single reaction systems – batch reactor, CSTR, PFR and recycle reactor, auto catalytic reactions, reactor choice for single reaction - size comparison of single reactors and multiple-reactor systems.
Unit-III	**Design for Multiple Reactions:** Parallel and series reactions, quantitative treatment of product distribution and of reactor size for different types of ideal reactors, selectivity and yield factors, potpourri of multiple reactions, reactor choice for multiple reactions, Denbigh reactions.
Unit-IV	**Non-isothermal Operation and Stability of Reactors:** Non-isothermal design of ideal reactors, hot spot in tubular reactor, auto-thermal process, steady state multiplicity optimal temperature progression for first order reversible reaction.

Unit-V	**Non-ideal Flow:** Residence time distribution (RTD) theory, role of RTD in determining reactor behavior, age distribution (E) of fluid, experimental methods for finding E, relationship between E and F curve, models for non-ideal flow – single parameter and multi parameter models (axial dispersion, tanks in series), performance estimation of reactor using reactor models.
Unit-VI	**Solid-Catalyzed and Non-catalytic Reactions:**Catalytic reactions - homogeneous and heterogeneous,steps in solid catalyzed reaction, rate limiting steps, effect of external resistance and diffusion on reaction, Thiele modulus and effectiveness factor, performance equations for catalytic reactors (packed bed, fluidized bed), basic equations for trickle bed and moving bed reactors, fluid-particle reactions-shrinking core model.

Books Recommended

Text Books	1.	Levenspiel, O., "Chemical Reaction Engineering", 3rdEdn., John Wiley & Sons, New York (1998).
	2.	Fogler, H.S., "Elements of Chemical Reaction Engineering", 4thEdn., Prentice-Hall of India Pvt. Ltd. (1995).
Reference Books	1.	Smith, J.M., "Chemical Engineering Kinetics", 2ndEdn., McGraw-Hill Book Company, New York (1981).
	2.	Doraiswamy, L.K., Uner, D., "Chemical Reaction Engineering: Beyond the Fundamentals", CRC Press (2013)
	3.	Froment, G.F., Bischoff, K.B., De Wilde, J.D., " Chemical Reactor Analysis and Design", 3rdEdn., John Wiley & Sons, Inc. (2011).

Mass Transfer-I(CET-307)

Subject: Mass Transfer-I (CET-307)	B. Tech Chemical Engineering 5thSemester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective:

The main purpose of the course is to provide fundamental understanding of basic principles of mass transfer in gases and in liquids and their applications in various mass transfer systems used in process and allied industries.

Course Outcomes (COs):

CO1	Fundamental understanding of mass transfer operations.
CO2	Acquiring knowledge of inter phase mass transfer, and their coefficients.
CO3	Exhibiting basic understanding and analysis of gas absorption, humidification, drying and crystallization.
CO4	Understanding and analysis of the equipments used for the mass transfer operations.

Details of the Syllabus

Unit-I	**Principles of Mass Transfer, Steady and Unsteady States** Molecular diffusion in fluids, diffusivities of fluids, applications of moleculardiffusion-analogies and mass transfer coefficients in laminar flow, concepts of effective diffusivity.Eddy diffusion, mass transfer in turbulent flow, models of mass transfer operations.
Unit-II	**Interphase Mass Transfer** Interphase mass transfer-diffusion between phases, two phases mass transfer coefficients, individual and overall coefficients, stage wise process. Concurrent and counter current processes.
Unit-III	**Gas Absorption** Equilibrium relationships. Material balances for co-current and counter current multistage equipment. Dilute system. HETP, HTU and NTU individual and overallcoefficients. Equipment: General characteristics of tray towers, efficiencies, wetted wall towers, packedtowers, characteristics of packed towers, mass transfer coefficients in packed towers.
Unit-IV	**Humidification** General theory, psychometric chart, fundamental concepts in humidification and dehumidification. Cooling towers and related equipment.

	Crystallization Principles, yield calculation, heat effects and equipment.
Unit-V	**Drying** Equilibria, drying rate curve definitions. Batch and continues drying. Mechanism of drying. Calculation of batch and continuous drying.

Books Recommended

Text Books & Reference Books	**1.**	McCabe, W.L., Smith, J.C., "*Unit Operation of Chemical Engineering*",7th Edn., **McGraw-Hill (2011).**
	2.	Treybal, R.E., "Mass Transfer Operations" 3rd Edn., McGraw-Hill Book Company (1980).
	3.	Basmadjian, D., "Mass Transfer and Separation Processes: Principles and Applications", CRC Press (2007).
	4.	Foust, A. S., Wenzel, L. A., Clump, C. W., Maus, L., Andersen, L. B., "Principles of Unit Operations", 2 nd Ed., Wiley-India (2008).
	5.	Seader J DErnest J. Henley, D. Keith Roper, Separation Process Principles , with application using process simulators. 4rth edition John Wiley.

<table>
<tr><td rowspan="3">Subject: Chemical Technology-I
(CET-308)</td><td rowspan="3">Year & Semester: B.Tech. Chemical Engineering 3rd year &5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term
(30 Marks)</td><td>Class Assessment
(10 Marks)</td><td colspan="2">Final-Term
(60 Marks)</td></tr>
</table>

Chemical Technology-I (CET-308)

Course Objective

To study process technology, availability of raw materials, production trends, preparation of flow sheets, engineering and environmental problems of various chemical industries and manufacturing technologies.

Course Outcomes (COs)

CO1	Understanding of processes used by chemical process industries for production of various chemical products.
CO2	Application of process flow diagram for the chemical process industries.
CO3	Ability to deal with apparatus, unit operations, and chemical economics.

Details of the Syllabus

Unit-I	Technology of Water: Classification of water, industrial and municipal purposes, methods for obtaining fresh water from sea water.
Unit-II	Basic Chemical Industries: Common salt, its uses, economics and manufacture. Soda ash, its uses, raw materials, manufacture by Solvay process and its modification. Caustic soda-chlorine types of cells, raw materials, reactions, uses and manufacture.
Unit-III	Bleaching Powder and Hypochlorites: The methods of production. Sulphuric acid: Raw materials, method of manufacture by contact process. Synthetic ammonia: Uses, reactions, manufacturing process, concentration of nitric acid.
Unit-IV	Nitrogenous Fertilizers: Ammonium sulphate, ammonium nitrate and urea, their methods of production. Phosphate Industries: Phosphorous, uses and manufacture; phosphoric acid, uses and types of manufacturing procedures; phosphate fertilizers, raw materials and uses. Manufacture of super-phosphates, granular super phosphate and triple super-phosphate
Unit-V	Cement: History, various types of cements, raw materials, manufacture of Portland cement. Glass: history, uses and composition of glass; different types of glasses, unit operation and processes in the glass manufacture. Ceramics: Uses, basic raw materials, unit processes in ceramic industry. Porcelain: Manufacturing procedure. Enamels: Raw metals, preparation of metal paint, application of enamel and firing.

Books Recommended

Text Books	1.	Rao, M.G., Sittig, M., “Dryden’s Outlines of Chemical Technology for the 21st Century”, East-West Press, New Delhi (2002).
	2.	Austin, G.T., “Shreve’s Chemical Process Industries”, 5thEdn., McGraw Hill Book Company (1984).
	3.	Kent, J.A., *"Riegel's Handbook of Industrial Chemistry*,” *CBS* Publishers (1997).
Reference Books	1.	Mall I. D., "Petrochemical Process Technology", Macmillan India Ltd., New Delhi (2007).
	2.	Moulijn, J. K., Makkee, M., Van Diepen, A., “Chemical Process Technology”, Wiley (2001).

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Basic Management Principles (HST-309)

<table>
<tr><td rowspan="3">Subject: Basic Management Principles (HST-309)</td><td colspan="2" rowspan="3">Year & Semester: B.Tech Chemical Engineering 3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term (30 Marks)</td><td>Class Assessment (10 Marks)</td><td colspan="3">Final-Term (60 Marks)</td></tr>
</table>

Course Objective

The main objective of the course is to make the students aware of the fundamental understanding of the management principles which could be useful for them in the process, bioprocess industries or in any organization with respect to management.

Course Outcomes (COs): At the end of the course, student will be able to:

CO1	Acquiring basic knowledge of management and function of the managers.
CO2	Exhibiting understanding about planning, organizing, decision making and objectives.
CO3	Fundamental knowledge with respect to delegation and decentralization of authority.
CO4	Enabling with the importance of human resource development, motivation, communication skill and management information systems.

Details of the Syllabus

Unit-I	Management: It's nature, purpose and definition, management as a pre-requisite for any organization, aims of management, management-art of science. Functions of Managers: Planning, organizing, actuating and controlling.
Unit-II	Planning: Nature and purpose of planning, types of plans, steps in planning/planning process. Objectives: The nature and importance of objectives, types of objectives, primary, secondary, individual and personal objectives. Guidelines for setting objectives.
Unit-III	Decision Making: Importance and limitations of rational decision making, types of decisions, programmed and non-programmed decisions, process of decision making under certainty. Organizing: Nature and process of organizing, steps in organizing/process of organizing, formal and informal organization, span of control, and factors determining effective span.
Unit-IV	Decentralization of Authority: The nature of decentralization, degrees of decentralization, decentralization, philosophy and policy. Delegation of Authority: Meaning of authority/delegation, steps in the process of delegation, factors determining the degree of delegation, art of delegation.

Unit-V	Line/Staff Organization: Line organization, staff organization, line and staff organization, functional and committee organization, the nature of line and staff relationship. Actuating: Nature and purpose of actuating, steps in actuating/actuating process.
Unit-VI	Human Resource Management: Importance of human resource planning, recruitment, selection, training and development, performance appraisal, compensation, packages, promotions, transfers, demotion and separation etc. Leadership: Meaning and importance leadership qualities, effective and ineffective leaders, leadership styles.
Unit-VII	Motivation: Need, want and satisfaction chain. Need hierarchy. Improving employee motivation. Communication: Meaning and importance of effective communication, communication process, formal and informal communication. Controlling: Nature and purpose of controlling, steps in controlling/process of controlling, types of controls, requirement of effective controls.
Unit-VIII	Management Information System (MIS): Definition, elements and importance of MIS, manager, management and information, changing MIS environment, managing and controlling the MIS function. New Trends in Management.

Books Recommended

Text Books& Reference Books	1.	George, R., Terry, Irwin, “Principles of Management”, (1974).
	2.	Tara Chand, “Industrial Organization and Management”, Nem Chand & Brothers, (1973).
	3.	Shukla , M.C., “Business Organization Management 3rd Edition”, S. Chand(1967).
	4.	Dean, J. “Management Economics” Prentice-Hall of India Pvt. Ltd., New Delhi (1976).
	5.	“Principles of Management (Ascent Series)” Tata McGraw-Hill (2004).

Numerical Methods (MAT-310)

Subject: Numerical Methods (MAT-310)	Year & Semester: B.Tech Chemical Engineering 3rd Year & 5th Semester		**Total Course Credit: 4**		
			L	T	P
			4	0	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective: The objective is to make the students aware of the numerical methods for the solution of scienceand engineering related problems which cannot be solved analytically.

Course outcomes (COs)

CO1	Acquire fundamental understanding with respect to error estimation and solving algebraic and transcendental equations, and ordinary differential equations with the help of numerical techniques.
CO2	Exhibiting knowledge for solution of simultaneous linear algebraic equations.
CO3	Fundamental knowledge for construction of interpolating polynomial and finding intermediate values.
CO4	Applying the knowledge of numerical methods for solution of chemical engineering based problems

Details of the Syllabus

Unit-I	**Errors in Numerical Calculations** Floating- point form of numbers, Round-off, Algorithm, Stability, Programming errors, Errors of Numerical Results, Error propagation, Basic error principle, Loss of significant digits.
Unit-II	**Numerical Solution of Algebraic and Transcendental Equations** Bolzano's bisection method, iteration method, Regula-Falsi method, Newton-Raphson method, Numerical Solution for system of equations.
Unit-III	**Solution of Simultaneous Linear Algebraic Equations** Gauss elimination method, Gauss-Jordan method, Computation of Inverse by Gauss's Method, LU decomposition, Gauss-Siedel iteration method, Jacobi method, The Eigen value problem.
Unit-IV	**Finite Differences and Interpolation** interpolation Forward, Backward and Shift operators, Central differences, their relations . Existence, Uniqueness of interpolating polynomial, error of interpolation - unequally spaced data; Lagrange's formula, Newton's divided difference formula.

	Equally spaced data : finite difference operators and their properties, , Newton's forward and backward interpolation formulae, Gauss's forward and backward.
Unit-V	**Numerical Differentiation and Integration** Numerical differentiation using difference techniques, Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rule, Truncation error, Romberg's method.
Unit-VI	**Numerical Solution of Ordinary Differential Equations** Picard's method, Taylor series method, Euler and modified Euler method, Runge-Kutta method of 4th order, Predictor-Corrector methods (Adam's-Moulton method & Milne's method.
Unit-VII	**Application of Numerical Methods in Chemical Engineering** Numerical treatment of chemical reaction kinetics, Transport processes, Numerical methods for solving problems arising in heat and mass transfer.

Books Recommended

Text Books	1.	Numerical Methods for Scientists and Engineering M.K. Jain, S. R. Iyengar& R.K. Jain, Wiley Eastern Ltd New age international publishers, 7th Edition, 2019, ISBN: 9789387477254, 9387477258..
	2.	Introductory methods in Numerical Analysis, S.S. Sastry, 5th Edition, Prentice Hall India learning Pvt Ltd, ISBN: 9788120345928, 9788120345928.
	3.	Elementary Numerical Analysis, Kendall E. Atkinson, Han , 3rd Edition, 2006, Wiley India Pvt Ltd, ISBN-13: 978-9754142747
Reference Books	1. 2.	S. D. Conte and C. de Boor, Elementary Numerical Analysis An algorithmic approach, McGraw-Hill, 1980, **ISBN-13:** 978-0070124479. Mathematical Numerical Analysis J.B. Scarborough, Oxford and IBH Publishers, 6th Edition, 2020, ISBN: 9788120417595, 9788120417595
	3.	Numerical Methods for Mathematics, Sciences and Engg. J. H. Mathews, Publishers: Prentice hall college division, 2nd Edition, 1992, ISBN: 9789387477254, 9387477258.

Subject: Heat Transfer Lab. (CEL-311)	**Year & Semester: B.Tech Chemical Engineering 3rd Year & 5th Semester**	**Total Course Credit: 1**		
		L	T	P
		0	0	2
Evaluation Policy*	Total Marks (100)			

Heat Transfer Lab (CEL-311)

**Based on written examination and viva-voce. External examiner from the department to be nominated by H.O.D.*

Course Objective: Purpose of the course is to provide basic understanding of various modes of heat transfer operations, the equipments used for, and their applications.

Course outcomes (COs)

CO1	Acquiring knowledge about estimation and measurement of physical parameters, such as thermal conductivity, heat transfer coefficients and emissivity in various heat transfer systems.
CO2	Generation and analysis of the data with respect to the physical parameters and their applications in design.

List of Experiments

S.No	Experiment
1.	Study of heat transfer by natural convection.
2.	Study of heat transfer by forced convection.
3.	Study of heat transfer in filmwise and dropwise condensation.
4.	Study of heat transfer through a multiple composite wall.
5.	Emissivity measurement of a gray body.
6.	Study of finned tube heat exchanger.
7.	Study of shell and tube heat exchanger.

Books Recommended

1.	McCabe, W.L., Smith, J.C., "Unit Operation of Chemical Engineering", 7thEdn., McGraw-Hill (2011).
2.	Holman, J.P., " Heat Transfer", 10thEdn., McGraw-Hill (2009)
3.	Bergman, T.L., Lavine, A.S., Incropera, F.P., DeWitt, D.P., "Introduction to Heat Transfer", 6thEdn., Wiley (2011).
4.	Kreith, F., Manglik, R.M., Bohn, M., "Principles of Heat Transfer", 7thEdn.,Cengage Learning (2010).
5.	Hewitt, G.F., Shires, G.L., Bott, T.R., "Process Heat Transfer", Begell House (1995).

Computer Simulation Lab (CEL-312)

Subject: Computer Simulation Lab (Code: CEL312)	**Year & Semester: B.Tech Chemical Engineering 3rd Year & 5thSemester**	**Total Course Credit: 1**		
		L	T	P
		0	0	2
Evaluation Policy*	Total (100 Marks)			

**Based on written examination and viva-voce. External examiner from the department to be nominated by H.O.D.*

Course Objective: The objective of the laboratory is to encourage the students to use **Software's pertaining to Chemical Engineering stream.**

Course outcomes (COs): At the end of the course, student will be able to:

CO1.	Understand the basics of some software/s.
CO2.	Model development of the chemical engineering process systems.
CO3.	Perform the simulation of individual equipments.
CO4.	Simulation of Flow Sheets

Details of the Syllabus

A basic background in Numerical Methods and Chemical Engineering is expected, though all the key concepts required for the lab will be reviewed during the course of the semester. Basics of software, key computational techniques relevant to software and use them for simulation and analysis, Simulation of individual equipments and Simulation of flow sheets, Simulation of case studies related to chemical engineering applications.

Books Recommended

1.	Nayef Ghasem, "Modeling and Simulation of Chemical Process Systems", CRC Press, Taylor & Francis Group (2019).
2.	Amiya K Jana, "Chemical Process Modelling and Computer Simulation", 2nd Edition, PHI Learning Private Limited, (2011).
3.	http://courses.washington.edu/overney/ChemE435.html.

<table>
<tr><td rowspan="3">Subject: Process Equipment Design-II (CET-355)</td><td rowspan="3">Year & Semester: B.Tech. Chemical Engineering 3rd year &6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term (30 Marks)</td><td>Class Assessment (10 Marks)</td><td colspan="3">Final-Term (60 Marks)</td></tr>
</table>

Process Equipment Design-II (CET-355)

Course Objective

The main purpose of the course is to enable the students to acquire fundamental knowledge with respect to the design and selection of process equipments.

Course Outcomes (COs)

CO1	Acquire basic understanding about the process equipments based on heat and mass transfer operations.
CO2	Exhibit knowledge with respect to design of Process equipments.
CO3	Selection of equipments for various applications.

Details of the Syllabus

Unit-I	Shell-Tube Heat Exchangers: Basic design procedure of heat transfer equipment, overall heat transfer coefficient and fouling factors, shell & tube heat exchangers – construction details, selection algorithm, design codes, mean temperature difference, general design considerations, tube-side heat transfer coefficient and pressure drop, shell-side heat transfer coefficient and pressure drop, various design methods, CAD of shell & tube heat exchangers, mechanical and fabricational aspects. Drawing of heat exchangers.
Unit-II	Condensers: Design of condensers for single vapors, heat transfer coefficient correlations for condensation inside and outside of tubes of the vertical and horizontal condensers, design of desuperheater-cum-condenser and condenser-cum-sub-cooler, condensation of mixtures, pressure drop in condensers.
Unit-III	Reboilers, Vaporizers and Evaporators: Pool boiling, convective boiling, selection of reboilers, & vaporizers, design of reboilers, vaporizers and evaporators, drawing of evaporators

Unit-IV	Distillation Column: Basic design consideration of distillation column, degree of freedom analysis, various design methods of distillation column, general design consideration of multicomponent distillation, plate efficiency, tray hydraulics of sieve and valve – trays. Drawing of distillation column
Unit-V	Packed Columns: Type of packing, packed bed height, column diameter, column internals, design methods, Design of liquid-liquid extraction equipment.
Unit-VI	Miscellaneous Equipment: Design of Crystalizers, Agitated vessels and selection of agitators, design of gas-liquid separators and mixing equipment.

Books Recommended

Text Books	1.	Brownell, L. E., Young, H. E., "Process Equipment Design", John Wiley (2004). 4. 6.
	2.	Bhattacharya, B. C., "Introduction of Chemical Equipment Design", CBS Publisher (2003).
	3.	I.S.:2825-1969, "Code for Unfired Pressure Vessels", (1969).
	4.	I.S.:803-1974, "Code of Practice for Design, Fabrication and Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks", (1984).
Reference Books	1.	Moss, D. R., "Pressure Vessel Design Manual", 3rd Edn., Gulf (2004).
	2.	Megyesy, E. F., "Pressure Vessel Handbook", 12th Edn., Pressure Vessel Publishing (2001

Mass Transfer-II (CET-356)

<table>
<tr><td rowspan="2">Subject: Mass Transfer-II (CET-356)</td><td colspan="2" rowspan="2">Year & Semester: B.Tech Chemical Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L
3</td><td>T
1</td><td>P
0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term
(30 Marks)</td><td>Class Assessment
(10 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Objective

The aim of the course is toenable the students to understand the fundamentals of mass transfer operations, such as distillation, extraction, adsorption and leaching along with their commercial significance and applications.

Course Outcomes (COs)

CO1	Exhibit knowledge about various types and aspects of distillation operations which are commercially important.
CO2	Acquiring basic understanding with respect to extraction, adsorption and leaching operations and their applications.

Details of the Syllabus

Unit-I	**Distillation: V**apour-liquid equilibria for ideal and non-ideal systems. Relative volatility. Azeotropes, enthalpy-concentration diagrams. Single stage flash vaporisation. Partial condensation. Differential distillation for binary systems. Fractionation, McCabe-Thiele and Ponchen-Savarit methods for multistage operations. Reflux, reflux ratio and optimum reflux ratio. Reboilers. Total and partial condensers. Tray efficiencies. Azeotropic, extractive and steam distillations.
Unit-II	**Extraction:** Ternary liquid equilibria, calculation of single stage, multistage cocurrent and multistage counter current operations.
Unit-III	**Adsorption:** Adsorption equilibria, calculations for vapour, gas and liquid adsorptions. Adsorption operations such as single stage, multi stage, cocurrent and multistage counter current operations. Equipments.
Unit-IV	**Leaching:** Principles. Equilibria, Calculations of single stage and multistage leaching processes equipment.

Books Recommended

	1.	Treybal, R.E., “Mass Transfer Operations” 3rd Edn., McGraw-Hill Book Company (1980).

Text Books & Reference Books	2.	McCabe, W.L., Smith, J.C., Harriott, P., "Unit Operations of Chemical Engineering", 7thEdn., McGraw-Hill Book Company (2011).
	3.	Basmadjian, D., "Mass Transfer and Separation Processes: Principles and Applications", CRC Press (2007).
	4.	Foust, A. S., Wenzel, L. A., Clump, C. W., Maus, L., Andersen, L. B., "Principles of Unit Operations", 2nd Edn., Wiley-India (2008).

Chemical Technology-II (CET-357)

Chemical Technology-II (CET-357)	Year & Semester: B.Tech. Chemical Engineering 3rd year & 6th Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective

To study process technology, availability of raw materials, production trends, preparation of flow sheets, engineering and environmental problems of various chemical industries.

Course Outcomes (COs)

CO1	Understanding of processes used by chemical process industries for production of various products.
CO2	Application of process flow diagram by the chemical process industries.
CO3	Ability to deal with apparatus, unit operations, and chemical economics.

Details of the Syllabus

Unit-I	Coal and Coal Tars: Cola chemicals, law temperature and high temperature carbonization, chemicals from coal tar.
Unit-II	Sugar and Starch: Manufacture of raw sugar crystals from sugar cane, refining operations, manufacture of starch from various materials, starch derivatives, manufacture of glucose. Leather and Gelatin: Preparation of hides, vegetable and chrome tanning, finishing operations, manufacture of gelatin from its raw materials, uses. Glues and adhesives-types and their manufacture.
Unit-III	Pulp & Paper: Sulphite and Kraft processes for manufacture of paper.
Unit-IV	Oils, fats, soaps and detergents: Classification of vegetable oils and fats, production of edible oil and fats, purification, hydrogenation of oils, classification of cleaning compounds and their uses, methods for the production of soaps and detergents.

Unit-V	Man Made Fibres: Classification, cellulosic products. Viscose Rayons, their uses and manufacture. Polyamides-66-nylon, chemical process and method of production. Polyester (Dacron miller), its manufacturing process. Synthetic Plastics: Methods of polymerization, phenol formaldehyde, urea formaldehyde, polyethylene and polyvinylchloride their uses and methods of production. Natural and Synthetic Rubbers: Natural rubber and its processing. Butadiene-styrene polymer, its methods of production. Polychloroprene and its manufacture.
Unit-VI	Dyestuffs: A general study of dye stuffs with reference to their classification based on chemical structure & on its application, azo and vat dyes.
Unit-VII	Petroleum and Petrochemicals: Occurrence, refinery, practice, chemical refining, ethylene, acetylene, synthesis gas, butadiene, their uses and methods of production.

Books Recommended

Text Books	1.	Rao, M.G., Sittig, M., "Dryden's Outlines of Chemical Technology- for the 21stCentury.East-West Press (1997).
	2.	Austin, G.T., "Shreve's Chemical Process Industries", McGraw-Hill Book Company (1984).
	3.	Kent, J.A., "Riegel's Handbook of Industrial Chemistry," CBS Publishers (1997).
Reference Books	1.	Pandey, A., "Concise Encyclopaedia of Bioresource Technology", CRC Press (2004).
	2.	Mall I. D., "Petrochemical Process Technology", Macmillan India Ltd., New Delhi (2007).
	3.	Moulijn, J. K., Makkee, M., Van Diepen, A., "Chemical Process Technology", Wiley (2001).

Subject: Energy Technology (CET-358)	Year & Semester: B.Tech. Chemical Engineering 3rd year &6th Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Energy Technology (CET-358)

Course Objective:

The aim of this course is to provide the fundamental knowledge regarding the utilization and characteristics of various energy resources available (natural or transformed) which usually pertain to Chemical Engineering field.

Course Outcomes (COs):

CO1	Exposure todifferent types of energy resources available.
CO2	Acquire knowledge of different types of nonconventional sources of energy.
CO3	Learn the fuel and flue gas calculations.
CO4	Exposure to design of combustion equipment and energy audit.

Details of the Syllabus:

Unit-I	Survey of different sources of energy and their utilization. Natural fuels-coal, petroleum, processed fuels, coke, water gas, producer gas, refinery gas-LPG,
Unit-II	Non-conventional sources of energy: Introduction to geothermal energy, wind energy, solar energy,nuclear energy, Biogas/Gobar Gas. Harnessing of energy from biomass and its transformed forms.
Unit-III	Combustion calculation of coal and petroleum fractions.
Unit-IV	Design of burner, stackers and furnaces. Recovery of waste heat from chemical and metallurgical processes, selection of suitable energy sources.
Unit-V	Energy audit and management- Role of Energy Managers in Industries – Energy monitoring, auditing &targeting – Economics of various Energy Conservation schemes.

Books Recommended

Text Books	1.	Sarkar, S. "*Fuel and Combustion*" (2000).
	2.	Griswold, J. , "Fuels, Combustion and Furnaces"
	3.	Larry C Whitetal, "*Industrial Energy Management & Utilization*".
	4.	Himus, G.W., "*The Elements of Fuel Technology*"
Reference Books	1.	Duffia , Beckman "*Solar Energy-Thermal Processes*" .
	2.	Beredict, M., Pigford, T.M., "*Nuclear Chemical Engineering*".
	3.	KhadiGrammodyog Commission Report on "*Gobar Gas Plant*".
	4.	S. Van Loo, "*Handbook of Biomass Combustion and Co-Firing*" ,Twente University Press, 2002.

Chemical Process Safety (CET-359)

Subject: Chemical Process Safety (CET-359)	Year & Semester: B.Tech Chemical Engineering 3nd Year &6thSemester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term (30 Marks)	Continuous Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objectives

The objective is to impart knowledge about the importance of safety and evaluate suitable strategies for risk mitigation with the help of basic understanding of physical, chemical and physico-chemical transformations of the materials in process industries with respect to safety.

Course Outcomes (COs): Upon successful completion of the course, students must be able to:

CO1	Exhibit understanding about anticipation, recognition, investigation and evaluation of thehazardous conditions and practices which affect the masses, their properties and the environment.
CO2	Develop and evaluate appropriate strategies designed to mitigate risk by understanding the importance of plant safety and safety regulations, different types of plant hazards and their measurement, control, principles and procedures of safety audit.
CO3	Appreciate the importance of physical, chemical and physico-chemical transformations of the material in process industries with respect to safety.
CO4	Analyze the hazards and assess therisk and undertake appropriate preventive steps to address the need of safety.

Details of the Syllabus

Unit-I	**Introduction:**Introduction, safety program, engineering ethics, concept of loss prevention, acceptable risks, accident and loss statistics, nature of accident process, inherent safety, accident investigations-case histories.
Unit-II	**Toxicology:**UN and other classification of chemicals, toxicants entry route, acute and chronic exposure effects, Dose versus response, models for dose and response curves, TLV and PEL. **Industrial Hygiene:** Identification, Material safety data sheets, Industrial hygiene evaluation and control
Unit-III	**Basics of Fires and Explosion:** Fire triangle, definitions, flammability characteristics of liquid and vapours, LOC and inerting, types of explosions, Designs for fire prevention.
Unit-IV	**Hazard Identification:**Work permit systems, color coding of chemical pipe lines, HAZCHEM Code, Hazard survey, checklist, HAZOP, safety reviews, what if analysis
Unit-V	**Risk Assessment:** Probability theory, event tree, fault tree, QRA and LOPA, Dow's fire and explosion index, Mond's index, Dow's Chemical release model.

Books Recommended

Text Book	1.	Crowl, D.A., Louvar, J.F., "Chemical Process Safety: Fundamentals with Applications", Prentice Hall (2011).
Reference Books	1.	Coulson, Richardson &Sinnott R.K., " Chemical Engineering Volume-6, An Introduction to Chemical Engineering Design", Elsevier Butterworth Heinemann (2005).
	2.	Dow Chemical Company, Dow's Chemical Exposure Index Guide (1993).
	3.	Lees, F. P., "Loss Prevention in Process Industries", Butterworth, London (1996).
	4.	Wells, G. L., "Safety in Process Plant Design", George Godwin Ltd., New York (1980).

Transport Phenomena (CET-360)

Subject: Transport Phenomena (CET-360)	Year & Semester: B.Tech Chemical Engineering 3rd Year & 5th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective:
The aim of this course is to provide the basic understanding of various Transport Processes, Momentum, Mass and Heat.

Course Outcomes (COs):

CO1	To understand Newton's Law of Viscosity (Molecular Momentum) and use vectors /tensors for analysis of same.
CO2	To study the Momentum Transport.
CO3	To study the Energy Transport.
CO4	To study the Mass Transport.

Details of the Syllabus:

Unit-I	Introduction of Transport phenomena. Newton's Law of Viscosity (Molecular Momentum) Transport) Momentum Flux. Generalization of Newton's Law of Viscosity. Vector and Tensor calculations.
Unit-II	Shell Momentum Balances and VelocityDistributions in Laminar Flow The Equations of Change forIsothermal Systems The Equation of Continuity Normal Stresses at Solid Surfaces forIncompressible Newtonian Fluids The Equation of Motion The Bernoulli Equation for the Steady sate case Use of the Equations of Change to Solve Flow of Various typical cases.
Unit-III	Shell Energy Balances andTemperature Distributions. Heat Conduction in various typical cases like a Nuclear HeatSource , Viscous HeatSource , Chemical Heat source and through CompositeWalls etc.
Unit-IV	Mass Transport Diffusivity and the Mechanisms ofMass Transport Molecular Mass Transport Temperature and Pressure Dependence of Diffusivities Mass and Molar Transport by Convection Mass and Molar Fluxes

Subject: Energy TechnologyLab. (CEL-361)	Year & Semester: B.Tech. Chemical Engineering 3rd year &6th Semester	Total Course Credit: 1		
		L	T	P
		0	0	2
Evaluation Policy*	Total Marks (100)			

	Concentration Distributions in Solids and Laminar Flow Shell Mass Balances of some selected cases.

Books Recommended

Text Books	1.	Bi Bird, R.B., Stewart, W.D., Lightfoot, E.W., "*Transport Phenomena*", 2nd Edn., JohnWiley & Sons (2002).
Reference Books	1.	Deen, W. M., "*Analysis of Transport Phenomena*", Oxford University Press (1998).
	2.	Brodkey R. S. and Hershey H. C., "*Basic Concepts of Transport Phenomena*", Vol. 1 and 2, Brodkey Publishing (2001).

Energy Technology Lab. (CEL-361)

**Based on written examination and viva-voce. External examiner from the department to be nominated by H.O.D.*

Objective:

The aim of this laboratory is to perform various experiments pertaining to solid and liquid fuels and their characteristics.

Outcomes (COs):

CO1	Exposure todifferent types of energy resources.
CO2	Analyze the Proximate analyses parameters of fuels.
CO3	Characterize the various liquid and solid fuels.

Details of the Experiments:

Experiments	1: To determine the Proximate analysis Parameters of coal and other solid fuels. 2. Determination of calorific value of solid fuels. 3. Test for cloud and pour point of petroleum products. 4. Determination of flash point, fire point and specific gravity of petroleum products. 5. To find the Smoke point of a liquid fuel. 6. To study the briquetting/pelletization of biomass.

Books Recommended

Text Books	1.	Sarkar, S. "*Fuel and Combustion*" (2000).
	2.	Griswold, J. , "Fuels, Combustion and Furnaces"
	3.	S. Van Loo, "*Handbook of Biomass Combustion and Co-Firing*" ,Twente University Press, 2002.

Thermodynamics and Reaction Engineering Lab (CEL-362)

Subject: Thermodynamics and Reaction Eng. Lab. (CEL-362)	Year & Semester: B.Tech Chemical Engineering 3rd Year & 6th Semester	Total Course Credit: 1		
		L	T	P
		0	0	2
Evaluation Policy*	Total Marks (100)			

**Based on written examination and viva-voce. External examiner from the department to be nominated by H.O.D.*

Course Objective

To provide experience on analysis of reaction engineering

Course Outcomes (COs): At the end of the laboratory course, student will be able to:

CO1	The students could independently calculate the reaction kinetics of various reactors used for manufacturing of chemicals in industries.
CO2	Characterize laboratory reactors through residence time distributions.

List of Experiments

Experiment No. 1: Standardization of the given solution of NaOH.

Aim: To determine the normality of NaOH solution

Experiment No. 2: Plug flow reactor

Aim: To determine the second order reaction rate constant for saponification reaction between NaOH and ethyl acetate in a plug flow reactor

Experiment No. 3: RTD study in CSTR

Aim: (a) To plot the RTD curve for a CSTR using a pulse input as a tracer

(b) To determine the dispersion number

Experiment No. 4: Isothermal batch reactor

Aim: To determine the pseudo first order reaction rate constant for the saponification reaction between NaOH and $CH_3COOC_2H_5$ in a constant volume adiabatic batch reactor

Experiment No. 5: Adiabatic batch reactor

Aim: To determine the pseudo first order reaction rate constant for the saponification reaction between NaOH and $CH_3COOC_2H_5$ in a constant volume adiabatic batch reactor

Experiment No. 6: Continuous Stirred Tank Reactor (CSTR)

Aim: To study of a non-catalytic homogeneous second order liquid phase reaction in a CSTR under ambient conditions.

Experiment No. 7: RTD study in Packed Bed Reactor (PBR)

Aim: (a) To plot the RTD curve for a PBR, using a pulse input as a tracer

(b) To determine the dispersion number

Books Recommended

Text Books	1.	Levenspiel, O., "Chemical Reaction Engineering", 3 rdEdn., John Wiley & Amp;Sons, New York (1998).
	2.	Fogler, H.S., "Elements of Chemical Reaction Engineering", 4 thEdn. Prentice-Hall of India Pvt. Ltd. (1995).
	3.	Smith, J.M., "Chemical Engineering Kinetics", 2 ndEdn., McGraw-Hill Book Company, New York (1981).

Industrial Training & Presentation (Code: CEI-363)

<table>
<tr><td rowspan="3">Subject: Industrial Training & Presentation (Code: CEI-363)</td><td rowspan="3">Year & Semester: B.Tech Chemical Engineering 3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 2</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Evaluation Policy*</td><td colspan="4">Total Marks
(100 Marks)</td></tr>
</table>

**Based on presentations by each of the student before a panel of examiners nominated by H.O.D with due weightage to report submitted.*

Course Objective:
To gain practical experience in Industry or research organization.

Course Outcomes (COs): At the end of the course, student will be able to:

CO1	Correlate class room learning to real industrial applications.
CO2	Development of written and oral communication skills.
CO3	Ability to be a multi-skilled engineer with good practical knowledge.
CO4	Development of management, leadership and entrepreneurship skill.

7th Semester

Pre-Project work (CEP-413)

Subject: Pre-Project work (CEP-413)	Year & Semester: B.Tech. Chemical Engineering 4th Year &7thSemester	Total Course Credit: 2		
		L	T	P
		0	0	4
Evaluation Policy*	Total Marks (100)			

**Based on presentations by each of the student before a panel of examiners nominated by H.O.D with due weightage to Supervisor evaluation and final report submitted.*

Course Objective

This course enables the students to get first-hand experience acquainting with principles and applications of chemical engineering by analysing as well as solving problems concerning industries, research etc.

Course outcomes (COs):

CO1	Acquaint students with research methodology.
CO2	Enable students to correlate class mode learning to real industrial as well as research applications
CO3	Understand the literature and previous studies concerning the problem
CO4	Learn technical report writing and enhance the communications skills.

Note: This is prerequisite for completion of the seventh semester along with other subjects. There is no course content fixed. Collection of information, survey of literature and procurement of materials including chemicals are in scope. Objective of the pre-project work is decided, how the project work would be carried out in the eighth semester, same is finalized at this stage. The same project may be continued for the eighth semester. This includes report writing for pre-project work, presentation of the work done followed by viva-voce examination by the examiner (preferably external).

Seminar (CES-414)

<table>
<tr><td rowspan="3">Subject: Seminar (CES-414)</td><td rowspan="3">Year & Semester: B.Tech. Chemical Engineering 4th year & 7th Semester</td><td colspan="3">Total Course Credit: 2</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Evaluation Policy*</td><td colspan="4">Total Marks
(100)</td></tr>
</table>

**Based on presentations by each of the student before a panel of examiners nominated by H.O.D with due weightage to report submitted.*

Course Objective

To nurture skills in writing and communication of technical papers amongst the students so as to become effective engineering professionals.

Course Outcomes (COs)

CO1	Carry out up to date and effective literature study upon a selected topic.
CO2	Report writing and submission under the guidance of a faculty member of the Department.
CO3	Enhancement in communication skills through seminar presentation.

Details of the Syllabus

Each student in batch will be assigned a topic pertaining to Chemical Engineering field. He /she will carry out up-to-date literature survey regarding the topic under guidance of a faculty member. Evaluation will be carried out towards end of semester by a committee of faculty members nominated by the HOD. The evaluation will be based on

i) Report writing (format and originality)

ii) Presentation skill

iii) Understanding and solution of problem/topic assigned.

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Process Dynamics & Control (CET-415)

<table>
<tr><td rowspan="3">Subject: Process Dynamics & Control (CET-415)</td><td colspan="2" rowspan="3">Year & Semester: B.Tech Chemical Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term
(30 Marks)</td><td>Class Assessment
(10 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Objective:

The aim of this course is to provide the basic understanding of process control;its elements, various order processes and their behaviour towards different inputs/disturbances.

Course Outcomes (COs):

CO1	To understand and introduce the control problem.
CO2	To study the dynamics of a First order system.
CO3	To study the dynamics of a Second order system.
CO4	To study the dynamics of various controllers.

Details of the Syllabus:

Unit-I	Introductory concepts of process control. The chemical process industrial perspective of a typical process control problem, variables of a process. Use of Laplace transformation in control systems.
Unit-II	Feed forward, feedback systems, block diagrams. Linear open loop system transfer function. Derivation of Transfer function and study of transient response of a *First Order* system towards different inputs.
Unit-III	Study of 1st order systems in series. Transfer function and Study of transient response and of *2nd order* system. Study of parameters of *2nd order* under damped response.
Unit-IV	Components of control system. Negative versus positive feedback. Study and behavior of different controllers like Proportional controller, PD Controller, PID Controller.
Unit-V	Derivation of Closed loop transfer functions for physical systems. Transient response of simple control systems for Servo and Regulatory case. Stability criterion, Routh test.

Books Recommended

<table>
<tr><td rowspan="2">Text Books</td><td>1.</td><td>Coughanowr, D.R., LeBlanc, S., “Process System Analysis and Control”, 3rd Edn., McGraw-Hill (2017).</td></tr>
<tr><td>2.</td><td>Stephanopoulos G. “Chemical Process Control – An Introduction to Theory and Practice”, Prentice-Hall of India (2015)</td></tr>
<tr><td>Reference Books</td><td>1.</td><td>Carlos A. Smith, Armando B. Corripio “Principles and Practices of Automatic Process Control (latest edition).</td></tr>
</table>

Process Economics & Plant Design (CET-416)

Subject: Process Economics & Plant Design (CET-416)	Year & Semester: B.Tech Chemical Engineering 4th Year & 7th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective
The objective of the course is to provide basic concepts in engineering economics, plant design, safety features and its importance for chemical engineering.

Course Outcomes (COs): At the end of the course, student will be able to:

CO1	Understand the role of economics in process plant design.
CO2	Exhibit knowledge in design optimization, depreciation and cost estimation.
CO3	Understand the application of various project management techniques.
CO4	Know about the replacement and maintenance analysis.

Details of the Syllabus:

Unit-I	**Time Value of Money**: Interest; Compounding and Discounting Factors; Loan Payments; Cash Flow Pattern: Discrete Cash Flow, Continuous Cash Flow. **Methods for Calculating Profitability**: Methods that do not consider the time value of money; Methods that consider the time value of money; Alternative Investments by Different Profitability Methods; Effect of Inflation on Profitability Analysis; Methods of Profitability Evaluation for Replacements.
Unit-II	**Depreciation**: Straight Line, Declining Balance, Double Declining Balance, sum-of-the years-digit, Sinking Fund. **Analysis of Cost Estimates:** Factors Affecting Investment and Production Costs; Capital Investment; Types of Capital Cost Estimates; Methods for Estimating Capital Investment; Estimation of Revenue; Estimation of Total Product Cost; Gross Profit; Net Profit and Cash Flow; Contingencies.
Unit-III	**Optimum Design and Design Strategy:** Procedure with one, two and more variables; Optimum Production Rates in Plant Operation; Case Studies; Linear Programming: Simplex Algorithm, Dynamic Programming for Optimization; Application of Lagrange Multipliers; Method of Steepest Ascent or Descent.

Unit-IV	**Plant Location and Layout**: Factors for Selection of Plant Location; Site Selection and Preparation; Plant Layout and Installation. **Scale-Up:** Pilot Plants and Models; Principle of Similarity; Dimensional Analysis; Empirical and Semi-empirical Model Building; Regime Concept: Static Regime, Dynamic Regime; Similarity Criteria and Scale Equations for Important Equipments.

Books Recommended

1.	Peters, M. S., Timmerhaus, K. D. and West, R. E., "Plant Design and Economics for Chemical Engineers", McGraw Hill, (2002).
2.	Towler, G., Sinnott, R. K., "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design", Butterworth-Heinemann, (2012).
3.	Couper, J. R., "Process Engineering Economics (Chemical Industries)", CRC Press, (2003).
4.	Zlokarnik, M., "Scale-up in Chemical Engineering", Wiley-VCH, (2006).
5.	Silla H., "Chemical Process Engineering: Design and Economics”, Marcel Dekker (2003).

Biochemical Engineering (CET-417)

<table>
<tr><td rowspan="3">Subject: Biochemical Engineering (CET-417)</td><td colspan="2" rowspan="3">Year & Semester: B.Tech. Chemical Engineering 4th year & 7th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term (30 Marks)</td><td>Class Assessment (10 Marks)</td><td colspan="3">Final-Term (60 Marks)</td></tr>
</table>

Course Objective: The objective ofthecourse is to provide basic understanding of biochemistry and microbiology, and their applications to analysis and design of the biological systems with the help of chemical engineering principles.

Course Outcomes (COs)

CO1.	Fundamental understanding of the subject based on various conversion routes.
CO2.	Acquire basic knowledge of microbiology and biochemistry.
CO3.	Exhibit knowledge for analysis of the bioprocess and the unit operations used.
CO4.	Able to analyze the data and their application for bioprocess development.

Details of the Syllabus

Unit-I	Evolution of modern biochemical processes. Role of biochemical engineer in the development of modern fermentation processes. Status of biochem. eng. in the fermentation industry.
Unit-II	Types of Microorganism: Bacteria, fungi, viruses, algae, protozoa. Cell types and structure (Eucaryotic and Procaryotic).
Unit-III	Chemicals of Life: Carbohydrates, fats, proteins, RNA and DNA (structure, uses and functions). Understanding Enzymes: Naming and classification, specificity of enzyme action, active cites, factors affecting enzyme-catalyzed reactions. Kinetics of enzyme-catalysed reactions (Michaelis-Menten equation and Lineweaver Burk Plot).
Unit-IV	Sterilization. Aerobic and anaerobic fermentation. Requirement for growth and media formation. Growth cycle phases for batch cultivation. Parameters of growth and analysis of growth data. Growth kinetics. Aeration and agitation. Scale-up. Bio-reactors. Bioseparation processes.

Books Recommended

Text Books	**1.**	Shijie, L., "Bioprocess Engineering-Kinetics, Sustainability and Reactor Design", 2nd Edn., Elsevier (2017).
	2.	Shuler, M., Kargi, F., “Bioprocess Engineering, Basic Concep”, 2nd Edn.,Prentice Hall of India Pvt. Ltd. (2004).

	3.	Bailey, J. E., Ollis, D. F., “Biochemical Engg. Fundamentals”, 2nd Edn., McGraw-Hill Book Company, New York (1985).
	4.	Paul A. Belter, E.L. Cussler, Wei-Shou Hu, "Bioseparations, Downstream Processing for Biotechnology", 2nd Edn., Wiley-India (1988).
Reference Books	1.	Pelczar, M.J., Chan, E.C.S., Krieg, N.R., “Microbiology”, 5th Edn. McGraw-Hill Book Company (1986).
	2.	Fairley, J .L.,Kilgour, G. L., “Essentials of Biological Chemistry”, 2nd Edn., Van Nestrond Reinhold Publishing Corporation (1966).
	3.	Palmer, T., “Understanding Enzymes”. Ellis Horwood Limited, Halsted Press, a division of John Wiley & Sons (1985).
	4.	Pirt, S.J., "Principles of Microbe and Cell Cultivation", 1stEdn., Blackwell Scientific Publications, 1975
	5.	McCabe, W., Smith, J. and Harriott, P., "Unit Operations of Chemical Engineering", 7thEdn.McGraw-Hill (2017).

Process Dynamics & Control Lab (CEL-418)

<table>
<tr><td rowspan="3">Subject: Process Dynamics & Control Laboratory (CEL-418)</td><td rowspan="3">Year & Semester: B.Tech Chemical Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy*</td><td colspan="4">Total Marks
(100)</td></tr>
</table>

**Based on written examination and viva-voce. External examiner from the department to be nominated by H.O.D.*

Objective

The purpose of the course is to impart practical understanding about the dynamic behaviour of the control systems and evaluate the responses with respect to the first and higher order systems.

Outcomes (COs): At the end of the laboratory course, student will be able to:

CO1	Estimate the dynamic behavior of the control systems
CO2	Understand the controllability, speed of response of the control systems.
CO3	Tuning of a PID control via manual and automatic tuning.
CO4	Choose PID modes that effect controllability, speed of response the control systems.

List of Experiments:

1. **Temperature Measurement**
   a) Study the different types of temperature sensor for characteristics and time constants.
   b) Study the Seebeck effect
2. **Temperature control Trainer**
   a) Study of on-off controller
   b) Study of open loop response
   c) Study of proportional controller
   d) Study of proportional integral controller
3. **Level control Trainer**
   a) Study of on-off controller
   b) Study of open loop response
   c) Study of proportional controller
   d) Study of proportional integral controller
4. **Multiprocess Control Trainer**
   a) To study the multi process control trainer for various control experiments simultaneous on a single setup.
5. **Pressure control Trainer**
   a) Study of on-off controller
   b) Study of open loop response
   c) Study of proportional integral controller
   d) Study of proportional integral controller
6. **Two tank interacting liquid level system**
   e) To study the operation of the interacting system and find its Transfer Function
7. **Two tank non interacting liquid level system**
   a) To study the operation of the non-interacting system and find its Transfer Function
8. **First order and second order system**
   a) Study of step response of thermometer
   b) Study of step response of mercury manometer

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Mass Transfer Lab (CEL-419)

<table>
<tr><td rowspan="3">Subject: Mass Transfer Lab (CEL-419)</td><td rowspan="3">Year & Semester: B. Tech Chemical Engineering
4th year 7th Semester</td><td colspan="3">Total Course Credit: 2</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Evaluation Policy*</td><td colspan="4">Total Marks
(100)</td></tr>
</table>

**Based on written examination and viva-voce. External examiner from the department to be nominated by H.O.D.*

Course Objective

The purpose of the course is to impart fundamental understanding with respect to the experimental determination of physical parameters, such as diffusivity, heat and mass transfer coefficients, and their significance in mass transfer operations, and in chemical reactions.

Course outcomes (COs): At the end of the course, student will be able to:

CO1	Acquire knowledge of basic techniques for determining gas and liquid diffusivities.
CO2	Exhibit fundamental understanding with respect to the experimental determination of heat and mass transfer coefficients using wetted wall column and cooling tower, respectively.
CO3.	Plot drying rate cure using wet solid.
CO4.	Determine gas absorption characteristics using packed tower.

Details of the Experiments:

Expt-I	To determine the mass transfer coefficient in wetted wall column
Expt-II	To determine effectiveness/efficiency and heat and mass transfer coefficient of cooling tower
Expt-III	To determine the diffusion coefficient of organic vapor in air
Expt-IV	To produce drying rate curve for wet solid being dried with air of fixed temperature and humidity
Expt-V	To determine diffusivity of ionic salt in water at different temperature
Expt-VI	To study absorption with chemical reaction in packed bed

Books Recommended

1.	Treybal, R.E., “Mass Transfer Operations” 3rd Edn., McGraw-Hill Book Company (1980).
2.	McCabe, W.L., Smith, J.C., Harriott, P., “Unit Operations of Chemical Engineering”, 7 thEdn., McGraw-Hill Book Company (2011).
3.	Basmadjian, D., “Mass Transfer and Separation Processes: Principles and Applications”, CRC Press (2007).

4.	Foust, A. S., Wenzel, L. A., Clump, C. W., Maus, L., Andersen, L. B., "Principles of Unit Operations", 2nd Edn., Wiley-India (2008).

Elective-I: Polymer Science and Engineering (CET-020)

Subject: Polymer Science and Engineering (CET-020)	Year & Semester: B.Tech. Chemical Engineering 4th Year & 7th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective

To impart knowledge about polymers, polymerization reactions and their kinetics, polymerization processes, and the mathematical understanding with respect to the rheological behavior of polymers.

Course outcomes (COs): At the end of the course, student will be able to:

CO1	Acquire knowledge about polymerization reaction and its kinetics.
CO2	Exhibit understanding with respect to estimation of molecular weight.
CO3	Get knowledge of processes about polymerization.
CO4	Conceive understanding of mathematical expressions reflecting rheological behavior of polymers.

Details of the Syllabus

Unit-I	**Chemistry of Polymerisation Reaction:** Functionality, polymerization reactions, polycondensation, addition free radical and chain polymerization, copolymerization, block and graft polymerizations, stereo specific polymerization
Unit-II	**Polymerisation Kinetics:** Kinetics of radial, chain and ionic polymerization and co-polymerisation systems.
Unit-III	**Molecular Weight Estimation:** Average molecular weight, number average and weight average, theoretical distributions, methods for the estimation of molecular weight.
Unit-IV	**Polymerisation Processes:** Bulk, solution, emulsion and suspension polymerization. Thermoplastic composites, fibre reinforcement fillers, surface treatment, reinforced thermoset composites-resins, fibers additives, fabrication methods.
Unit-V	**Rheology:** Simple rheological equations, simple linear viscoelastic models-Maxwell, Voigt, materials response time, temperature dependence of viscosity.

Books Recommended

1.	Kumar, A., Gupta, R., "Fundamentals of Polymer Engineering", CRC (2003).
2.	Fried, J., "Fundamentals of Polymer Science", Prentice Hall (2004).
3.	Williams, D.J., "Polymer Science &Engg." Prentice Hall (1971).
4.	Billmayer, Jr., W., "Textbook of Polymer Science" Wiley Tappers (1984).
5.	Rodriguez, F., "Principles of Polymer Systems", 5thEdn., CRC Press (2003).

Elective-I: Managerial Economics for Engineers (HST-021)

<table>
<tr><td rowspan="3">Subject: Managerial Economics for Engineers (HST-021)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Chemical Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term
(30 Marks)</td><td>Class Assessment
(10 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Objective

The objective is to familiarize the students with the basic understanding of managerial economics essential for engineers.

Course Outcomes (COs): At the end of the course, students will be able to:

CO1	Exhibit fundamental understanding about business economics.
CO2	Acquire knowledge of demand and supply.
CO3	Get basic concept with respect to production and cost.
CO4	Understand the market structure and monopoly.

Details of the Syllabus

Unit-I	Introduction to economics & business economics, definition of economics, branches of economics , meaning of business economics, nature, scope &objective of business economics
Unit-II	Theory of demand & supply, meaning of demand & supply, the demand & supply schedule, demand function & supply function, law of demand & supply, individual and market demand & supply, determinants of demand & supply, semand& supply curve, equilibrium with supply & demand curve, types of elasticity of demand & supply, calculating elasticity, measurement of elasticity, degree of elasticity, Consumer Equilibrium – utility analysis, consumer equilibrium – Indifference curve analysis
Unit-III	Theory of production and cost, basic concept of production, the production function, factors of production, total average & marginal product, short & long run production function, law of variable proportion, law of return to scale, law of diminishing marginal product, expansion path, concept of cost and total, marginal & average cost, short run &long run cost, relationship between marginal & average cost
Unit-IV	Market Structure: Meaning & characteristics of perfect competition, price & output determination under perfect competitive market, short run & long run equilibrium, monopoly, definition of imperfect competition , basic concept of monopoly, features

	of monopoly equilibrium under monopoly short & long run, concept of monopolistic competition, features of monopolistic competition

Books Recommended

Text Books	Paul,Koushil:"ManagerialEconomics", Cengage Learning, New Delhi,
	Vanita Agarwal: "Managerial Economics", Pearson, New Delhi, 2013.
	Dominick Salvatore: "Managerial Economics", Oxford University Press, New Delhi,2010.
	H.L. Ahuja: "Managerial Economics", S. Chand & Company Ltd, New Delhi-55.
Reference Books	1. Managerial Economics, Geetika, Piyali Ghosh, Purba Roy Choudhury
	2. Principle of Microeconomics, Gregory Mankiw, Cenagage Learning Publications
	Economics, Samuleson and Nordhaus, TMH Publishers Ltd. New Delhi

Elective-I: Advanced Separation Processes (CET-022)

<table>
<tr><td rowspan="3">Subject: Advanced Separation Processes (CET-022)</td><td colspan="2" rowspan="3">Year & Semester: B.Tech Chemical Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 0</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term
(30 Marks)</td><td>Class Assessment
(10 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Objective:
The aim of this course is to study the basic concepts of some separation processes usually not covered in other core subjects.

Course Outcomes (COs):

CO1	Introduce various traditional separation processes emphasizing the drying and crystallization processes.
CO2	To study the adsorption separation process.
CO3	To study the membrane separation processes.
CO4	To study the Ionic separations and some novel separation processes.

Details of the Syllabus:

Unit-I	Introduction: Review of conventional separation processes based on size and surface properties. (Theory and equipment used). Classification of Dryers, Dryer Selection and Design. Crystallization: Solid-Liquid Phase Equilibrium, Nucleation and Crystal Growth.
Unit-II	Separations by adsorption techniques Separation by adsorbents and foam separation.Hydro-cyclones, platecolumns, electro static precipitators.
Unit-III	Membrane separations: Types of membranes. Fundamentals of Dialysis, microfiltration, ultrafiltration, nanofiltration& reverse osmosis.
Unit-IV	Ionic separations: Electrophoresis, Dielectrophoresis, Electrodialysis .
Unit-V	Introduction to other novel techniques: Pervaporation , crystallization ,Supercritical extraction,Flash Vaporization etc.

Books Recommended

Text Books	1.	R. E. Treybal, Mass Transfer Operations, 3rd Ed., McGraw Hill, 1983
	2.	Ernest J. Henley, J. D. Seader Separation Process Principles, 2nd Edition" (2010)
	3	Baker, R.W., *Membrane technology and applications*, 2nd ed., John Wiley 2004

Elective-I: Operations Research (MAT-023)

<table>
<tr><td rowspan="3">Subject: Operations Research (MAT-023)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech. Chemical Engineering
7th Sem. and 4th year</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term
(30 Marks)</td><td>Class Assessment
(10 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Objective

This course enables the students to understand mathematical models used in Operations Research and to apply these techniques constructively to make effective business decisions.

Course Outcomes (COs): At the end of the course, student will be able to:

CO1	Identify, formulate, and solve the practical Engineering design problems by applying the optimization techniques.
CO2	Determine the schedule for transporting goods from source to destination in a way that minimizes the shipping cost.
CO3	Figure out the optimal value of the objective function besides presenting an organized strategy for evaluating a feasible region's vertices.
CO4	Determine performance of queuing situation for deciding an appropriate level of service for the facility. Utilize concepts of game theory to tackle safety management in multi-plant Chemical Industrial settings.

Details of the Syllabus:

Unit-I	**<u>Introduction to Operations Research</u>** Concepts and utility of OR in Chemical Engineering, Formulation of Linear Programming Problems, General Statement of LPP, Assumptions Underlying LP, Solution of Linear Programming Problems: Graphic Method. Some Special Cases of Graphic Method, Convex Set: Extreme points of Convex Set, Convex hull.
Unit-II	**<u>Transportation Problem- Models & Solutions</u>** Mathematical Model of Transportation Problem, Methods of finding Initial basic feasible solution by NWC Rule, LCM, VAM, Test for optimality by Stepping Stone and MODI method, Balanced and Unbalanced Transportation Problems, Degeneracy. Assignment Model: Mathematical Model of Assignment Problem, The Hungarian Method, Simplex Explanation of the Hungarian Method.
Unit-III	**<u>Simplex Techniques</u>**: LP Model in Equation Form, Transition From Graphical To Algebraic Solution, Simplex Algorithm, Artificial starting solution: Big M-Method, Two-phase Method, Special cases in Simplex Method: Degeneracy, Alternative Optima, Unbounded solution, infeasible solution.
Unit-IV	**<u>Engineering Applications</u>:**

	Queuing Theory: General Structure of Queuing System, Operating Characteristics of Queuing System, Queuing Models, Role of Poisson and Exponential Distributions, Pure Birth and Death Models, Generalized Poisson Queuing Model, Specialized Poisson Queues: Single, Multiple and Machine Serving Models. Game Theory: Introduction to Game theory, Two-person, zero-sum games.Dominance.

List of Books:

Recommended Books:	1. Linear Programming by G. Hadlay, Addison Wasley. 2. Operations Research – An Introductory by Hamidi A. Taha, Macmillan. 3. Operations Research – Methods and problems by M. Sasieni, A. Yaspam and L. Friedman, John Wily and Sons Inc. London.
References:	1.Linear Programming by S.I. Gass, Mc-Graw Hill. 2. Introduction to Operations Research. John Wiley and Sons, New York. 3. Operations Research: An Introduction. Prentice Hall of India Private Limited, New Delhi Wagner.

Elective-I: Process Heat Integration (CET-024)

Subject: Process Heat Integration (CET-024)	Year & Semester: B.Tech Chemical Engineering 4th Year & 7th Semester		**Total Course Credit: 3**		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective: Optimizing industrial processes by identifying the heat recovery potential and the optimal integration of energy conversion systems.

Course Outcomes (COs): At the end of the course, student will be able to:

CO1.	Ability to understand the fundamentals of process integration
CO2.	Ability to determine the minimum heating and cooling requirements
CO3.	Ability to design minimum energy heat exchanger networks
CO4.	Ability to understand the composite and grand composite curves

Details of the Syllabus:

Unit-I	**Process Integration and its Building Blocks:** Definition of Process Integration (PI), School of thoughts, Areas of application and Techniques available for PI, Onion diagram.
Unit-II	**Pinch Technology – An Overview:** Introduction, Basic concept, How it is different than energy auditing, Role of thermodynamic laws, Problem addressed by Pinch technology.
Unit-III	**Pinch Technology:** Data extraction, Targeting, Designing, Optimization-Supertargteing. Grid diagram, Composite curve, Problem table algorithm, Grand composite curve. **Targeting of Heat Exchanger Network (HEN):** Energy targeting, Area targeting, Number of units targeting, Shell targeting, cost targeting.
Unit-IV	**Designing of HEN:** Pinch design methods, Heuristic rules, Stream splitting, Design of maximum energy recovery (MER), Design of multiple utilities and pinches, Design for threshold problem, Loops and Paths.
Unit-V	**Heat Integration of Equipments:** Heat engine, Heat pump, Distillation column, Reactor, Evaporator, Drier, Refrigeration systems. **Heat and Power Integration:** Co-generation, Steam turbine, Gas turbine.

Books Recommended

Text and Reference Books	**1.**	Kemp I. C., "Pinch Analysis and Process Integration: A user Guide on Process Integration for the Efficient Use of Energy", Butterworth-Heinemann. (2007)
	2.	Smith R.., "Chemical Process Design and Integration", 2nd Ed., Wiley. (2005)
	3.	Shenoy U. V., "Heat Exchanger Network Synthesis", Gulf Publishing Company. (1995)

	4.	Halwagi, M. M., “Process Integration”, 7th Ed., Academic Press. (2006)

Elective-II: Cement Technology (CET-025)

Subject: Cement Technology (CET-025)	Year & Semester: B. Tech. Chemical Engineering 7th Sem. and 4th year		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective: To learn the fundamental concepts of the behavioral aspects of various materials in cement making and special concretes.

Course Outcomes (COs):

CO1	Describe the materials used to make cement and technology involved in manufacturing the cement
CO2	Identify, describe and carry out tests relevant to the use of cement and concrete on site
CO3	Explain how good cement is produced

Details of the Syllabus:

Unit-I	Introduction to Cement and cement manufacturing process: Cement and its importance in construction, History of cement and Cement manufacturing process, flow sheet & material composition of cement, various unit operation of cement manufacture, the present status and future of cement industry in India.
Unit-II	Types of Cement and their brief description and application. Calcareous Raw Materials: Source of Lime, Limestone, Chalk, Marl, Industrial waste, geological distribution of limestone deposits in India, Argillaceous Raw Materials: Source of Silica, Alumina, Iron Oxide, Shale and effect of coal ash and additives use as corrective materials, Fly ash , Slag, lime sludge as cement raw materials. Reactivity of Raw materials, Proportioning of Raw materials and preparation of kiln feed.
Unit-III	Pyroprocessing and clinker formation. Characterization of Portland Cement Clinker., Mineralizer, Role of additive in clinker formation, various mineralizer and fluxes, their role in manufacture of clinker. Properties of Cement Paste.
Unit-IV	Cement milling, Finess of cement, Setting times, workability, Compressive strength, Heat of hydration.
Unit-V	Environmental impact of Cement manufacture. Air and Water emissions,

Books Recommended

Text Books	**1.**	Properties of concrete / A.M.Neville / Pearson 5th edition.
	2.	Concrete Technology,(4th edition) by Gambhir, M.L., Tata McGraw-Hill, New Delhi, 2009.
	3.	Rao, M.G., Sittig, M., "*Dryden's Outlines of Chemical Technology- for the 21stCentury*.East-West Press (1997).

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Elective-II: Computational Fluid Dynamics (CET-026)

Subject: Computational Fluid Dynamics (CET-026)	Year & Semester: B.Tech Chemical Engineering 4th Year & 7th Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective: To learn the fundamental concepts of computational fluid dynamics along with basic numerical techniques and discretization techniques using Finite difference method.

Course outcomes (COs):

CO1.	Fundamental understanding and interpretation of governing equations involved in heat and fluid flow problems
CO2.	Understanding of basic numerical technique's involved
CO3.	Understanding of Grid formation
CO4.	Understanding discretization technique's using FDM

Details of the Syllabus

Unit-I	**Basic Concepts of Fluid Flow**: Philosophy of computational fluid dynamics (CFD), review of equations governing fluid flow and heat transfer, simplified flow models such as incompressible, inviscid, potential and creeping flow.
Unit-II	**Overview of numerical methods:** understanding of numerical methods involved like Gauss-Seidel,Rungekutta and Crank Nicolson method**.**
Unit-III	**Grid Generation**: Structured and unstructured grids, choice of suitable grid, grid transformation of equations, Grid Independence test.
Unit-IV	**Finite Difference Method (FDM):** Discretization of ODE and PDE, approximation for first, second and mixed derivatives, implementation of boundary conditions, discretization errors, applications to the engineering problems.

List of Books:

Text and Reference Books	1. Ghosh, P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw-Hill (1998). 2. Patankar, S.V., "Numerical Heat Transfer and Fluid Flow", Taylor and Francis (2004). 3. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics, Vol. 1: Fundamental and General Techniques", Springer-Verlag (1998). 4. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics, Vol. 2: Specific Techniques for Different Flow Categories", Springer-Verlag (1998). 5. Anderson, J.D., "Computational Fluid Dynamics", McGraw Hill (1995).

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Elective-II: Multi-component Distillation (CET-027)

Subject: Multi-component Distillation (CET-027)	Year & Semester: B.Tech Chemical Engineering 4th Year & 7th Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective: The objective of the course is to understand the principles and operation of various distillation processes for Multi-component distillation systems.

Course outcomes (COs): At the end of the course, student will be able to:

CO1:VLE calculations like determination bubble point and dew point for multi-component systems using K-values and relative volatility.
CO2:They learn about various types of MCD column.
CO3:Students able to design multi-component distillation unit.

Details of the Syllabus:

Unit-I	Basic concepts of phase equilibria. Distribution co-efficient. Ideal and non-ideal systems. Design variables.
Unit-II	Equilibrium flash separation. Binary distillation, x-y diagrams. Enthalpyconcentration diagrams. Design calculations.
Unit-III	Multi-component distillation. Design calculations. Theoretical analysis. Azeotropic and extractive distillation. Distillation equipment. Plate and packed towers. Design procedures.

List of Books:

Recommended Books:	1. Holland, C. D., "Fundamentals of Multi-component Distillation", McGraw-Hill (1981). 2. *Sherwood, T.K., Pigford, R.L.,Wilkes, C.R.,"MassTransfer", McGraw-Hill* (1975). 3. Buford D. Smith, B.D., Brinkley, W. K., " General Short- cut Equation for Equilibrium stage Processes", AIChE Journal: 6 (3),446–450 (1960).
References:	1. Sawistowski, H., Smith, W. "Mass Transfer Process calculations", Eng. News: 41, 68 (1963). 2. Treybal, R. E., " Mass-Transfer Operations", 3rdEdn., McGraw-Hill (1981).

Elective-II: Optimization Techniques in Chemical Engineering (CET-028)

Subject: Optimization Techniques in Chemical Engineering(CET-028)	Year & Semester: B.Tech Chemical Engineering 4th Year & 7th Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective: The objective of the course is to understand the detailed theory and application of optimization in chemical engineering and related fields.

Course outcomes (COs): At the end of the course, student will be able to:

CO1	understand the objective functions and conditions for optimization
CO2	Application of optimization to different chemical engineering problems, problem formulation procedures for optimization
CO3	Use of various methods for both constrained and unconstrained optimization problems.

Details of the Syllabus:

Unit-I	Basic concepts of systems analysis and optimization, classical optimization techniques, linear programming, two phase simple method and duality in linear programming,
Unit-II	Transportation models, assignment models, non-linear programming, method of Lagrange multipliers, Wolf's method for solving N.L.P.P,
Unit-III	Formulation of optimization problems in Chemical and allied Engineering. Introduction to dynamic programming, application to chemical engineering.

List of Books:

Recommended Books:	1. Rangaiah, G.P., "*Multi-Objective Optimization: Techniques and Applications in Chemical*", World Scientific Publishing Company Pvt. Ltd. (2009). 2. Deb, K., "*Optimization for Engineering Design: Algorithms and Examples*", 2nd Edn.,PHI (2012). 3. Rao., S.S., " *Engineering Optimization: Theory and Practice*", John Wiley & Sons Inc. (2009).
References:	1. Vlide, I., "*Optimum Seeking Methods"*, Prentice-Hall Inc. (1964). 2. Gass, S.I., "*Linear Programming: Methods and Applications*", McGraw-Hill (2003). 3. Bazaraa, M. S., ,Sherali, H. D., Shetty, C.M., "*Non-Linear Programming: Theory and Algorithms*", John Wiley & Sons (2013).

Elective-II: Heterogeneous Catalysis and Catalytic Processes (CET-029)

Subject: Heterogeneous Catalysis and Catalytic Processes (CET-029)	Year & Semester: B.Tech. Chemical Engineering 4thYear &7th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term (30 Marks)	Class Assessment (10 Marks)	Final-Term (60 Marks)		

Course Objective

To gain the knowledge of catalyst characteristics, mechanism of catalytic reactions, and design of catalytic reactors.

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Course outcomes (COs): At the end of the course, student will be able to:

CO1	develop various catalytic reaction mechanisms.
CO2	characterize a catalyst.
CO3	assess the effects of external heat and mass transfer effects in heterogeneous catalysis.
CO4	calculate the effectiveness of a porous catalyst.
CO5	design different types of reactors for catalytic reactions.

Details of the Syllabus

UNIT-01	**Catalysis:** Homogeneous and heterogeneous catalysts, classification of catalytic reactions and catalysts, commercial chemical catalysts, steps in catalytic reactions.
UNIT-02	**Preparation and Properties of Catalysts:** Methods of catalyst preparation, physical properties of catalyst – surface area, pore volume, pore size distribution, solid density, particle density, bulk density, void volume, catalyst promoters and inhibitors, catalyst accelerators and poisons.
UNIT-03	**Adsorption and Catalytic Reactions:** Adsorption isotherms, surface reaction, single site and dual site mechanism, desorption, catalyst deactivation, pore structure and surface area estimation and their significance.
UNIT-04	**External Transport Processes:** Fluid particle mass and heat transfer, Mass transfer-limited reactions in packed beds, Non-isothermal behavior of packed-bed reactors, Staged packed bed reactors for approaching optimum temperature

	progression, Stable operating conditions in reactors and hot spot formation, Effect of external transport processes on selectivity under non-isothermal conditions.
UNIT-05	**Diffusion and Reaction in Porous Catalysts:** Intra-pellet mass transfer and diffusion in cylindrical and spherical porous catalyst particles, Thiele modulus, Diffusion controlled and surface reaction controlled kinetics, Effectiveness factor for catalysts, Effects of heat transfer – temperature gradients across fluid-solid film and across catalyst pellet, Fluidized bed reactors, Three phase reactors – slurry and trickle bed reactors.
UNIT-06	**Generalized Design:** Design of catalytic reactors under adiabatic and non-adiabatic conditions, Design of industrial fixed-bed, fluidized-bed and slurry reactors.

Books Recommended

1.	Smith, J.M., “Chemical Engineering Kinetics”, McGraw-Hill (1981).
2.	Fogler, H.S., “Elements of Chemical Reaction Engineering”, Prentice-Hall India (2009).
3.	Denbigh, K.G., and Turner, J.C.R., “Chemical Reactor Theory: An Introduction”, Cambridge University Press (1984).
4.	Carberry, J.J., “Chemical and Catalytic Reaction Engineering”, McGraw-Hill, (2001).
5.	Levenspiel, O., “Chemical Reaction Engineering”, John Wiley (2006).

8th Semester

Project (CEP-464)

Subject: Project (CEP-464)	Year & Semester: B. Tech Chemical Engineering 4th Year & 8th Semester	**Total Course Credit: 8**		
		L	T	P
		0	0	16
Evaluation Policy*	Total Marks (100)			

**Based on presentations by each of the student before a panel of examiners nominated by H.O.D with due weightage to Supervisor evaluation and final report submitted.*

Course Objective
This course enables the students to get first-hand experience acquainting with principles and applications of chemical engineering by analyzing as well as solving problems concerning industries, research etc.

Course outcomes (COs): At the end of the course, student will be able to:

CO1	Acquaint students with research methodology.
CO2	Enable students to correlate class mode learning to real industrial as well as research applications
CO3	Understand the literature and previous studies concerning the problem
CO4	Facilitate the learning of proper report writing and comprehensive communications skills.

Note: There is no course content fixed. Based on collection of information, survey of literature and procurement of materials including chemicals during the pre-project work, the final semester project work is carried out in the eighth semester and is finalized by the end of the semester. The final evaluation is based on quality of report, presentation and viva voice examination by the examiner (preferably external).

<table>
<tr><td rowspan="2">Subject: Bioresource Technology (CET-465)</td><td rowspan="2">Year & Semester: B.Tech. Chemical Engineering 4th year &8th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td></td><td></td><td>3</td><td>0</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term (30 Marks)</td><td>Class Assessment (10 Marks)</td><td colspan="3">Final-Term (60 Marks)</td></tr>
</table>

Bioresource Technology (CET-465)

Course Objective:

The aim of this course is to provide fundamental knowledge for bioenergy generation and product formation with the help of various conversion processes adequate to diverse bioresource characteristics.

Course Outcomes (COs):

CO1	Fundamental understanding of the bioresourcesand its applications for attainment of social objectives (energy, environment, product, sustainability).
CO2	Acquire knowledge with respect to the properties of the bioresources and the conversion technologies.
CO3	Exhibiting knowledge of the systems used for bioresource technology.
CO4	Understanding about analysis of data and their applications in design of the systems and development of the bioprocess.

Details of the Syllabus:

Unit-I	Bioresources- natural and anthropogenic; importance of bio-resources and their utilization. Natural bio-resources: agricultural, forestry and aquatic biomass. Biomass availability, production and food security, non- edible biomass characteristics. Anthropogenic bio-resources: Organic wastes-domestic and industrial; characteristics of municipal sewage / sludge and industrial sludges.
Unit-II	Conversion processes : biochemical, thermo-chemical and physico-chemical conversion processes. Biochemical processes : Microbial anaerobic and aerobic processes, enzymatic processes ; fermentation for alcohols and acids ; penicillin and other therapeutic products. Production of single cell protein (SCP) ; bio-pulping, biogasification. Thermo-chemical processes: pyrolysis (coke and pyro-oils), oxidation-combustion, gasification (downdraft, updraft and fixed bed gasification, fluidized bed and entrained bed gasification). Various methods of manufacture of activated carbons
Unit-III	Physico-chemical processes: Pretreatment, steam/acid/alkali hydrolysis, effect of temperature onhydrolysis.
Unit-IV	Special topics: biofuels , biomaterials, specialty chemicals (gylcol, acetic acid and downstreamchemicals), anhydrous alcohols-ethanol and butanol; biodiesel, bio-aviation turbine fuel (BATF).

Books Recommended

Text Books	1.	Shuler, M., Kargi, F., "*Bioprocess Engineering, Basic Concep"*, 2ndEdn.,Prentice Hall of India Pvt. Ltd. (2004).
	2.	Chakraverty, A., "*Biotechnology and other Alternative Technologies*", Oxford and IBH Publishing Co. Pvt. Ltd. (1995).
	3.	Rao, M.G., Sittig, M., "*Dryden's Outlines of Chemical Technology- for the 21$_{st}$Century*.East-West Press (1997).
	4.	Austin, G.T., "*Shreve's Chemical Process Industries*", McGraw-Hill Book Company (1984).
Reference Books	1.	Pandey, A., "*Concise Encyclopaedia of Bioresource Technology*", CRC Press (2004).
	2.	Glaucia, M.S. et al. (eds), "Bioenergy &Sustainability: Bridging the Gaps", SCOPE 72, Universidade de São Paulo, Brazil (2015).
	3.	Eckert &Trihn (eds), "Biotechnology for Biofuel Production and Optimization", Elsevier (2016).
	4.	Cock, "Encyclopedia of Life Support Systems (EOLSS)", UNESCO, (2011)
	5.	S. Van Loo, "Handbook of Biomass Combustionand Co-Firing" ,Twente University Press, 2002.
	6.	Wang, W.C. et al., " Review of Biojet FuelConversion Technologies", National Renewable Energy Laboratory (USDE), Technical Report, 2016.

Subject: Biochemical Engineering Lab. (CEL-466)	Year & Semester: B.Tech. Chemical Engineering 4th year &8th Semester	Total Course Credit: 2		
		L	T	P
		0	0	4
Evaluation Policy*	Total Marks (100)			

Biochemical Engineering Lab (CEL-466)

Course Objective:

The purpose is to impart fundamental knowledge with respect to the equipments and techniques essential for carrying out fermentation for generation and analysis of the data and finally development of the bioprocess.

Course Outcomes (COs):

CO1	Acquire basic knowledge of various equipments used in biochemical engineering lab.
CO2	Fundamental understanding of techniques with respect to sterilization, preparation of solid and liquid media, culture growth and preservation.
CO3	Basic understanding of estimation techniques for biomass, substrate and product.
CO4	Generation and analysis of data for design and development of bioprocess.

Details of the Syllabus:

Unit-I	Study of various equipments used in biochemical engineering lab.
Unit-II	Study of sterilization. Preparation of culture media, agar slants and agar plates, growth and preservation of microbial cultures.
Unit-III	Study of aeration and agitation, determination of volumetric mass transfer coefficient ($k_l a$) of oxygen. Methods for estimation of biomass, substrate and product concentrations.
Unit-IV	Kinetic study of fermentation. Study of bioseparation.

List of Experiments

S.No.	Experiments
1.	Study the fundamentals of bioreactor, shaking incubator, spectrophotometer, HPLC, laminar flow chamber, autoclave, centrifuge. w.r.t. its construction, function (application) and principle of operation.
2.	To prepare basic solid media as agar slants and agar plates.
3.	Study of sterilization by application of a steam autoclave.
4.	Quantitative estimation of glucose concentration by DNS colorimetric method or by phenol-sulfuric acid method.

5.	Estimation of cell concentration.
6.	Determination of volumetric mass-transfer co-efficient of O_2 by static method.
7.	Determination of volumetric mass-transfer co-efficient of O_2 by dynamicmethod.
8.	To study the kinetics of alcohol (ethyl alcohol) fermentation by using baker's yeast (*Saccharomyces cerevisae*) in a batch bioreactor.

References

1.	Shuler, M., Kargi, F., "*Bioprocess Engineering, Basic Concep"*, 2nd Edn.,Prentice Hall of India Pvt. Ltd. (2004).
2.	Bhattacharya, R.N., "Experiments with Microorganisms", Emkay Publications, Delhi (1986).
3.	Aneja, K.R., "Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation", VishwaPrakashan (New Age International (P) Limited), New Delhi (1996).
4.	Experiments Handouts (Departmental)

Modelling& Simulation of Chemical Process Systems (Code: CET-467)

<table>
<tr><td rowspan="3">Subject: Modelling& Simulation of Chemical Process Systems (Code: CET-467)</td><td colspan="2" rowspan="3">Year & Semester: B.Tech Chemical Engineering 4th Year & 8th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term (30 Marks)</td><td>Class Assessment (10 Marks)</td><td colspan="3">Final-Term (60 Marks)</td></tr>
</table>

Course Objective: To provide adequate information to the modelling of chemical engineering process systems and also familiarize the numerical simulation of model equations.

Course Outcomes (COs): At the end of the course, student will be able to:

CO1.	Identify the terms involved in inventory rate equation of mass, energy and momentum
CO2.	Recall the basic concepts involved in modeling and simulation
CO3.	Apply conservation of mass, momentum and energy equations to engineering problems
CO4.	Develop model equations for chemical engineering systems
CO5	Solve the model equations and chemical engineering problems using numerical techniques

Details of the Syllabus:

Unit-I	**Introduction**: Introduction to process modeling and simulation, terminology of Process modeling and simulation, Steps for building a mathematical model, Inventory rate equation of the conserved quantities, Mathematical formulation of the conserved quantities (Mass, Momentum and Energy equations), Molecular and Convective Transport.
Unit-II	**Rate of generation term and steady state macroscopic balance:** Rate of Generation in Momentum, Energy and Mass Transfer, Steady-State Macroscopic Balances, comparison of microscopic and macroscopic balances, steady state macroscopic balance problem solving using least square method.
Unit-III	**Unsteady state macroscopic balance:** Building blocks of unsteady state macroscopic balance, Pseudo-Steady-State-Approximation, Conservation of Chemical Species, Momentum, Energy and total Mass, Unsteady state Energy balance around a Continuous Stirred Tank, unsteady state macroscopic balance problem solving using Euler's method.
Unit-IV	**Modeling of chemical process systems:** Models, need of models and their classification, models based on transport phenomena principles, alternate classification of models, Continuous Stirred Tank Reactor (CSTR) with constant holdup, Continuous Stirred Tank Reactor (CSTR) with Variable holdup, Two Heated Tank, Gas phase

	Pressurized CSTR, Multi-Component Flash Drum, Gravity Flow Tank, Non-isothermal CSTR, Ideal Binary Distillation Column, Batch reactor.
Unit-V	**Process simulation:** Simulation of chemical process equipment, program development and numerical solution, Case Studies.

Books Recommended

Text Books	1.	Luyben, W. L., "Process Modeling, Simulation and Control for Chemical Engineers". McGraw Hill (1990).
	2.	NayefGhasem**, "**Modeling and Simulation of Chemical Process Systems", CRC Press, Taylor & Francis Group (2019).
	3.	Ismail Tosun, Modeling in Transport Phenomena – A Conceptual Approach, 2nd Edn, Elsevier Publications 2007.
Reference Books	1.	Davis M.E., Numerical Methods and Modeling for Chemical Engineers, Wiley, New York, 1984
	2.	Ashok Kumar Verma, Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Press, Taylor & Francis Group (2015).
	3.	Amiya K Jana, "Chemical Process Modelling and Computer Simulation", 2nd Edition, PHI Learning Private Limited, (2011).

Industrial Pollution Abatement (CET-468)

<table>
<tr><td rowspan="3">Subject: Industrial Pollution Abatement (CET-468)</td><td rowspan="3" colspan="2">Year & Semester: B.Tech Chemical Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term
(30 Marks)</td><td>Continuous Assessment
(10 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Objectives:

1. To understand the significance of industrial pollution abatement
2. To understand the sources, effects and prevention of pollution and recycling of water and waste
3. To design and understand the working of pollution control equipment

Course outcomes (COs): Upon successful completion of the course, students will be able to:

CO1.	Understand the sources, effects and prevention of pollution and recycling of water and waste
CO2.	Illustrate the methods to measure the industrial pollution
CO3.	Understand the principles of industrial pollution control and design air pollution control systems
CO4.	Apply the basic chemical engineering concepts in design of industrial wastewater treatment systems

Details of the Syllabus:

Unit-I	**Introduction:** Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental Laws and rules, standards for ambient air, noise emission and effluents
Unit-II	**Pollution Prevention**: Process modification, alternative raw material, recovery of by/co products from industrial emissions/effluents, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization. Water use minimization, Fugitive emission/effluents and leakages and their control-housekeeping and maintenance
Unit-III	**Air Pollution Control:** Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by absorption and adsorption; Design of cyclones, ESP, fabric filters and absorbers.
Unit-IV	**Water Pollution Control:** Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation. *Biological Treatment:* Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying
Unit-V	**Solids Disposal:** Solids waste disposal – composting, landfill, briquetting / gasification and incineration

Books Recommended

Text Books	1.	Tchobanoglous , G., Burton, F. L., Stensel, H.D., “Waste Water Engineering: Treatment and Reuse”, Tata McGraw Hill, (2003)
	2.	Vallero, D., “Fundamentals of Air Pollution”, Academic Press, (2007)
	3.	Eckenfelder W. W., “Industrial Water Pollution Control”, McGraw Hill, (1999)
Reference Books	1.	Kreith F. and Tchobanoglous G., “Handbook of Solid Waste Management”, Mc Graw Hill, (2002)
	2.	Pichtel, J., “Waste Management Practices: Municipal, Hazardous and Industrial”, CRC (2005)

Elective –III (CET-069-072)
Elective- IV (CET-073--076)

The two of the electives will be online courses, each having 03 no. of credits (Total 06 credits). Courses will be managed by the faculty mentor from the Department (to be nominated). The courses will be floated at the time of beginning of semester preferably from SWAYAM .The student will have to opt for any two of such courses of his/her choice.

BTECH. 5th- SEMESTER (Civil)

Course No.	Course title	L	T	P	C
CVT301	Design of Structures-I	2	2	0	4
CVL301	Concrete Laboratory	0	0	2	1
CVT302	Highway Engineering and PMS	3	1	0	4
CVL302	Highway Laboratory	0	0	2	1
CVT303	Geotechnical Engineering-I	2	2	0	4
CVL303	Geotechnical Laboratory-I	0	0	2	1
CVT304	Water Resources Engineering	2	2	0	4
CVT305	**Structural Analysis-III**	2	1	0	3
	Elective Courses				
	Architecture and Town Planning				
CVT307	Concrete Technology	2	1	0	3
	Engineering Seismology				
Total Lecture Hours and Credits		28			25

B.TECH. 6th SEMESTER (Civil)

Course No.	Course title	L	T	P	C
CVT350	**Design of Structures-II**	2	2	0	4
CVL350	Structural Engineering Lab.-II	0	0	2	1
CVT351	Traffic Engineering and Road Facilities	2	2	0	4
CVL351	Traffic Engineering Laboratory	0	0	2	1
CVT352	Geotechnical Engineering-II	2	2	0	4
CVL352	Geotechnical Laboratory-II	0	0	2	1
CVT353	Irrigation and Hydraulic Structures	2	1	0	3
CVT1453	Industrial Training &Presentation	0	0	0	1
	Elective Courses (Departmental Elective / Swayam Course)				
CVT354	Water Shed Management				
	Numerical Methods in Civil Engineering	2	1	0	3
MAT050	Operations Research				
	Computer Aided Design				
CVT355	Disaster Management	2	1	0	3
	Applied Hydrology				
Total Lecture Hours and Credits		27			25

B.TECH. 7th SEMESTER (Civil)

Course No.	Course title	L	T	P	C
CVT401	Environmental Engineering-I	2	1	0	3
CVL401	Water Quality Lab	0	0	2	1
CVT402	Structural Dynamics	3	1	0	4
CVT403	Construction Technology & Management	2	1	0	3
CVT404	Design of Structures-III	2	2	0	4
CVT405	Quantity Surveying and Cost Evaluation	3	1	0	4
CVS405	Seminar	0	2	0	1
CVP406	Project Pre-Work	0	0	4	2
Elective courses (Departmental Elective/ Swayam Courses)					
CVT406	Railway and Airport Engineering Fluvial Hydraulics Advanced Geotechnical Engineering	2	1	0	3
Total Lecture Hours and Credits		28			25

B TECH. 8th SEMESTER (Civil):

Course No.	Course title	L	T	P	C
CVT450	Hydropower Engineering	2	2	0	4
CVT451	**Bridge Design**	**3**	**1**	**0**	**4**
CVP452	Project*	0	5	10	10
ELECTIVE COURSES (Departmental Elective/Swayam Courses)					
CVT454	Rock Mechanics and Tunneling Technology Transportation Planning and Economics **Advanced Structural Analysis**	2	1	0	3
CVT455	Ground Improvement Techniques Earthquake Resistant Design Environmental Engineering-II	3	1	0	4
Total Lecture Hours and Credits		30			25

*The evaluation will be done as per statutes.

<table>
<tr><td colspan="1">Course Title: DESIGN OF STRUCTURES-I
(Code: CVT301)</td><td>Syllabus for B.Tech. 5th Semester (Civil Engineering)</td><td colspan="4">Total Course Credit: 4</td></tr>
<tr><td>Midterm Examination</td><td>Class Assessment (Assignments, interaction, tutorials, viva etc.)</td><td>End-Term Examination</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td>60 Marks</td><td>2</td><td>2</td><td>0</td></tr>
</table>

Course Objective: The objective is to equip students with basic understanding of the behavior of the reinforced concrete structures and to develop the skill to analyze and design basic concrete members.

Course Outcomes:

CO1: To develop basic understanding of reinforced concrete as a construction material.

CO2: To develop understanding of various design philosophies and their differences.

CO3: To understand behavior of RCC beams.

CO4: To understand behavior of RCC members under flexural shear.

CO5: To understand behavior of compression members.

CO6: To understand behavior of two-way slabs using moment coefficients.

S. No.	Course Contents	Contact Hours
01.	**General material properties** Properties of Concrete & Reinforcing Steel, Characteristic Strength, Stress Strain Curves, Shrinkage & Creep Phenomenon.	03
02.	**Basic design Philosophies** Working Stress, Ultimate Load & Limit State Method of Design. Analysis & Design of Structures In Flexure/Torsion By Limit State Method.	03
03.	**Design & Analysis of Flexural members** Design of singly and doubly reinforced sections: rectangular sections & T sections; codal provisions. Behavior of beam in shear & bond, design for shear, anchorage & slipping of reinforcement. Detailing of reinforcement as per codal provisions with reference to IS 456-2000. Serviceability limit state of deflection and cracking. Calculation of deflection, codal requirements.	18
04.	**Design & analysis of columns** Design of columns: short and long column, eccentrically loaded columns using interaction curves	05
05.	**Design & Analysis of solid slabs** Design of one-way and two-way slabs with and without corners held down. Introduction to design by moment coefficients. Introduction to Masonry retaining walls	07

References:

1. Mosley ,W.H Hulse ,R and Bungey."Reinforced concrete design to EuroCode 2",7th Edition,Palgrave Macmillan ,London,2012
2. Wight,J.K," Reinforced Concrete: Mechanics & Design",7th Edition,Pearson/Prentice Hall,2015.
3. S Unnikrishna Pillai,Devdas Menon,"Reinforced Concrete Design" 3rd Edition, Mcgraw Hill Publication.
4. Kong & Evans, Design of reinforced concrete & Pre-stressed concrete Structures, CRC Press Published, 1987

Course Title: Concrete Lab. (Code: CVL 301)	**Syllabus for B.Tech. 5th Semester (Civil Engineering)**	**Total Course Credit: 1**		
Internal Examination	External Examination	L	T	P
50 Marks	50 Marks	0	0	2

CO1 To handle concrete and its constituents in laboratory.

CO2 To design experiments related to testing various aspects of concrete and its constituents.

CO3 To test concrete and concrete structures for various characteristics/properties and compare the same with those given as per IS codes.

CO4 To understand how concrete behaves in actual buildings.

List of Experiments / Objective

A) CEMENT: Standard Consistency and setting times

To determine: i) Standard consistency ii) Initial setting time iii) Final setting time in conformity with IS code 4031.

Tensile and Compressive strength

To determine the tensile strength and compressive strength of Cement in accordance with IS code - 403 1.

B) AGGREGATES:

Particle size distribution and fineness modulus

To determine the particle size distribution and fineness modulus of coarse and fine aggregates (IS - 460). All the relevant tests for aggregates as per I.S. codes.

C) CONCRETE:

Workability test

i) To determine the consistency of fresh concrete by slump test.
ii) To determine the workability of freshly mixed concrete by the compaction factor test

Compressive strength of Cement Concrete (Nominal mix)

To determine the cube strength of concrete for different mixes and different W/C ratios.

Flexural Strength of Concrete

To determine the flexural strength (Modulus of Rupture) of concrete (Nominal Mix)

Ultimate strength of Beams

To determine the flexural ultimate strength of

i) an under reinforced beam
ii) an over reinforced beam

Bond strength

To determine the bond strength between

i) Mild steel plain bars & concrete
ii) Tor Steel/cold twisted bars and concrete

Course Title: Highway Engg. And PMS (Code: CVT302)	**Syllabus for B.Tech. 5th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Outcomes:

CO1: To design roads and highway alignment.
CO2: To develop geometric design of highways.
CO3: To design pavements.
CO4: To test properties of road aggregates and bituminous material.
CO5: To select materials for cement concrete roads.
CO6: To perform pavement management.

S. No.	**Course Contents**	**Contact Hours**
01.	**INTRODUCTION** Scope, History, classification of roads. Comparison with other modes of transportation	04
02.	**Alignment design:** route survey and highway Location.	03
03.	**Geometric design:** cross-section elements; sight distances, horizontal and vertical alignment	12
04.	**Pavement design:** factors affecting pavement design, types of pavements, Empirical methods of flexible pavement design (e.g. C.B.R, group index and Burmister's layer theory), stresses due to load and temperature in rigid pavements, introduction to design methods of rigid pavements.	08
05.	**Highway materials and construction**: Properties and tests for road aggregates and bituminous materials, design of bituminous concrete mix, methods of preparing sub grade, base course and construction of various types of surface covers, joints in cement concrete roads.	07
06	**Pavement management system:** basic concept, data requirements & collection methods, maintenance and rehab treatments, priority programming, implementation of PMS.	06

References:

1) Khanna, S.K. and Justo, C.E.G. 2002. "Highway Engineering". Nem Chand Brothers, Roorkee.
2) Bhanot, K.L.1990. " Highway Engineering", S. Chand and Company (P) Ltd., New Delhi.

3) Rao, G.V. 1996. ”Principles of Transportation and Highway Engineering”, Tata McGraw Hill, New Delhi.
4) Pavement Design and Management Guide by Transportation Association of Canada, Ottawa, Ontario, Edn. Dr. Ralph Haas, University of Waterloo.
5) Relevant IRC Codes/Specification

Course Title: Highway Lab. (Code: CVL 302)	**Syllabus for B.Tech. 5th Semester (Civil Engineering)**	**Total Course Credit: 1**		
Internal Examination	External Examination	L	T	P
50 Marks	50 Marks	0	0	2

CO1 Conduct tests on aggregate; aggregate gradation, specific gravity, aggregate crushing, aggregate abrasion, aggregate impact: follow standard test procedures, design observation sheet, record observations and analyze, presentation and analysis of test results, derive conclusions

CO2 Conduct tests on aggregate; soundness, flakiness, elongation, combined flakiness & elongation, deleterious material: follow standard test procedures, design observation sheet, record observations and analyse, presentation and analysis of test results, derive conclusions

CO3 Conduct tests on coarse and fine aggregate and bitumen; fineness modulus, silica content, organic content, silt content, alkalinity, viscosity; penetration, softening point, flash & fire point, ductility, specific gravity,: follow standard test procedures, design observation sheet, record observations and analyze, presentation and analysis of test results, derive conclusions

CO4 Conduct tests on modified binders, bituminous Mixes and subgrade soil; elastic recovery, separation difference, Marshall stability, flow value, index properties of soil, CBR of soil, subgrade modulus: follow standard test procedure, design observation sheet, record observations and analyse, presentation and analysis of test results, derive conclusions

Expt. No	**Contents**
1	Tests on aggregate: Aggregate grading, Specific gravity, crushing, Abrasion, Impact test, Soundness, Flakiness, Elongation, Fineness Modulus, Silica content, Organic content, Silt content, Alkalinity, Deleterious material.
2	Tests on bitumen and bituminous mixes: Viscosity, Penetration, Softening point, Flash & fire point, Ductility, Specific gravity, Elastic recovery, Marshall Stability.
3	Tests on sub-grade: sub-grade modulus, CBR.

Geotechnical Engineering-I

Geotechnical Engineering-I (Code: CVT303)	**Syllabus for B. Tech. 5th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	End-Term Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Objective: To develop analytical and experimental skills to determine various stresses acting on soil material.

Course Outcomes:

CO1: To classify soils and understand their properties.

CO2: To analyze flow through soils.

CO3: To perform/demonstrate soil compaction tests.

CO4: To determine stress distribution in soils.

CO5: To utilize various methods of soil investigation in field and laboratory.

Detailed Syllabus:

Sr. No.	**Course Contents**	**Contact Hours**
1	**INTRODUCTION:** **Soil Engineering-**Origin and formation of soils & Rocks, Weathering of Rocks & Soil deposits, Types of Soil Deposits, Clay and Clay Mineralogy, Types of clay minerals, Structure of Clay Minerals, Physical and Geochemical Properties of Clays and Clay Minerals, Role of Soils in Engineering, Problems in Soil Engineering, Application of properties of soils, Scope of Soil Mechanics in Civil Engineering Practice.	04
2	**SOIL PHASE-SYSTEM:** Soil as a Three/Two Phase Soil System- Soil Constituent Properties and Inter-relationships, Description & Evaluation of Index Properties of soils, Engineering Soil Classification systems	08
3	**ENGINEERING PROPERTIES OF SOILS- SITE IMPROVEMENT:** **Determination of Compaction Characteristics** - Need for soil compaction, Compaction Mechanism, Influencing factors, Proctor theory of compaction, Compaction tests, Compaction curve & parameters, Zero-air-void or saturation curve, Properties of compacted soils, Field compaction and field compaction control.	04
4	**EFFECTIVE STRESS AND STRESS DISTRIBUTION:** Total and effective stresses, pore water pressure, Concept of stresses & Strains in soils, Settlement, Soil Modulus for Soils under application of stresses, Stress distribution under concentrated load. Boussineq's method, Westergard's method, and Burmister's Approach.	04

5	**ENGINEERING PROPERTIES OF SOILS - MOVEMENT OF WATER THROUGH SOIL-SOIL HYDRAULICS:** **Soil Hydraulics-** Different forms of water flow through soils, Hydraulic heads, Pore water pressure, Principle of Effective stress, Capillarity, Darcy's law, **Permeability of soils**, factors influencing permeability, Lab & field methods of determination of permeability, Permeability of stratified soil deposits. **SEEPAGE THROUGH SOILS**-Seepage & Flow Nets, laplace equation for steady state flow, Seepage force, Quick sand & Critical Gradient, Construction of flow nets and their typical applications, Flow nets. for homogeneous embankments/dams with and without toe filters, Concrete dams without & with sheet-pile at U/S, D/S or at both locations.	04
6	**ENGINEERING PROPERTIES OF SOILS - VOLUME CHANGE:** **SOIL COMPRESSIBILITY-** Fundamental concepts of consolidation, Types of Volume changes in Soil masses**,** Terzaghi's One dimensional consolidation equation- Consolidation concept by Spring Analogy & Soil Skeleton, One dimensional consolidation, Terzaghi's equation, **Consolidation Lab. tests**, e - σ and e -logσ curves, Compressibility parameters, Pre-consolidation pressure, OCR, Rate of Consolidation, Consolidation settlement, Degree of Consolidation, Secondary Consolidation, Time required for settlement, Field consolidation curve.	06
7	**<u>BEHAVIOR OF SOILS - SOIL INVESTIGATION</u>** Soil Exploration **-** Soil Types: Coarse grained and Fine grained soils, Objectives of Soil Exploration, Planning of Soil Exploration, Boring & Sampling in Soils, Field and Laboratory Investigation methods, Penetration methods, Geo physical methods- electric resistivity method and Seismic method, Suitability of tests	06
		36

<u>COURSE TEXTBOOK</u>: ***Some useful resources are:***

1. Kasmalkar, B. J. (1997). Geotech. Engineering. Pune Vidyarthi Griha Prakashan-1786, Sadashiv Peth, Pune-411030
2. Murthy, V. N. S. (1991). Principles of Geotechnical Engineering, CBS publishers & distributors, 4819/XI, 24 Ansari Road, Daryaganj, New Delhi-002
3. Coduto, D.P., *Geotechnical Engineering - Principles and Practices*, Prentice Hall, New Jersey, 1999.
4. Cernica, John N. (1995). *Geotechnical Engineering*, John Wiley & Sons, New York.
5. Das, Braja M. (1999). *Principles of Geotechnical Engineering.* PWS Publishing, Pacific Grove, Calif.
6. Gopal Ranjan & ASR Rao (2000). Basic ans Applied Soil Mechanics, New Age Int`l Publishers New Delhi 002
7. P. Purushothama Raj (1995). Geotechnical Engineering, Tata McGraw-Hill, New Delhi-002

8. David F. McCarthy (2007). Essentials of Soil Mechanics & Foundations: Basic Geotechnics (7/E), Prentice-Hall, New Jersey, Columbus, Ohio

9. Alam Singh & G R Chowdhary (1990). Soil Engineering in Theory & Practice: Vol-2, Geotechnical Testing & Instrumentation, CBS publishers & distributors, 4819/XI, 24 Ansari Road, Daryaganj, New Delhi-002

10. K. H. head (2006). Manual of Soil Laboratory Testing: Vol-1, Whittles Publishing, CRC Press, UK

Title: Geotechnical Lab – I (Code: CVL 303	**Syllabus for B. Tech. 5th Semester (Civil Engineering)**	**Total Course Credit: 1**		
Internal Examination	External Examination	L	T	P
50 Marks	50 Marks	0	0	2

COURSE OUTCOMES:

1. To determine basic soil properties and consistency limits.
2. Draw complete particle size distribution curve of a given soil.
3. Determine Compaction characteristics of a given soil.
4. Determine Permeability of any given soil specimen.

Expt. No.	Name of the Experiment
1	Soil Identification Tests
2	Water Content Determination Test
3	Field Density Measurement
4	Specific Gravity Test
5	Sieve Analysis Test
6	Sedimentation Analysis Test
7	Atterberg and Shrinkage Limits
8	IS Light Heavy Compaction Tests
9	Permeability Tests

Course Title: WATER RESOURCES ENGINEERING (Code: CVT304)	**Syllabus for B.Tech. 5th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	End-Term Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Objective: To impart the knowledge for understanding elementary aspects of hydrology and Fluvial Hydraulics for use in the planning, design, and management of water resources projects. Also to impart understanding of introductory aspects of integrated water resources development and management.

Course Outcomes:

CO1: To perform multiple analysis on precipitation data.

CO2: To estimate various components of hydrological cycle such as stream flow, runoff, evapotranspiration and infiltration.

CO3: To measure components of hydrological water balance in field.

CO4: To perform hydrograph analysis and estimate magnitude of flood.

CO5: To determine reservoir capacity and sedimentation.

CO6: To perform steady state analysis of groundwater movement.

CO7: To determine the technical, social and economic aspects of water resources planning and management.

S. No.	**Course Contents**	**Contact Hours**
01.	Definition and scope of hydrology, hydrological cycle, water balance equation.	02
02.	Precipitation, its mechanism, forms, weather systems, Indian scenario, measurement, average precipitation, gauge network adequacy, missing data determination, and consistency.	03
03.	Evaporation: factors affecting, measurement, empirical equations, analytical methods, reservoir evaporation; Evapotranspiration, its measurement, ET equations, potential evapotranspiration.	03
04.	Interception and depression storage.	01
05.	Infiltration, infiltration capacity, measurement, indirect determination, infiltration indices.	03
06.	Streamflow measurement: Direct and indirect methods, depth measurement, velocity measurement, stage-discharge relationship.	03
07.	Runoff: Factors affecting, runoff characteristics of streams, rainfall-runoff relationships.	02

08.	Hydrographs: Definition, components, base flow separation, effective rainfall, unit hydrograph, its derivation, applications, and limitations.	03
09.	Floods: Rational method, empirical methods, U.H. method, Design flood definition.	02
10.	Flood routing: Reservoir and channel routing.	03
11.	Reservoir Design Studies: Types of reservoirs, storage capacity, fixation of capacity, safe yield,reservoirse dimentation: trap efficiency, capacity-inflow ratio, life of reservoirs.	03
12.	Groundwater: Introduction, types of aquifers, aquifer properties, Darcy's law, Dupuit assumptions, steady one-dimensional aquifer flow, Well Hydraulics: Steady flow towells in confined and unconfined aquifers.	03
13.	Fluvial Hydraulics: Introduction, properties of sediment particles, brief description of incipient motion, bed load, and suspended load.	03
14.	Water Resources Planning and Development: National water policy, Single and multi-purpose development, Integrated water resources development and management, inter-state and international aspects of river basin development.	02

References:

1. Subramanaya, K."Engineering Hydrology" Tata McGraw Hill, New Delhi, 2001.
2. Linsely,K.,Kohler, A. and Paulhus L.H. "Hydrology for Engineers" McGrawHill BookCompany Inc. New York, 1975.
3. Ragunath, H.M. "Hydrology Principles Analysis and Design" New AgeInternational (P) Ltd Publishers., New Delhi, 2005.
4. Garde, R.J. and RangaRaju K.G. "Mechanics of sediment transportation andalluvial stream problems". New Age International (P) Ltd. Publishers, NewDelhi, 1994.
5. Arora, K.R. "Irrigation Water power and water Resources Engineering".Standard Publishers Distributors, Delhi, 2002.
6. Wilson, E.M. "Engineering Hydrology" ELBS, English Language book Society/Macmillam Education Ltd., London, 1999.
7. Asawa, G.L. Irrigation and Water Resources Engineering, New ageInternational Publishers, 2005.

Structural Analysis – III (Code: CVT305)	**Contact Hours = 42**	**Total Course Credit: 3**			
Mid-Term	Class Assessment	End-Term	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

Course Objective: To learn the method of drawing influence lines for determinate and indeterminate structures. The students are expected to analyze the arches and suspension bridges and learn the plastic analysis of beams and rigid frames.

Course Outcomes:

CO1: Draw influence lines for statically determinate structures and calculate critical stress resultants.

CO2: Understand Muller-Breslau principle and draw the influence lines for statically indeterminate beams.

CO3: Analyze three hinged, two hinged and fixed arches.

CO4: Analyze the suspension bridges with stiffening girders.

CO5: Understand the concept of Plastic Analysis and the method of analyzing beams and frames.

S. No.	Contents	Contact Hours
01.	**Influence Line Diagrams for Determinate Structures:** Influence lines for reactions in statically determinate beams, Girders with floor systems, Trusses: ILD for deflections. Calculation of critical stress resultants due to concentrated and distributed moving loads – absolute maximum bending moment – influence lines for member forces in pin jointed plane frames. Muller-Breslau Principle	10
02	**Arches** – Types of arches – Analysis of three hinged, two hinged and fixed arches – Parabolic and circular arches – Rib shortening and temperature effects.	8
03.	**Cables and Suspension Bridges:** Statics of a suspension cable. Analysis of cables and suspension bridges with and without stiffening girders. Influence lines for three hinged stiffening girders.	8
04.	**Plastic Analysis:** Plastic theory, Plastic Section Modulus, Shape factor and Moment of resistance, Plastic hinge and Mechanism – Collapse load – Static and Kinematic methods- Upper and Lower Bound Theorems – Plastic Analysis of Indeterminate beams and frames including Gable Frames. Plastic moment distribution for multi-storey and multi-bay frames.	10
05.	**Influence Line Diagrams for Indeterminate Structures: -** Influence lines for shear force, bending moment and support reaction components of beams, arches. Development of force envelope.	6

Textbooks:

1. Hibbeler, R. C. (2002). *Structural Analysis*, Pearson Education (Singapore) Pt. Ltd., Delhi

2. Leet, K. M. and Uang, C-M. (2003). *Fundamentals of Structural Analysis*, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. V.K. Manicka Selvam: Fundamentals of Limit Analysis of Structures (A Course in Plastic Analysis of Structures), Dhanpat Rai Publications.

References:

1. C. S. Reddy, ‘Basic Structural Analysis’, Tata McGraw Hill, New Delhi.
2. C.K. Wang, ‘Intermediate Structural Analysis’, Tata McGraw Hill, New Delhi.
3. Junnarkar.S.B. and Shah.H.J, “Mechanics of Structures”, Vol II, Charotar Publishing House, New Delhi 2016.

Concrete Technology (Code: CVT307)	Syllabus for B.Tech. 3rd Year (5th Semester) (Civil Engineering)	Total Course Credit: 3			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

Course Objective: To impart understanding of various aspects related to ingredients and properties of concrete and concrete mix design.

Course Outcomes:

CO1: Understand properties and role of ingredients like cement, aggregate etc. to produce better quality concrete

CO2: Understand the behavior of fresh and hardened concrete.

CO3: Apply design mix to produce concrete with adequate strength

CO4: Understand the need for special concrete

S. No.	Course Contents	Contact Hours
01.	Cement: Its Basic Chemistry, Types of Portland cement	05
02.	Normal aggregates and their properties	05
03.	Fresh Concrete and its properties. Strength of Concrete: Water/Cement ratio-Gel/Space Ratio, Influence of Temperature on Strength of Concrete and Bond between concrete and Reinforcement, Mixing, handling, placing, and Concrete. Elasticity, Shrinkage and Creep of Concrete	18
04.	Mix Design: IS method	05
05.	Special Concretes	05

References:

1) Neville, A.M. “Properties of Concrete. Pearson Publishers, New Delhi, 2004
2) Shetty, M.S. “Concrete Technology” S.Chand& Company New Delhi, 2002
3) Gambhir,M.L. “ Concrete Technology” TaTa McGraw Hill New Delhi, 1995
4) Neville, A.M. and Brookes, J.J.” Concrete Technology”, Pearson. 1994

Course Title: ENGINEERING SEISMOLOGY (Code: CVT307)	**Syllabus for B.Tech. 5th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	End-Term Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

Course Objective: To impart the basic understanding of earthquakes, physics of the earth's interior from a practical side, to foresee the potential consequences of strong earthquakes on urban areas and civil infrastructure and how to do more efficient hazard management and mitigation. This module will communicate how science can enhance community resilience and has relevance far beyond any site for earth sciences, earthquake engineering, preparedness, mitigation, emergency response, decision-making, and public policy.

Course Outcomes:

CO1: Properties of the Earth's interior, physical characteristics of seismic sources, Estimation of seismic hazard and risk

CO2: Effects of earthquakes on humans, objects and surroundings.

CO3: Information on the soil structure and properties at the construction site, as well as on the path between epicentre and the site

CO4: Parameters needed in order to construct seismically safe and sound structures.

S. No.	**Course Contents**	**Contact Hours**
01.	Engineering Seismology, Seismology and Seismic Exploration (Definitions). Introduction to Seismic Hazard and Earthquake Phenomenon. Global seismicity - Analysis of earthquake focal mechanisms.	06
02.	Seismotectonic and Seismic Zoning of India. Micro-zonation. Mechanism of Faulting. Earthquake Prediction.	07
03.	Site Response to Earthquakes: Local geology and soil conditions. Site investigations and soil tests. Dynamic design criteria for a given site.	08
04.	Earthquake Monitoring and Seismic Instrumentation. The Seismograph – Principles of Seismometer. Location of the epicenter of an earthquake. Earthquake size and intensity. Energy released in an earthquake.	08
05.	Earthquake: Risk and Preparedness. Earthquake: Social Consequences; Codes and Public Policy.	08

References:

1. Bolt, B.A., W.H. Freeman, Earthquake, New York, 1993.
2. Kearey P and Brooks, An Introduction to Geophysical by Exploration, M. Blackwell PublishersOxford, 1991.
3. Robinson, E.S andCoruch, Basic Exploration Geophysics, C. John Wiley & Sons, 1998.
4. Walker, B.S., Earthquake Time-Life Books Inc.,Alexandria, Virgina, 1982.
5. Bott, M.H.P., EdwardArnold, The Interior of the Earth. London, 1982.
6. Flower, C.M.R, The Solid Earth: An Introduction to GlobalGeophysics., CambridgeUniversity Press, 1990.
7. Lay, T. and Wallace,T.C, Modern Global Seismology., Academic Press, San Diego, 1995.

Course Title: Architecture & Town Planning (Code: CVT307)	Syllabus for B.Tech. 5th Semester (Civil Engineering)	Total Course Credit: 3			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	End-Term Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

Objective: To impart understanding of various aspects related to architecture planning and design. Various aspects of town planning, city master plans, etc.

Course Outcomes:

CO1: To be able to understand the importance of Architecture, its history and relationship with Civil Engineering.

CO2: To develop and understanding of Architectural Planning, Design and functional analysis.

CO3: To be able understand various aspects of town, city and regional planning.

CO4: To understand the concept of Master plan and City zoning.

Details of Course:

S.No.	Contents	Lecture Hours
	A. ARCHITECTURE:	
1	INTRODUCTION: Architecture and Civil Engineering, Classical Architecture, Contemporary Architecture , Genaral aspects of Architectural projects.	**4**
2	ARCHITECTURAL PLANNING AND DESIGN: Introduction, factors affecting Architectural design, principles of Architectural design , organization of space , space standards , modular co-ordination.	**6**
3	FUNCTIONAL ANALYSIS: Analytical study of buildings in respect of functional efficiency, Architectural efficiency , Building science ,environmental controls- both exterior and interior , physical and economical constraints with reference to residential and public buildings.	**6**
4	ARCHITECTURAL PLANS AND PROJECTS: Introduction to Architectural plans, preparation and reading of Architectural plans , analytical study of various works/ projects of some architects like LE Corbusier , Phillip Jhonson , F.L. Wright , etc.	**10**
	A. TOWN PLANNING:	
5	INTRODUCTION: Planning at various levels- national , regional , city and village.	**3**
6	HISTORY:	**3**

	Brief historic review of some ancient towns , present day planning in India.	
7	MASTER PLAN: Importance of master plan for redevelopment of existing townsand planning of new towns , implementation , building bye-laws , concept of Redburn neighbourhood pattern.	**2**
8	ZONING: Zoning regulations for various urban land uses including density and height zoning , multi-story buildings and their implications on urban planning.	**2**
Total		**36**

BOOKS RECOMMENDED:

1. Architectural Design by K.R. Moudgil
2. New Concepts in Architecture and Design by Yoshikawa
3. Reading Architectural Plans by Ernest R. Weidhaas
4. Introduction to Architecture by V.B. Vaidya.
5. Town Planning by Rangawala.
6. Town Design by Fredrick Gibberd.

B.TECH. 6th SEMESTER (Civil)

<table>
<tr><th>Course No.</th><th>Course title</th><th>L</th><th>T</th><th>P</th><th>C</th></tr>
<tr><td>CVT350</td><td>Design of Structures-II</td><td>2</td><td>2</td><td>0</td><td>4</td></tr>
<tr><td>CVL350</td><td>Structural Engineering Lab.-II</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>CVT351</td><td>Traffic Engineering and Road Facilities</td><td>2</td><td>2</td><td>0</td><td>4</td></tr>
<tr><td>CVL351</td><td>Traffic Engineering Laboratory</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>CVT352</td><td>Geotechnical Engineering-II</td><td>2</td><td>2</td><td>0</td><td>4</td></tr>
<tr><td>CVL352</td><td>Geotechnical Laboratory-II</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>CVT353</td><td>Irrigation and Hydraulic Structures</td><td>2</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td>CVT1453</td><td>Industrial Training &Presentation</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td></td><td>Elective Courses</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">CVT354</td><td>Water Shed Management</td><td rowspan="3">2</td><td rowspan="3">1</td><td rowspan="3">0</td><td rowspan="3">3</td></tr>
<tr><td>Numerical Methods in Civil Engineering</td></tr>
<tr><td>MAT050</td><td>Operations Research</td></tr>
<tr><td rowspan="3">CVT355</td><td>Computer Aided Design</td><td rowspan="3">2</td><td rowspan="3">1</td><td rowspan="3">0</td><td rowspan="3">3</td></tr>
<tr><td>Disaster Management</td></tr>
<tr><td>Applied Hydrology</td></tr>
<tr><td colspan="2">Total Lecture Hours and Credits</td><td colspan="3">27</td><td>25</td></tr>
</table>

Design of Structures -II (Code: CVT350)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Objective: This course is designed to introduce the behavior and design of structural steel members according to the limit states design concept. Students are expected to obtain basic knowledge about the design and failure mode of structural steel members after finishing this course.

Course Outcomes:

CO1: Design of bolted and welded connections; concentric and eccentric
CO2: Design of rolled and built-up tension members.
CO3: Design of rolled and built-up compression members.
CO4: Design of laterally supported and unsupported flexural members
CO5: Design of plate girders
CO6: Understanding failure modes and application of Limit States Design philosophies of steel design.

S. No.	**Course Contents**	**Contact Hours**
01.	**General considerations** Introduction to structural steel and their design philosophies. Properties, rolled sections.	2
02.	**Simple Connections** Design of bolted connections, welded connections: concentric and eccentric connections, load transfer mechanism, failure of joints, prying action ,selection of fasteners	8
03.	**Tension members** Types & design of tension members; Rolled and Built-up sections, types of failures, lug angles, gusset plates.	4
04.	**Compression members** Effective length, slenderness ratio & types of buckling, design of compression members; Rolled and Built-up sections. Design of column bases.	6
05.	**Beams** Behaviour of beams in flexure, classification of sections, lateral torsional buckling, shear strength of beams. Design of flexural member, laterally supported, laterally unsupported and built-up beams.	6

06.	**Roof Truss** Types of roof trusses, Loads on a roof truss, Design of truss members	4
07.	**Plate Girders** Elements & proportioning of plate girder, shear buckling design methods, types & design of stiffners, curtailment of flanges, design procedure of Plate Girders with special focus on shear buckling & use of web stiffeners.	4

References:

1) Design of steel structures By Subramanian
2) Steel structures – Design & Behaviour By Salmon & Johnson
3) Design of steel structures By SK Duggal.
4) Design of steel structures By Vizrani and Ratwani

Structural Engg. Lab – II (Code: CVL – 350)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 1**		
Internal Examination	External Examination	L	T	P
50 Marks	50 Marks	0	0	2

CO1 Ability to demonstrate professional engineering approach, including application of principles and utilization of technical resources such as software's towards solving technical problems requiring civil engineering interventions.

CO2 Ability to furnish and/or analyse designs and construct structural systems, produce related documents, drawings and reports, and present objective estimates of the related quantities.

CO3 Ability to conduct field and laboratory investigations pertaining to civil engineering domain, and utilize modern tools and techniques of surveying.

CO4 To understand the behaviour of structural members

Name of the experiment:

Expt. No	**Contents**
1.	Deflection of curved beams
2.	Behaviour of a portal frame under different load combinations
3.	Deflection of Truss
4.	Behaviour a cantilever beam under symmetrical and un-symmetrical loading
5.	Analysis of an elastically coupled beam
6.	Analysis of a redundant joint

7.	Analysis of two hinged arch

Traffic Engg. And Road Facilities (Code: CVT351)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	End-Term Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Objective: To impart understanding and knowledge of various aspects of Traffic Engineering and Road Facilities.

Course Outcomes:

CO1: To understand the various aspects of roads, road characteristics, road capacity

CO2: To understand the level of service concept &traffic control devices.

CO3: To understand the aspects of traffic flow, fundamental relation of traffic flow, etc.

CO4: To understand the intersections and interchanges along with their requirement and design.

S. No.	**Course Contents**	**Contact Hours**
01.	Components of traffic system-vehicle characteristics; human characteristics, road characteristics & Traffic Studies.	10
02.	Intersections-unsignalized intersections, channelization and round abouts, interchanges- requirement & design.	08
03.	Traffic-control devices, Traffic signs- role and types, signalized intersections, signal timing design; signal coordination, Parking facilities-parking demand, on-street parking, off-street parking.	12

04.	Traffic flow theory-flow parameters; fundamental relation of traffic flow, road capacity and level of service concept.	10

References:

1. CA O'Flaherty, Transport Planning and Traffic Engineering, John Wiley & Sons, Inc., New York; Toronto,2002.
2. McShane &Roess, Traffic Engineering, Prentice-Hall of India Private Ltd, NewDelhi-110001 ,1990.
3. Kadiyali & Lal, Principles and Practices of Highway Engineering, Khanna Publishers, Delhi-6, 1996.
4. Chakarborty & Das, Principles of Transportation Engineering, Prentice-Hall of India Private Ltd, New Delhi-110001 .
5. L. R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, 2-B, NaiSarak, Delhi- 110006, 1999.

Traffic Engineering Lab- II (Code: CVL 351)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 1**		
Internal Examination	External Examination	L	T	P
50 Marks	50 Marks	0	0	2

CO1 To understand the road user/ driver characteristics in Lab, traffic volume studies in field, intersection volume studies in field: design of questionnaires, data collection, compilation and analysis of field and lab data, presentation of results and derive conclusions

CO2 To perform small-network volume studies and OD volume studies: design of questionnaires, data collection, compilation and analysis of field and lab data, presentation of results and derive conclusions

CO3 To understand the traffic speed (spot speed) studies, conduct of travel-time & delay studies, accident studies: design of questionnaires, data collection, compilation and analysis of field and lab data, presentation of results and derive conclusions

CO4 To understand and perform pedestrian and parking studies: design of questionnaires, data collection, compilation and analysis of field and lab data, presentation of results and derive conclusions.

Expt. No	**Contents**
1	Study of Road user characteristics
2	Traffic volume studies

3	Intersection volume studies
4	Small-network volume studies
5	OD volume studies
6	Study of traffic speed
7	Speed & delay studies
8	Travel-time studies
9	Accident studies
10	Pedestrian studies
11	Parking studies

Geotechnical Engineering – II (Code: CVT352)	**Syllabus for B.Tech. 6TH Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Outcomes (COs)

CO1: To equip the knowledge of strength and mechanical behaviour of soils.

CO2: To understand the concepts of bearing capacity and foundations.

CO3: To understand the practical aspects of earth pressure and retaining structures.

CO4: To understand the concepts of slope stability along with its practical application

Detailed Syllabus:

Sr. No.	**Course Contents**	**Contact Hours**

1	**SHEAR STRENGTH:** Shear Strength Concept, Theories of shear strength, Mohr-Coulomb Law, Laboratory determination of: a. Triaxial Compression Test under Different Drainage Conditions, viz undrained, drained and consolidated undrained. b. Direct Shear Test c. Unconfined Compression Test, and. d. Vans shear test	10
2	**EARTH PRESSURE:** Lateral earth pressure. Rankine's theory Active and Passive States. Lateral earth pressure under various conditions, like surcharge, sloping backfill and high water table behind the wall. Earth pressure diagrams, Total thrust, Tension Cracks and bracing of excavations.	04
3	**STABILITY OF SLOPES:** Infinite slopes, conjugate stresses, stability number, Swedish and Friction circle methods. Submergence case, complete draw down case, Steady seepage case.	04
	STABILISATION: Methods of stabilization. Brief introduction to each of the methods of stabilization	02
	INTRODUCTION TO FOUNDATION ENGINEERING Foundation, Foundation types, Construction materials, Principles of foundation Engineering, Foundations applications**,** Challenging problems **BEARING CAPACITY AND FOUNDATIONS:** Basic terminology, bearing capacity of shallow foundations. Methods of determination of bearing capacity, Prandtl's solution Terzaghi's solution for ultimate bearing capacity. Size effects. Effects of rigidity of footings. Plate load test.	06
	FOUNDATION DESIGN: • Design principles for footing and rafts. • Foundations on clays and sands • Pile foundation types, classifications and determination of load carrying capacity, dynamic and static methods. • Pile load test, pile groups efficiency of pile groups.	10
	Total	**36**

References:

1. Ranjan, G and Rao, P.,"Basic and Applied Soil Mechanics", New Age International Pvt. Limited, New Delhi, 2002.
2. Arora, K.R., "Soil Mechanics and Foundation Engineering", Standard Publishers Distributors, Delhi, 1987.
3. Singh, A., "Basic Soil Mechanics & Foundations", CBS Publishers & Distributors, 2004.
4. Taylor, D.W., "Fundamentals of Soil Mechanics", Wiley, New York, 1948.
5. Bowles, J.E., "Physical and Geotechnical properties of Soils", McGraw Hill Publishers, 1979.
6. Terzaghi, K., "Theoretical Soil Mechanics", Wiley, New York, 1943.
7. Terzaghi, K., Peck, R.B. and Mesri, G., "Soil Mechanics in Engineering Practice", 1996.
8. Jumikis, A.R. "Soil Mechanics", R.E. Krieger Pub. Co., Florida, US, 1984.
9. Purushothama, P. "Geotechnical Engineering", McG00raw Hill Education, 1995.
10. Venkataramaiah, C., "Geotechnical Engineering", New Age International Publishers, Daryagunj, New Delhi, 1995.

Geotechnical Engineering Lab- II (Code: CVL -352)	**Syllabus for B. Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 1**		
Internal Examination	External Examination	L	T	P
50 Marks	50 Marks	0	0	2

COURSE OUTCOMES

CO1. Determine consolidation characteristics of a given soil sample.

CO2. Obtain shear strength parameters of different types and/or consistencies of soils and under different drainage conditions.

CO3. Perform Standard Penetration test of soil to obtain SPT (N) – value.

CO4. Determine allowable soil pressure of soil foundation system by vertical plate load test.

Expt. No.	Name of the Experiment
1	Consolidation Test

2	Direct Shear Test
3	Unconfined Compression Test
4	Unconsolidated Undrained Triaxial Test
5	Vane Shear Test
6	Consolidated Undrained Triaxial Test
7	Standard Penetration Test
8	Plate Load Test

Irrigation And Hydraulic Structures (Code: CVT353)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

Course Outcomes:

CO1: To appreciate various methods of irrigation and water application to agricultural fields.

CO2: To carry out hydraulic design of irrigation canals, diversion headworks and cross-drainage works.

CO3: To appreciate the soil-water- plant relationship and understand the crop water requirements.

CO4: To Understand various aspects of water logging of agricultural lands.

S. No.	Course Contents	Contact Hours
01.	**INTRODUCTION** Present status of irrigation in India, Advantages of irrigation, brief description of Gravity, Lift and Sprinkler irrigation.	04
02.	**SOIL-WATER- PLANT RELATIONSHIP. CROP WATER REQUIREMENTS:** Soil moisture and crop water relationships, Duty, Delta, Consumptive use, Irrigation requirements, Principal Indian crops, Multiple Cropping, etc.	08
03.	**CANAL IRRIGATION:** Types of canals, parts of canal irrigation system, channel alignment, assessment of water requirements, estimation of channel losses, Design of channels, Regime and semi theoretical approaches, Canal lining, factors affecting choice of various types of canal linings.	04
04.	**DIVERSION HEADWORKS:** Selection of site and layout, Parts of diversion head works, types of weirs and barrages, Design of weirs on permeable foundations, control of silt entry into canal, Silt excluders and different types of silt ejectors	04
05.	**CROSS DRAINAGE WORKS:** Necessity of cross drainage works, their types and selection, Design of various types of cross drainage works-Aqueduct, Siphon aqueduct, Super passage, Siphon, Level crossing.	06
06	**WATER LOGGING:** Causes, preventive and curative measures, drainage of irrigated lands, saline and alkaline lands.	04

References:

2. Singh Bharat. "Fundamentals of Irrigation Engineering", Nem Chand & Brothers, Roorkee.
3. Varshney, Gupta and Gupta, Irrigation Engineering and Hydraulic Structures". Nem Chand &
   Brothers, Roorkee.
4. Arora, K.R. Irrigation, water power and Water Resources Engineering", Standard Publishers Distributors, Delhi.
5. Asawa, G.L. "Elementary Irrigation Engineering" New Age International (P) Ltd. Publishers, New Delhi.

Water Shed Management Structures (Code: CVT 354)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	3

Course Outcomes:

CO1: To perform studies related to watershed management.

CO2: To prepare pre-feasibility and detailed project reports, etc.

CO3: To appreciate the concept of integrated water resources management.

CO4- To understand the concepts of renewable energy, biomass, etc.

CO5- To equip with the rural technological delivery systems and low cost technology that can be used in the farm.

S. No.	**Course Contents**	**Contact Hours**
01.	**INTRODUCTION** Importance of Water Shed Development for improvement in Environment.Status of Watershed Development in India, Watershed Concepts	04
02.	**Land:** Survey(layout), Soil and Soil Moisture Conservation, Rainwater Management, Reclamation of saline soils.	08
03.	**Water: :** Data and Analysis, Integrated Water Resources Management, Conjunctive Use	04
04.	**Greenery:** Agriculture, Crop Husbandry, Sustainable Agriculture, Biomass, Management, Dryland Agriculture, Irrigation, Pastures and Silvipastures, Horticulture, Social Forestry, Afforestation.	04
05.	**Energy:** Renewable Resources, Biomass, small hydropower, Ocean Tides and Waves.	06
06	**Socioeconomics:** Peoples'part, State and Integrated Approach, Sustainable Society, Economics.	04
07	**Appropriate Technology** Farm Equipment, Contour Methods, Check Dams, Water Catchment and Harvesting, Low Cost Technology, Rural Technological Delivery Systems.	03

References:

1 Murthy, J.V.S. Watershed Management, New Age International Publishers (P) Ltd. India.

2 Suresh, R. Watershed Hydrology, Standard Book House, India. .

3 Das, Ganshyam.Hydrology and Soil Conservation Engineering, Prentice Hall of India. .

Operations Research (Code: MAT 050)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	3

Objective: To familiarize the students with different aspects of optimization theory.

Course Outcomes:

CO1: Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand

CO2: Understand the relationship between a linear program and its dual, including strong duality and complementary slackness

CO3: Be able to build and solve Transportation Models and Assignment Models.

CO4: Learn optimality conditions for single- and multiple-variable unconstrained and constrained non-linear optimization problems, and corresponding solution methodologies.

Details of Course:

S.No.	**Contents**	**Lecture Hours**
1	Linear programming - Formulation of Linear programming problem, Theory of Convex sets, Graphical solution of L.P.P, Simplex Method, Two Phase Simplex Method, Duality in Linear Programming, Transportation and Assignment problem. Application of Linear programming to Industrial Problems.	**20**
2	Non-Linear programming- quadratic form, Hessian Matrix, Positive definite and Negative Definite, Method of Lagrange multipliers, Wolfe's method of solving Quadratic Programming problem. Illustrations of some civil Engineering problems.	**16**
	Total	**36**

BOOKS RECOMMENDED

1. Linear Programming by S.I. Gass, Mc Graw Hill.
2. Operations research An Introduction, by Hamidi A.Taha, Macmillan.
3. Principles of Operations Research: with Application to Management Decisions.by H.M.Wagner, Prentice-Hall
4. Linear Programming by Hadley, Adison Wesley
5. Non Linear and Dynamic Programming by G.Hadley, Addison Wasley
6. Theory of Linear and Non-Linear Programming by S.Vajda, Longmans (London)

7. Foundations of Optimization, by D.I.Wilde and C.Boigtler Prentice Hall (1977).

Numerical Methods in Civil Engineering (Code: CVT 354)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	3

Objective: To impart understanding and knowledge of various aspects of numerical methods in the field of Civil Engineering – its various sub-disciplines.

Course Outcomes:

CO1: Apply numerical methods to obtain approximate solutions to mathematical problems.

CO2: Understand numerical techniques to find the roots of non-linear equations and solution of system of linear equations.

CO3: Understand the difference operators and the use of interpolation.

CO4: Understand numerical differentiation and integration and numerical solutions of ordinary and partial differential equations

Course Details:

S. No.	**Contents**	**Lecture Hours**
1	Finite Difference Difference table and its usage, the difference operator Δ,▼ and the operator E.	2
2	Interpolation Interpolation with equal intervals, Newton's forward difference formula, Newton's backward difference formula, interpolation with unequal intervals, Newton's divided difference formula, and Lagrange's interpolation formula.	4
3	Central Differences The central difference operator δ and the averaging operator μ. Relations between the operators, Guass's backward and forward interpolation formula, Sterling's ,Bessel's,Laplace and Everett's formulae.	4
4	Inverse Interpolation The central difference operator δ and the averaging operator μ. Relations between the operators Δ,▼, δ and μ. Guass's, Sterling's and Evett's formulae and their applications. Numerical Solutions of Algebraic and Transcendental Equations Regula-Falsi method, Bolzano's process of bisection of intervals, Newton-Raphson method.	6
5	Numerical Differentiation and Integration	10

	Numerical differentiation of a function, differential coefficients of a function in terms of its difference, numerical integration of a function, trapezoidal rule, Sympson's rule, Weddle's rule, The Euler-Maclaurin expansion formula.	
6	Difference Equations Linear homogeneous and non-homogeneous difference equations of order n with constant coefficients and their solutions, method of undetermined coefficients.	4
7	Numerical Solutions of Ordinary Differential Equations Picard's method, Taylor series method, Euler's method and Runga-Kutta method.	4
8	Numerical Solution of Simultaneous Equations and Eigen Value Problems Guass elimination method, Guass-Jordan method, Guass-Jacobi and Guass-Seidel iteration methods, power methods for solving Eigen value problems.	6
Total		**40**

11. Books Recommended:

1. Mathematical numerical analysis by S.C. Scarborough
2. Numerical methods for scientific and Engineering computation by M.K. Jain, S.R.K. Iyenger & R.K. Jain.
3. Numerical solution of differential equations by M.K. Jain.
4. Numerical methods for Scientists and Engineers by R.G. Stanton.
5. Numerical methods by P.K. Kandasamy, K. Thilagavathy, & K. Gunavathi.
6. Numerical methods by E. Balagurusamy.

Computer Aided Design (Code: CVT 355)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	3

Objective: To impart understanding of various aspects related to various computer softwares

Course Outcomes:

CO1: To develop an aptitude to use modern computer tools to conceptualize, create, model, analyze and evaluate designs within the context of local and global needs.

CO2: Introducing various programming languages like C and Fortran to the students.

CO3: To teach the students to understand the details of various CAD packages.

CO4: To develop a basic understanding of how to apply CAD packages in various civil engineering related applications.

Course Details:

S. No.	**Contents**	**Lecture Hours**
1	**Introduction: -** Basic concepts of CAD. Digital computer systems, number systems, Hardware, System and application software, Hardware for CAD Systems, Management of storage devices Files and their management, management commands.	4
2	**Introduction to CAD Softwares:-** Concept and examples of programming languages, user friendly (Menu Driven) softwares, basic programming techniques, Development of Algorithms, Applications of CAD	6
3	**Programming softwares :-** Application of C/Fortran language, Characters, Constants and Variables, Input and Output operators, statements, Library functions and header files, Data Types, Declaration of variables, relational and logical operators Main, Include and Define functions, If else statements, While statement and loops, decision making alternatives, Switch statements, For and Go To statements, Do statement, sub routines etc, Arrays and their types. Application of the programming language using examples for all statements.	12
4	**Applications in Civil Engineering:-** Application of CAD in various fields of Civil Engineering. Formation of Computer aided programmes for design of simply supported beams carrying udl and point loads, design of columns, Retaining walls, slope analysis,	10

	Design of Pipes, Sedimentation Tank Design, Filter Designs, application to survey and other Civil Engineering related subjects.	
5	**CAD packages for Civil Engineers :-** Introduction to Menu Driven softwares i.e. Stadd, Stadd pro, Autocad, AutoCivil, Graphics packages etc	4
Total		**36**

Recommended Books:

1. Computer Aided Design ---M.N.Shesha Prakash , G.S.Suresh
2. Computer Applications-----Gautam Roy
3. Programming in C-----------E.Balaguruswamy
4. Fortran77/90------------------R.K.Jain, R.P.Suri
5. Autocad Fundamentals------Micheal E.Beall , Howard M.Fuller

Disaster Management (Code: CVT 355)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	3

Objective: To impart knowledge for understanding of various aspects of disaster management cycle. Control and mitigation measures for disasters like : floods, droughts, landslides, and earthquakes.

Course Outcomes:

CO1: To understand the basic principles and various stages of disaster management and develop a knowhow about regional, national and international level regulatory authorities.

CO2: To have an understanding of various aspects of floods as disasters and various planning and mitigation measures.

CO3: To develop an understanding about Droughts and their soci-economic impacts - drought management.

CO4: To be able to understand different aspects of landslides and their mitigation.

CO5 : To understand different aspects of earthquake and their impacts on the Civil Enginering Structures and control and mitigation measures thereof.

Details of Course:

S.No.	**Contents**	**Lecture Hours**
1	Introduction to disaster management, various stages of disaster management, Indian seup- National Disaster Management Authority, state level authorities, Objectives of NDMA	**4**
2	Flood Disasters: Occurrence, Causes and effects of floods; flood plain delineation, mitigation measures viz., structural and non-structural measures, flood fighting, etc.	**8**
3	Droughts: Various definitions, drought monitoring indices, combating drought	**8**
4	Landslides: Causes, effects, and control measures, instrumentation and monitoring.	**8**
5	Earthquakes: Causes and effects, earthquake resistant design of buildings.	**8**
Total		**36**

1. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Chow ,VenTe;Maidment,David, R., Mays Lary, W. Applied Hydrology, McGraw Hill Publications.	1988
2	Singh, Vijay P. Elementary Hydrology, Prentice Hall of India.	1994
3	Ragunath, H.M. “Hydrology Principles Analysis and Design” New Age International (P) Ltd Publishers., New Delhi.	2005
4	Yevjevich. Coping with drought, Water Resources Publications.	1977
5	Yevjevich, etal..Drought Research needs, Water resources Publications , Colorado State University, USA.	1977

Applied Hydrology (Code: CVT 355)	**Syllabus for B.Tech. 6th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	3

Objective: To impart the knowledge for understanding of some of the engineering and advanced applications hydrological analysis and design.

Course Outcomes

CO 1: To develop an understanding about various concepts of hydrometeorology.

CO2: To be able to compute hydrological abstractions.

CO3: To be able to compute flood runoff, extreme flows, etc.

CO4: To understand and perform calculations on problems involving regression analysis.

Details of Course:

S.No.	**Contents**	**Lecture Hours**
1	INTRODUCTION: Historical development, concepts of hydrometeorology.	**3**
2	PRECIPITATION: Selection of precipitation networks, Storm analysis, Storm selection, DAD Analysis, Depth-area frequency curve, Concept of probable maximum precipitation and effective rainfall.	**6**
3	EVAPORATION AND EVAPO-TRANSPIRATION: Measurement, factors affecting evaporation and evapo- transpiration, evaporation reduction, E.T. equations	**5**
4	INFILTRATION: Factors affecting measurement, infiltration capacity by hydrograph analysis, infiltration indices, empirical and analytical equations.	**5**
5	RUNOFF: Determination of available flow, derivation of unitgraph from complex storm hydrograph, S-curve hydrograph, IUH and its determination, elementary idea of conceptual models, Synthetic unitgraphs.	**8**
6	EXTREME FLOWS: Estimation of design flood, flood frequency analysis, factors affecting droughts, analysis of droughts.	**8**
7	REGRESSION AND CORRELATION: Elementary treatment with two variables and application to hydrologic problems.	**4**

Total	**39**

1. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Chow, VenTe, Maidment, David, R.,Mays Lary W. "Applied Hydrology", McGraw Hill Publications.	1988
2	Viessmann, Warren Jr., Lewis Gary L." Introduction to Hydrology" Prentice Hall of India, New Delhi.	2009
3	Wilson, E.M. "Engineering Hydrology" ELBS, English Language book Society/ Macmillam Education Ltd., London.	1999
4	Linsely,K.,Kohler, A. and Paulhus L.H. "Hydrology for Engineers" McGraw Hill Book Company Inc. New York.	1975
5	Linsely,K.,Kohler, A. and Paulhus L.H. "Applied Hydrology" McGraw Hill Book Company Inc. New York.	1949
6	Chow VenTe," Handbook of Applied Hydrology", McGraw Hill Book Company, New York.	1964
7	Singh, V.P."Elementary Hydrology", Prentice Hall of India, Pvt. Ltd., New Delhi.	1994

B.TECH. 7th SEMESTER (Civil)

Course No.	Course title	L	T	P	C
CVT401	Environmental Engineering-I	2	1	0	3
CVL401	Water Quality Lab	0	0	2	1
CVT402	Structural Dynamics	3	1	0	4
CVT403	Construction Technology & Management	2	1	0	3
CVT404	Design of Structures-III	2	2	0	4
CVT405	Quantity Surveying and Cost Evaluation	2	1	0	3
CVS405	Seminar	0	2	0	2
CVP406	Project Pre-Work	0	0	4	2
Elective courses					
CVT406	Railway and Airport Engineering Fluvial Hydraulics Advanced Geotechnical Engineering	2	1	0	3
Total Lecture Hours and Credits		28			25

Environmental Engg - I (Code: CVT401)	**Syllabus for B.Tech. 7th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

Objective: To impart training to the student of various aspects related to water quality, Quantity, Storage and Distribution in addition to sanitation of buildings.

Course Outcomes:

CO1 : To be able to identify the sources of water and assess it's water quality parameters.

CO2 : To be able to assess the water demand for various uses based on population estimation.

CO3 : To be able to understand various processes involved in water Treatment.

CO4 : To be able to design various components of water supply distribution system which includes reservoirs, pipe networks, pumps, etc.

CO5 : To be able to understand various aspects of water supply and sanitation in buildings including plumbing fixtures.

S No	**Contents**	**Lecture Hours**
1	Introduction and scope, Various sources of water, Water Quality Parameters, significance and codal recommendations of limits for various uses	**6**
2.	Water demand for various purposes, Population forecast, storage capacities of reservoirs, Variation in demand	**6**
3.	Water treatment: - Conventional treatments like screening, sedimentation, Coagulation, Filteration, Disinfection. Advanced treatments like Micro Filteration, Reverse osmosis, Activated carbon, etc	**10**
4.	Systems of distribution, Location of reservoirs, distribution patterns,	**2**
5.	Pipe designs, network analysis by various methods, pipe materials and joints, leakage prevention, types of pumps, Pump Design	**6**
6	Water supply in buildings, Plumbing and fixtures	**3**
7.	Sanitation of buildings.	**3**
	Total	**36**

Suggested books :-

S.No	**Name of books/Authors/Publishers**	**Year**
1.	"Water Works Engineering", /S.R Q , Motley E.M, Guang Zha/Prentice Hall	2009
2	"Env. Engg .Vol-1/ Modi P.N./ Standard Book House, Delhi.	2008

3	"Water and Waste Water Tech."/ Hammer M.J, / Prentice Hall	2001
4	"Water Supply and Sewerage," /McGhee T.J / McGraw Hill, Inc	1991
5	Dr. B. C. Punmia, Ashok Kr. Jain, Arun Kr. Jain, " Water Supply Engineering", Lakshmi Publications, New Delhi.	1995

Water Quality Laboratory (Code: CVL 401)	**Syllabus for B. Tech. 7th Semester (Civil Engineering)**	**Total Course Credit: 1**		
Internal Examination	External Examination	L	T	P
50 Marks	50 Marks	0	0	2

Course Outcomes:

CO1 **:** To be able to learn the basics of chemical analysis using gravimetric methods and develop an understanding about important Processes like filtration, titration, etc.

CO2 **:** To be able to use water testing kits and other devices like digital pH meter, flame Photometer etc.

CO3 **:** To be able to carry out all the requisite quality tests on water from the point of view of Drinking water standards.

CO4 **:** To be able to develop an understanding of various reagents used in water testing.

Details of Course:

S.No	**List of Experiments**	**Contact Hours**
1.	To determine the total solids, suspended solids and dissolved solids for a given sample of water	**2**
2.	To determine the alkalinity of a given sample of water	**2**
3.	To determine the total hardness and carbonate hardness for a given sample of water.	**2**
4.	To determine the turbidity of water.	**2**
5	To find the colour and odour of a given sample of water	**2**
6.	To determine the percentage of Sodium and potassium in a given sample of Water	**2**
7.	To determine the percentage of sulphates, chlorides, iodide, Floride.	**2**
8.	To determine the concentration of dissolved oxygen in a given sample of water and to find out the oxygen consumed.	**2**
9.	To determine the percentage of Ammonia and Nitrogen present in a given sample of water.	**2**
10.	To determine the percentage of Magnesium, Calcium, Iron, Silica and Aluminium in a given sample of water.	**2**
	Total	**20**

Structural Dynamics (Code: CVT402)	**Syllabus for B.Tech. 7th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	3	1	0

CO1 Get familiarized with basic principles, terminology etc. of structure dynamics and recognize the properties affecting the dynamic behavior of the structure including appropriate idealization for reliable dynamic analysis.

CO2 Understand free vibration of single degree of freedom systems particularly the determination of important dynamic properties (natural frequency and damping) and the forced vibration response of single degree of freedom systems under viscous dynamic excitation like harmonic, periodic, step/pulse and generalized type of loading.

CO3 Learn about some key concepts like natural frequencies, mode shapes and orthogonality relationships of multi degree of freedom systems, understand the free vibration of multi degree of freedom systems and computation of important dynamic properties and understand the forced damped and undamped vibration of multi degree of freedom systems under dynamic excitations using various methods.

CO4 Learn about Indian Standard Codal provisions for earthquake resistant design of buildings using Equivalent Static Method.

S. No.	**Course Contents**	**Contact Hours**
01.	Nature of dynamic loading: Harmonic, earthquake and blast loading,	08
02	Single degree of freedom systems, free vibrations and forced vibrations:	06
03	Harmonic force, Periodic force, Impulse, and General types of loading.	04
04	Multi-degree of freedom systems, numerical techniques for finding natural frequencies and mode shapes, orthogonality relationships of principal modes, Rayleigh's Principal and its application for determination of fundamental frequency. Evaluation of dynamic response by mode superposition method.	06
05	Discussion on Indian standards, codal provisions for earthquake resistant design. Design of buildings (Plane frames only) based on Codal provisions Nature of dynamic loading: Harmonic, earthquake and blast loading, Single degree of freedom systems, free vibrations and forced vibrations: Harmonic force, Periodic force, Impulse, and General type of loading	06

References:

1. Structural Dynamics by Anil.K. Chopra 2005
2. Dynamics of Structures ,Clough and Penzien 5th Edition
3. Dynamics of structures by Vinod Hosur
4. Structural Dynamics Theory and computation by Mario Paz

Construction Technology & Management (Code: CVT403)	**Syllabus for B.Tech.-7thsem**	**Total Course Credit: 3**			
Mid-semester Examination	Continuous Class-Assessment	End-Semester Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

Course Objective: To impart understanding of various aspects of construction equipment, and management of construction projects

Course Outcomes:

CO1- To understand the various techniques of civil engineering constructions.

CO2- To understand the various aspects of construction equipment's.

CO3- To develop the skill for the management of construction projects.

CO4- To develop the concept of works accounting and leadership organization.

Details of Course:

S. No	**Contents**	**Lecture Hours**
01.	Construction Management, its necessity; objectives &Functions	03
02.	Construction methods and plant important equipments only	06
03.	Project scheduling: Various techniques namely Bar chart; CPM and PERT.	07
04.	Engineering economics of projects; Depreciation; Sinking Fund; compound interest factors, Selection of most economical alternative by variable cost method/Cost benefit ratio. Owning and Operating cost.	10
05.	Organization of Leadership: Function of project organization. Principles and advantages of good organization. Leadership and motivation	04
06.	Works accounting. Cashbook, Imprest cash, contractors bills, store accounts. Materials at site account. Indent, invoice, Debit & Credit note, suspense head stock, Engineering Statements, Form of agreement.	06

Books Recommended:

1.Construction Management by Mahesh Verma

2. Construction of Plant and Equipment by Peurifay

3.CPM &PERT by B.C.Punmia
4.Project Management by K.N.JHA

Design of Structures III (Code: CVT404)	**Syllabus for B.Tech. 7th semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Outcomes:

CO1: Design RCC footings(Isolated footings and various types of combined footings) and Design of masonry foundations

CO2: Design cantilever and counter fort type RCC retaining walls. Design masonry retaining walls.

CO3: Design underground, circular and rectangular water tanks with reference to IS: 3370.Design of domes and ring beams.

CO4: Design Rectangular, T and I section beams of pre stressed concrete.

S. No.	**Course Contents**	**Contact Hours**
01.	Foundations: The design of RCC footings, isolated footings and various types of combined footings, design of masonry foundations	06
02.	Retaining walls: Design of cantilever and counter-fort type RCC retaining walls. Design of masonry retaining walls	05
03.	Water tanks: Design of underground, circular and rectangular water tanks with reference to IS:3370.	06
04.	Pre-stressed concrete: Design of Rectangular, T and I section beams of pre stressed concrete.	10
05.	Domes: Design of domes and ring beams.	04
06.	Works accounting. Cashbook, Imprest cash, contractor's bills, store accounts. Materials at site account. Indent, invoice, Debit & Credit note, suspense head stock, Engineering Statements, Form of agreement.	05

References:

1) Construction Management by Mahesh Verma
2) Construction of Plant and Equipment by Peurifay

Quantity Surveying & Cost Evaluation (Code: CVT405)	**Syllabus for B.Tech. 7th Semester (Civil Engineering)**	**Total Course Credit: 3**		
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	End-Term Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

Course Objective: To impart understanding of various aspects related to Material/labour analysis and other physical measurements in the field of Civil Engineering.

Course Outcomes:

CO1: Importance of estimation in civil engineering

CO2: Importance of specification in civil engineering

CO3: How we can perform estimate of different civil engineering structures

CO4: Importance and objective of rate analysis

CO5: Importance of road estimate and its cost analysis

S. No.	Course Contents	Contact Hours
01.	**Estimate:** Importance, Items of a work and their units. Types of estimates, viz. preliminary; approximate; Abstract estimate; Plinth area estimate; detailed estimate; revised estimate; supplementary estimate, bill of quantities and abstract of cost.	04
02.	**Analysis of Rates:** Preparing analysis of rates, Labour schedule, material schedule & rate schedule. Analysis of rates- of limeconcrete in foundation; Brickwork in foundation superstructure; stone masonry; R.C.C. work; R.B.work; Plastering; pointing; white washing; colour washing; painting; wood work, earth work in foundation; earth work in road; D.P.C.; Steel work for reinforcement; steelwork in trusses; wood work in frames, shutters etc.	08
03.	**Specifications:** General specifications and detailed specifications, Book of specifications, specifications for earth work in foundation; L.C. in foundation; R.C.C. work; Brick work; R. B. work; Wood work indoors, windows etc. D.P.C. centering and shuttering; earthwork incanal and road.	04
04.	**Works Estimate:** Estimates of building; Estimates of walls; methods of building estimate; Longwall-shortwall and centreline methods; Estimate of masonary platform, estimate of a masonry tank, estimate of roof trusses (wooden/steel) Estimate of a single roomed building; estimate of a two roomed building with C.G.I roof over wooden trusses and over steel truss. estimate of a shop; estimate of a R.C.C. beam, R.C.C. Slab	10

05.	**Estimate of Road:** Methods of estimating; materials for different items of work and labour; methods of estimating earth work; estimate of a metaled road.	04
06.	**Valuation & Rent Fixation:** Valuation of building-various methods; Rent fixation, plinth area requirement.	04
07.	**Introduction to Building Codes:** Sanitary fitting; Electrification; in-built furniture, Hazard safety measures in high rise buildings.	02

References:

1. Datta, B. N., Estimating and Costing in Civil Engineering (Theory & Practice), UBS Publishers' Distributors Pvt Ltd; 28th Revised Edition 2016.
2. Khanna, P.N. Indian Practical Civil Engineers Handbook by Published by UBS Publishers’ Distributors (P) Ltd in 2012.

Railway & Airport Engineering (Code: CVT-406)	**Syllabus for B.Tech.-4th Year (7th Semester)**	**Total Course Credit: 3**			
Mid-Term Examination	Continuous Internal Assessment	End semester examination	L	T	P
30 Marks	10 Marks	60 Marks	3	1	0

Course Outcomes:

CO1: Able to understand the transport system of the country.

CO2: Knowledge about various aspects of railway design

CO3: Able to understand various aspects of airport system and airport pavement design.

CO4: Understanding of Railway planning, design, construction and maintenance and planning and design principles of Airports

S. No	Topic	Lecture Hours
1.	Importance of transportation systems. History of railways and its development, development of Indian Railways. Surveys for Route location.	06
2.	Permanent way and it's component parts, Formation, Ballast, Sleepers, Rails. Gauge problem, Creep and Tilt in Rails. Track resistance and tractive effort, super- elevation near branching of curves; gradients. Track fittings and fastenings. Points and crossings. Station Platforms- Various types of yards and sidings. Signals.	06
3.	Classification of airports; planning, Surveys and site selection of airports. Runway Length, Patterns and orientation-wind rose diagram. Width and grades of runway; Taxiways and aprons. Difference between Highway and airport pavements; Introduction to various design methods. Airport DrainagE	08

Books Recommended:

1. Satish Chandra, M. M. Agarwal, "Railway Engineering", Oxford University Press (Latest Edition).
2. S. Ponnuswamy, "Railway Transportation- Engineering, Operation and Management", Narosa Publishing House, New Delhi (Latest Edition).
3. Rangawala, S.C, "Railway Engineering", Charotar Publishers, Anand (Latest Edition).
4. Arora, S.P. and Saxena, "Railway Engineering", Dhanpat Rai Publishers, New Delhi (Latest Edition).
5. Khanna, Arora and Jain, "Airport Planning and Design", Nem Chand and Brothers, Roorkee (Latest Edition).
6. Horren Jeff. "Airport Planning and Design"

Fluvial Hydraulics (Code: CVT-406)	**Syllabus for B.Tech.-4th Year (7th Semester)**	**Total Course Credit: 3**		
Mid-Term Examination	Continuous Internal Assessment	End semester examination	L	T	P
30 Marks	10 Marks	60 Marks	3	1	0

Course Outcomes:

CO1 : To develop an understanding about the origin and properties of Sediments.

CO2 : To be able to understand the establishment of threshold of particle transport and formation of various bed forms.

CO3 : To be able to understand the different aspects of channel roughness and resistance to flow in rigid and mobile boundary channels.

CO4 : To be able to understand various features of bed load, suspended load and total load transport.

CO5 : To be able to perform calculations leading to stable channel design.

Details of Course:

S. No.	Contents	Lecture Hours
1	**Introduction:** Sediment and fluvial hydraulics, nature of sediment problems.	**2**
2	**Properties of sediment:** Particle size, shape, density, fall velocity. Bulk properties viz particle size distribution, specific weight, and porosity.	**2**
3	Threshold of particle Transport: Introduction, Incipient motion criteria: component velocity, lift concept, critical tractive force (Shields and White’	**2**
4	**Bed Forms:** Terminology, Theoretical analysis of bed forms, empirical and graphical analysis, factors affecting bed forms.	**4**
5	Channel roughness and resistance to flow: Resistance to flow with rigid boundary: Velocity distribution approach, Darey-Weibach formula, Chezys formula, Manning’s formula, sediment size and Manning’s coefficient.	**4**
	Resistance to flow with movable boundary: Grain roughness and form roughness, surface drag and form drag, different approaches viz. Einstein;s, Einstein-Barbarosa, Engelund and Hansen etc.	**2**
	Bed Load Transport: Introduction, Shear stress approaches viz, Duboys; Sheilds, Kalinskes, etc. Energy Slope approaches viz Meyer-peter, meyer-	**6**

	Peter and Mueller, Discharge approach, velocity and Bed form approaches, Probabilistic approach viz ?Einstein's approach.	
	Suspended Load Transport: Introduction, general considerations, Exchange theory under equilibrium conditions-The Rouse equation, effect of suspended sediment on Z,K and velocity distribution, Suspended load formulas viz Lane and Kalinske, Eubsteub etc,	**6**
	Total Load Transpsort: Introduction; General approaches; Total Load Transport functions based on –Einsteins bed load function, power concept, etc.	**4**
	Stable Channel Design: The empirical stable channel design, Tractive force method of stable channel design: Drag distribution and resistance to motion, design values for boundary shear, the stable cross section, Design by tractive force method.	**4**

1. References:

1. Graf, W.H. Hydraulcis of Sediment Transport, McGraw Hill international
2. Garde, R.J. and Rangaraju, K.G. Mechanics of sediment transportation and alluvial stream problems
3. Yang, Chih Ted (1996) Sedient Transport Theory and Practice, McGraw Hill Companies Inc. New York.
4. Raudkivi, A.J. Loose Boundary Hydraulics, Pergamon Press.

Advanced Geotechnical Engineering (Code: CVT406)	**Syllabus for B.Tech. 7th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

CO 1: To understand the earth pressure analysis for sloping backfill, proportioning of retaining walls and stability checks.

CO 2: To understand the analysis and design of pile foundations, Raft foundations.

CO 3: To understand the various aspects of environmental geotechniques, including the basics and design of landfills.

CO 4: To learn the advanced methods of slope stability analysis

CO 5: To learn the basics of soil dynamics.

Detailed Syllabus:

Sr. No.	Course Contents	Contact Hours
1	**EARTH RETAINING STRUCTURES:** • Analysis and design earth retaining structures • Seepage through anisotropic soils	08
2	**GROUND IMPROVEMENT TECHNIQUES**: • Stone column and pre-consolidation • Analysis and design of raft footings • Analysis and design of pile foundations	12
3	**ENVIRONMENTAL GEOTECHNICS:** **Part-I: Evolution of Solid Waste** • Solid Waste-Sources, Types and Properties of Solid waste, Waste Handling and Separation, Storage & Processing at Source • Disposal & Residual Matter, Planning, Sitting & Permitting of Waste management Facilities **Part –II: Landfill Engineering** • **Introduction-**Need for Landfills, Types of Landfills, Physical Characteristics of Landfills. • **Barrier Systems-**Concept of Barrier Systems & Engineering Design, Transport Mechanism, Filter Criteria	12

	• **Landfill Liners-**Types of Landfill Liners, Engineering Properties, Analysis, design & Construction of Liners, Leachete Collection Pipes. • **Landfill Covers**-Basic Concepts for Cover Systems, Components, Assessment, Advantages & Disadvantages, Protection Layer, Barrier Layer	
4	**SOIL DYNAMICS:** Brief introduction; comparison of soil mechanics and soil dynamics; soil dynamic properties; laboratory and field tests for determination of dynamic soil properties; introduction to machine foundations; types of machine foundations	06
	Total	**38**

References:

1. Shamsher, P. (1996) Analysis and Design of Retaining Structures against Earthquakes, American Society of Civil Engineers
2. Bowles, J. E. (1988) Foundation Analysis and Design. New York: McGraw-Hill.
3. Mitchell, J. K and Soga, K. (2005). Fundamentals of Soil Behavior, John Wiley and Sons Inc.
4. Gulhati, S. K. and Datta, M. (2005). Geotechnical Engineering, Tata McGraw-Hill Education
5. Reddi, L. N. and Inyang, H. F. (2000). Geoenvironmental Engineering - Principles and Applications, Marcel Dekker Inc.

B TECH. 8th SEMESTER (Civil):

Course No.	Course title	L	T	P	C
CVT450	Hydropower Engineering	2	2	0	4
CVT451	**Bridge Design**	**3**	**1**	**0**	**4**
CVP452	Project*	0	5	10	10
ELECTIVE COURSES					
CVT454	Rock Mechanics and Tunneling Technology	2	1	0	3
	Transportation Planning and Economics				
	Advanced Structural Analysis				
CVT455	Ground Improvement Techniques	3	1	0	4
	Earthquake Resistant Design				
	Environmental Engineering-II				
Total Lecture Hours and Credits		30			25

*The evaluation will be done as per statutes.

Hydropower Engineering (Code: CVT450)	**Syllabus for B.Tech. 8th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Outcomes:

CO1: Analyze and perform hydro power potential assessment studies.

CO2 Understand various types of hydro power developments.

CO3: Develop a knowledge related to various hydropower structures viz., canals, tunnels, penstocks, dams, spillways, etc.

CO4: Appreciate and have basic knowledge about power house details – pertinent structures, Transmission systems, and economic feasibility of hydropower plants.

S. No.	**Course Contents**	**Contact Hours**
01.	**Introduction** Introduction and historical Development, Hydropower development Power equation, Assessment of potential, Comparison of Hydropower plant and nuclear power plant	02
02	**Classification** High, medium and low Head schemes, Run off river plants, Storage power station Tidal power plant, Recent experiences, Underground Power plant. Pumped Storage Schemes, Various hydropower systems. Power demand, Role of Hydropower grid.	04
03	**Water Conveyance System** Introduction to Power Canals, Power canals, Alignment Design of Power Canals Flumes, Covered conduits and Tunnels Penstocks, Types of penstocks	02
04	**Dams** Arch dam and classification with example Buttress dam, types Design: basic principles Design of gravity dams, Numerical questions for design of gravity dam Construction of Gravity Dams Details of construction of Gravity Dams	03
05	**Embankment Dams** Introduction to embankment dams Types of embankment dams, considerations for embankment dam Introduction to Earthen dams. Rock fill dams, types of rock fill dams. Design considerations for embankment dams. Design of embankment dams	04
06	**Spillway** Introduction, uses of spillway. Types of spillway, spillway as gate. Conditions for spillway. Design of silting basin. Numerical questions	05
07	**Power House Details** Forebay, intake of a power house with general Introduction Layout of a power house, site selection for a power house. Hydropower units arrangement, underground power station	03

08	**Transmission system** Introduction to transmission system Importance and use of transmission system	04

References:

1. Arora, K.R. "Irrigation water power and Water Resources Engineering", Standard Publisher Distributors, Delhi. 2002
2. Dandekar, M.M. "Water Power Engineering" , Vikas Publishing House Gaziabad, U.P. India 1985

Bridge Design (Code: CVT451)	**Syllabus for B.Tech. 8th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	3	1	0

Course Outcomes:

CO1: Classify different types of bridges and demonstrate fundamental knowledge of design of bridges and understand hydrologic and hydraulic aspects of waterway bridges.

CO2: Use influence lines to calculate maximum effects (forces) due to standard moving vehicle loads prescribed in IRC Codes. Select an appropriate load system as per IRC-6 and evaluate design forces and moments in bridges.

CO3: Design the slab culvert

CO4: Design the Truss type bridges including cross beams and stringers.

CO5: Design Plate Girder Bridges both composite and non-composite.

CO6: Design slabs for all types of bridges.

S. No.	**Course Contents**	**Contact Hours**
01.	**Introduction** Historical evolution of bridges. Types of bridges. Modern trends in bridge engineering. Bridge loading standards Evolution of bridge loading standards. Indian Roads Congress bridge loading standards. Impact factors. Comparative analysis of highway loading standards. Indian Railway bridge loading standards. Track load and wheel load. Influence line diagrams Introduction to influence line diagrams Use of influence line diagrams to calculate effect of moving loads on the bridge. Influence line diagram and IRC codes. Evaluation of design loads and moment forces in bridges.	08
02	**Slab culvert** Introduction to slab culvert. General features of slab culvert. Design coefficients for flexural members. Analysis of slab decks. Design aids and tables for R/C bridge deck slabs. Design of R/C slab culvert for IRC class AA loads.	10
03	**Steel Truss Bridges** Introduction to steel truss. General features of steel trussed bridges. Types of trusses. Analysis of truss frames. Design features of trusses. Design examples of truss bridges.	10
04	**Plate girder bridges.** Introduction to plate girder bridges. General features of plate girder bridges. Composite plate girder bridges and design principles. Design examples of plate	06

	girder bridges. Non composite plate girder bridges. Design principles. Design examples of non-composite plate girder bridges.	

References:

1. Design of Bridges N. Krishna Raju Oxford and IBH Publishing House
2. Essentials of Bridge Engineering Johnson Victor, D. Oxford and IBH Publishing House
3. Design of Highway Bridges Barker RM & Puckett JA WILEY
4. Bridge Engineering Ponnuswamy, S McGraw Hill

Course Title: Rock Mechanics and Tunneling Technology (Code: CVT454)	**Syllabus for B.Tech. 8th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	1	0

Course Outcomes:

CO1- Predict and validate the long-term strength and behavior of fractured rock

CO2-Concerned with the stability of engineering structures.

CO3-Influence of geological conditions on design and construction of tunnels.

CO4-The designing, planning, construction, maintenance and safety of tunnels.

S. No.	**Course Contents**	**Contact Hours**
01.	**Rock Mechanics** Introduction to rock mechanics and rock engineering.	06
02	Physical and Mechanical Properties of Rocks. Laboratory Testing.	03
03	Foundations and slope stability: foundations on discontinuous rock, slope instability basic mechanisms.	03
04	Rock reinforcement and rock support: underlying principles, similarities and differences. Rock Bolting.	03
05	Introduction to tunneling: Fundamental definitions, tunneling art and engineering, historical development, Classification of tunnels.	05
06	Geological aspects of tunneling: Geological investigation, evaluation and appreciation, importance of geological knowledge, aim of geological investigation, principal elements of exploration program, Influence of geological conditions on design and construction of tunnels.	08
07	Methods of Tunneling in soft and hard rock. Lining of tunnels. Tunnel supports.	05

References:

1. Brown, E.T.; Analytical and Computational Methods in Engineering Rock Mechanics, CBS Publishers and Distributors, New Delhi.
2. Goodman, P.E.; Introduction to Rock Mechanics, John Wiley & Sons.
3. Design and Construction of Tunnels: Analysis of Controlled Deformations in Rock and Soils(ADECO-RS) by Pietro Lunardi
4. Tunneling and Tunnel Mechanics: A Rational Approach to Tunneling by D. Kolymbas.
5. Introduction to Tunnel Construction (Applied Geotechnics) by David Chapman, Nicole Metje and Alfred Stärk.
6. Tunneling to the Center of the Earth: Stories (P.S.) by Kevin Wilson. Quantum Theory of Tunneling by Mohsen Razavy.
7.

Transportation Planning & Economics (Code: CVT454)	**Syllabus for B.Tech. 8th Semester (Civil Engineering)**	**Total Course Credit: 3**			
Midterm Examination	**Class Assessment (Assignments, interaction, tutorials, viva etc.)**	**Major Examination**	**L**	**T**	**P**
30 Marks	**10 Marks**	**60 Marks**	**2**	**1**	**0**

Course Outcomes:

CO1- To get to understand the basics and scope of transportation planning and transportation economics, transportation planning issues.

CO2-To learn about Public Transportation: public transport modes, desirable characteristics of public transport systems, transit system operations, route development, stopping policy, stop location, scheduling, capacity of transit systems, socially optimal pricing

CO3- To understand transport planning process, transportation and land use, transport planning strategies, transport planning models, travel demand analysis, operational transportation and land use models.

CO4-To learn transport economics and finance: pavement economics- construction cost; maintenance cost and vehicle operation cost, economic evaluation of highway projects- different methods; comparison of evaluation techniques, freight transport-trends and economic growth.

S. No.	Course Contents	Contact Hours
01.	Transportation Planning Scope Of Transportation Planning Scope Of Transportation Economics Transportation Planning Issues	03
02	Public Transportation Public Transportation: public transport modes Desirable Characteristics Of Public Transport Systems, Transit System Operations Route Development, Stopping Policy, Stop Location, Scheduling Travel Demand Analysis, Operational Transportation And Land Use Models	08
03	Transport Analysis And Forecasting Transport Planning Process. Transportation And Land Use. Transport Planning Strategies. Travel Demand Analysis. Growth Factor Models. Synthetic Models-1 Synthetic Models-2	12
04	Transport Economics And Finance Construction Cost; Maintenance Cost And Vehicle Operation Cost Economic Evaluation Of Highway Projects- Basic Principles; Time Value Of Money. Net Present Value (NPV) Method; Benefit-Cost (B/C) Ratio Method Internal Rate Of Return (IRR) Method. Freight Transport-Trends And Economic Growth	12

References:

1. Transport Planning and Traffic Engineering by CA O’Flaherty, John Wiley & Sons, Inc., New York; Toronto
2. Transportation Engineering and Planning by Papacostas&Prevedouros, Prentice-Hall of India Private Ltd, New Delhi-110001
3. Principles of Transportation Engineering by Chakarborty& Das, Prentice-Hall of India Private Ltd, New Delhi-110001
4. Urban Transportation Planning by Meyer & Miller, McGraw Hill, New Delhi.

Course Title: Advanced Structural Analysis Techniques (Code: CVT454)	**Syllabus for B. Tech. 8th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Outcomes:

1. To impart understanding of various aspects related to matrix element methods of structural analysis.
2. Introduction to Finite Element Analysis of Structural Analysis
3. To impart understanding of plane stress and plain strain problems

S.No.	**Topic/contents**	**Lecture Hours**
1	MATRIX METHODS OF STRUCTURAL ANALYSIS: Introduction to matrix stiffness and flexibility methods. Formulation of stiffness matrix for Simple Planar Elements, Trusses and beams. Analysis of Planar Trusses and Beams using – Direct Stiffness method. Application of matrix displacement method to Rigid jointed frames.	**20**
2	FINITE ELEMENT METHOD: Introduction to Finite Element Method of Structural Analysis. Review of Principle of Virtual work. Formulation of element stiffness matrix for one dimensional bar and beam element. Application to bar elements with varying areas of cross sections and beams with varying moment of inertia. Plane stress and plane strain problems, use of higher order elements.	**16**

1. Books Recommended:

1. Fundamentals of Structural Analysis ; Harry H. West . John Wiley & Sons.
2. Matrix Analysis of Framed Structures ; Gere and Weaver , CBS Publishers & Distributors.
3. Indeterminate Structural Analysis ; C.K. Wang , Mc-Graw Hill International Edition.
4. Concepts and Elements of Finite Element Analysis; Robert D. Cook.
5. Matrix and Finite Element Displacement analysis of Structures ; D.J Dawe

Course Title: Ground Improvement Techniques (Code: CVT455)	**Syllabus for B. Tech. 8th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	2	2	0

Course Outcomes:

CO1: The various aspects related to liquid, solid and gaseous waste

CO2 Quantification and projection of waste produced by communities.

CO3: Segregation and treatment of various types of wastes produced

CO4: Environmental effects of various types of wastes.

Detailed Syllabus:

Sr. No.	**Course Contents**	**Contact Hours**
01.	**Introduction:** Soil Types, Soil Investigation & Classification, Ground Modification/Stabilization, Need for Engineered Ground Improvement, Classification of Ground Improvement Techniques, Suitability, Feasibility and Desirability of Ground Improvement Techniques, Current & Future Developments	08
02	**Ground Improvement Techniques Mechanical Modification**: Introduction to Mechanical Modification, Principles of Soil Densification, Properties of Compacted Soil, Compaction Control, Specification of Compaction, Requirements, Types of Compaction Equipment	06
03	**Hydraulic Modification**: Objectives & Techniques, Dewatering Systems, Soil-Water Relationships, Single& Multiple Well Formulas, Drainage of Slopes, Filtration & Seepage Control, Pre loading & Vertical Drains, Electro kinetic Dewatering & Stabilization.	06
04	**Chemical Modification/Stabilization:** Effect of various admixtures on Engineering Properties of Soils such as: Cement, Lime, Fly ash, Bitumen, Cement Lime Fly ash. Other chemical additives such as NaCL, CaCL2 ,CaSO4 , Ca (OH)2 , NaOH etc., Grouting- Applications to Embankments, Foundations& Sensitive Soils, Admixtures in Pavement Design.	06

05	**Thermal Modification:** Thermal Properties of Soils, Heat Treatment of Soils, Ground Freezing, Strength &Behaviour of Frozen Ground. Modification By Inclusions & Confinement: Evolution of Soil Reinforcement, Applications of Geosynthetics Material in Civil Engineering, Soil Nailing, Soil Anchors, Soil Confinement by Formwork.	06
Total		32

References:

1. Methods of Treatment of Unstable Ground : Belt – Butterworths, 1975
2. Engineering Principles of Ground Modification: Manfired, R. H.
3. Engineering Treatment of Soils : Bell, F. G
4. Geosynthetics for Soil Improvement : ASCE, GST No. 18,New York
5. Grouting Theory & Practice : Nonveiller, E
6. Soil Stabilization : Ingles, O. G. &Metcalf, J. B.

Earthquake Resistant Design (Code: CVT455)	**Syllabus for B.Tech. 8th Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	3	1	0

Course Outcomes:

CO1 Introduction to some important definitions/ concepts, terminology, etc. about Engineering seismology such as origin of earthquakes, propagation of seismic waves, key ground motion characteristics in the form of response spectrum and Design response spectrum.

CO2 Response of building structures under ground motion followed by computation of seismic forces on buildings based on various methods (equivalent static method, dynamic analysis (i.e. Modal analysis) also called response spectrum method) as per IS 1893 code.

CO3 Seismic design and detailing of RCC elements as per IS 13920 code.

CO4 Seismic design of brick masonry buildings as per IS- 4326 code and repair of buildings as per IS-13935.

S. No.	**Course Contents**	**Contact Hours**
01.	Introduction to Earthquakes, Acceleration time history, Response Spectrum, Design Spectra.	08
02	Response of buildings subjected to ground motion based on modal analysis.	06
03	Seismic design of R.C.C Structures (upto 2-Storey Buildings) based on Codal provisions IS:1893.	07
04	Seismic design of brick masonry structures based on Codal provisions.	06
05	Detailing of R.C.C. Elements as per IS:13920. Repair and seismic strengthening of buildings IS:13935	06

References:

1. Earthquake Resistant Design of buildings Manish Shirkhinde and Pankaj Agarwal
2. Earthquake Resistant Design and risk reduction David. J. Dowrick
3. Earthquake Resistant Design by James .M.Kelly
4. Earthquake resistant design of structures by S.K Duggal.

Environmental Engineering (Code: CVT455)	**Syllabus for B.Tech. 8^{th} Semester (Civil Engineering)**	**Total Course Credit: 4**			
Midterm Examination	Class Assessment (Assignments, interaction, tutorials, viva etc.)	Major Examination	L	T	P
30 Marks	10 Marks	60 Marks	3	1	0

Course Outcomes:

CO1: The various aspects related to liquid, solid and gaseous waste

CO2 Quantification and projection of waste produced by communities.

CO3: Segregation and treatment of various types of wastes produced

CO4: Environmental effects of various types of wastes.

Course Details:

S.No	**Contents**	**Lecture Hours**
1.	Environment and its importance: Importance of clean Environment, co-existence, habitat and eco systems.	**2**
2.	Environmental pollution: Sources of pollution to Land, Water and Air. General effects of pollution. Pollution by sewage. Nature and types of sewages (domestic, Industrial etc). Calculation of storm water and sewage.	**6**
3.	Sewage disposal: - Methods of sewage disposal, effects of disposal on land and in water bodies, Self-purification of streams, BOD calculations, Design of sewers, Types of sewers	**8**
4.	Unit operations in sewage treatment: Unit operations in Sewage treatment, screening, grit removal, sedimentation, filtration, Activated sludge process. Septic and Imhoff tanks, soakages for isolated systems.	**10**
5	Prevention for ground water contamination.	**2**
6	Solid Waste management: Solid waste management, Constituents of solid waste, Sanitary land filling, Composting, Incineration	**4**
7	Air pollution: - Air pollution, Air quality standards, measurement of air pollution, factors responsible for pollution, engineering measures to check air pollution.	**4**
	Total	**36**

Suggested books

S.No	Name of Books/ Authors/ Publishers	Year of Publication
1.	Modi P. N.," Waste water Treatment"	2005
2.	McGhee, T.J., "Water Supply and Sewerage", McGraw Hill	1991
3.	Hammer, M.J. and Hammer M.J., " Water and Waste Water Technology" Prentice Hall of India	2000
4.	Nathanson J.A. " Basic Environmental Technology" 5th Ed.	2009
5.	Viessman W. and Hammer M.J. " Water Supply and Pollution Control" 6th Ed. Addison Wesley Longman	1999
6	Dhameja, Suresh K. Environmental Engineering and management	
7	Sincero and Sincero. Environmental Engg,(A Design Approach)	

Computer Science Engineering Department

Semester: 5th

S.No.	Subject	Code	L T P	Credits
1	Computer Organization & Architecture	CST305	3 1 0	4
2	Design & Analysis of Algorithms	CST306	3 1 0	4
3	Microprocessor	CST307	3 0 0	3
4	Microprocessor - Lab	CSL308	0 0 2	1
5	Operating Systems	CST309	3 1 0	4
6	Python Programming	CST310	3 1 0	4
7	Python Programming - Lab	CSL311	0 0 2	1
8	Data Communication	CST312	3 1 0	4
	Total Credits			**25**

Semester: 5th - Other Department Courses

- Electronics & Communication Engineering

S.No.	Subject	Code	L T P	Credits
1	Data Structures	CST313	3 1 0	4
2	Data Structures Lab	CSL314	0 0 2	1

- Information Technology

S.No.	Subject	Code	L T P	Credits
1	Design & Analysis of Algorithms	CST306	3 1 0	4

Semester: 6th

S.No.	Subject	Code	L T P	Credits
1	Artificial Intelligence	CST352	3 1 0	4
2	Artificial Intelligence - Lab	CSL353	0 0 2	1
3	Computer Networks	CST354	3 1 0	4
4	Computer Networks - Lab	CSL355	0 0 2	1
5	Theory of Computation	CST356	3 1 0	4
6	Computer Graphics	CST357	2 1 0	3
7	Computer Graphics -Lab	CSL358	0 0 2	1
8	Java Programming	CST359	2 0 2	3
9	Elective I	CSE0XX	3 0 0	3
10	Practical Training & Tour	CSI461	0 0 0	1
	Total Credits			**25**

Semester: 7th

S.No.	Subject	Code	L	T	P	Credits
1	Compiler Design	CST415	3	1	0	4
2	Compiler Design - Lab	CSL416	0	0	2	1
3	Network Security	CST417	3	1	0	4
4	Network Security - Lab	CSL418	0	0	2	1
5	Pre-Project	CSP419	0	0	6	2
6	Seminar	CSS420	0	0	2	1
7	Elective II	CST0XX	3	0	0	3
8	Elective III	CST0XX	3	0	0	3
9	Swayam Online Course		3	0	0	3
10	Operations Research & Optimization		3	0	0	3
	Total Credits					**25**

Semester: 7th - Other Department Courses

- Electronics & Communication Engineering (M.Tech.)

S.No.	Subject	Code	L	T	P	Credits
1	Internet & Web Design	CSL501	1	0	2	2
2	RDBMS	CST502	2	0	2	3

- Information Technology (Elective)

S.No.	Subject	Code	L	T	P	Credits
1	Compiler Design	CST415	3	0	0	3
2	Compiler Design - Lab	CSL416	0	0	2	1

Semester: 8th

S.No.	Subject	Code	L	T	P	Credits
1	Project	CSP460	0	0	12	10
2	Elective IV	CST0XX	3	0	0	4
3	Elective V	CST0XX	3	1	0	4
4	Swayam Online Course		3	0	0	3
6	Industrial Organization & Management		3	0	0	4
	Total Credits					**25**

List of Electives

S.No.	Subject	Code
1.	Simulation & Modeling	CST001
2.	Graph Theory	CST002
3.	Digital Signal Processing	CST003
4.	Multimedia Technology	CST004
5.	Logic Programming	CST005
6.	Embedded Systems	CST006
7.	Advanced Java & Android Programming	CST007
8.	System on Chip (SoC)	CST008
9.	Advanced Internet Technologies	CST009
10.	Wireless Communication	CST010
11.	Fault Tolerant Computing	CST011
12.	Image Processing	CST012
13.	System Design using HDL	CST013
14.	Real Time Systems	CST014
15.	Unix & Shell Programming	CST015
16.	High Speed Networks	CST016
17.	Advanced Algorithms	CST017
18.	Reconfigurable Computing	CST018
19.	Computer Vision	CST019
20.	Advanced Computer Networks	CST020
21.	Advanced Computer Graphics	CST021
22.	Advanced DBMS	CST022
23.	Advanced Computer Architecture	CST023
24.	Advanced Compilation Techniques	CST024
25.	Principles of Cryptography	CST025
26.	Neural Networks	CST026

27.	Pervasive Computing	CST027
28.	Distributed and Parallel Computing	CST028
29.	Cloud Computing	CST029
30.	Software Project Management	CST030
31.	Big Data	CST031
32.	Cyber laws and Forensics	CST032
33.	Expert Systems	CST033
34.	Mobile Computing	CST034
35.	Green Computing	CST035
36.	Introduction to Robotics	CST036
37.	Data Analytics	CST037
38.	Computational Biology	CST038
39.	Special topics in Computer Science	CST039
40.	System & Network Administration	CST040
41.	Pattern Recognition	CST041
42.	Natural Language Processing	CST042
43.	Quantum Computing	CST043
44.	Deep Learning	CST044
45	Introduction to Data Science	CST045
46.	Internet of Things (IoT)	CST046
47.	Advanced Cryptography	CST047
48.	Data Mining	CST048
49.	Advanced Graph Algorithms	CST049
50.	Advanced Java	CST050
51.	Numerical Methods	Maths

List of Swayam Online Courses

S.No	Course Name	Course Duration
1.	Animations	15 weeks
2.	Web based Technologies & multimedia	15 weeks
3.	Applied Natural Language Processing	12 weeks
4.	Art of C Programming	12 weeks
5.	Artificial Intelligence	12 weeks
6.	Artificial Intelligence Search Methods for Problem Solving	12 weeks
7.	Bandit Algorithm	12 weeks
8.	Computer Fundamentals	12 weeks
9.	Computational Number Theory and Algebra	12 weeks
10.	Computer Networks	12 weeks
11.	Computer Architecture &Organization	12 weeks
12.	Cyber Security	12 weeks
13.	Cyber Security	12 weeks
14.	Concrete Technology	12 weeks
15.	Data Mining	12 weeks
16.	Data Structure and Algorithm in Java	12 weeks
17.	Deep Learning	12 weeks
18.	Deep Learning in Computer Vision	12 weeks
19.	Design and Analysis of Algorithms	12 weeks
20.	Discrete Math	12 weeks
21.	Ecommerce Technologies	12 weeks
22.	Electricity and Safety Measures	12 weeks
23.	Energy Resources and Conversion Processes	14 weeks
24.	Fundamentals of computer systems	12 weeks
25.	Introduction to IT	12 weeks
26.	Linux for Sys-Ads	12 weeks
27.	Linux Bash	12 weeks
28.	Linux Operating System	12 weeks

<table>
<tr><td colspan="6">Department of Computer Science & Engineering
National Institute of Technology Srinagar</td></tr>
<tr><td>Course Title</td><td>Computer Organization & Architecture</td><td colspan="2">Semester</td><td colspan="2">5th</td></tr>
<tr><td>Department</td><td>Computer Science & Engineering</td><td colspan="2">Course Code</td><td colspan="2">CST305</td></tr>
<tr><td>Credits</td><td>04</td><td>L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td>Course Type</td><td>Theory</td><td>3</td><td colspan="2">1</td><td>0</td></tr>
</table>

Course Objectives

- To understand the basics of computer organization: structure and operation of computers and their peripherals.
- To describe arithmetic and logical operations with integer and floating-point operands and their representation in computers and implement the Hardware for Arithmetic Operations.
- To study basic processing unit and organization of simple processor, concept of pipelining and other large computing systems.
- To study hierarchical memory systems including cache memories and virtual memory.
- To study different ways of communicating with I/O devices and standard I/O interfaces.

Learning Outcomes

Upon completion of the course the student will be able to:

- Understand the basic structure and operation of digital computer;
- Study the design of arithmetic and logic unit and implementation of fixed point and floating-point arithmetic operations;
- Study the two types of control unit techniques and the concept of pipelining;
- Study the hierarchical memory system including cache memories and virtual memory;
- Study the different ways of communicating with I/O devices and standard I/O interfaces.

Course Synopsis

Overview of basic digital building blocks; Number system; building blocks for the ALU; CPU buses; Concept of sub-routine; Memory organization; interrupts; VHDL concepts.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Overview of basic digital building blocks; basic structure of a digital computer. Basic Performance Equation, Clock Rate, Performance Measurement. Number system and representation of information, arithmetic and logical operation, hardware implementation, Real numbers -fixed and floating point, IEEE754 representation.	3
2.	**CPU Subblock:** Datapath - ALU, Registers, CPU buses; Control path – microprogramming (only the idea), hardwired logic; External interface. Various addressing modes. Concept of sub-routine and sub-routine call. Use of stack for handling sub-routine call and return, instruction interpretation and execution.	3

3.	**Memory Subblock:** Memory organization; concepts of semi-conductor memory, CPU memory interaction, organization of memory modules, cache memory and related mapping and replacement policies, virtual memory	3
4.	**Pipelining:** Introduction to pipelining, Instruction pipeline, Arithmetic pipeline, Data hazards, instruction hazards, performance considerations.	2
5.	**I/O Subblock:** I/O techniques - interrupts, polling, DMA; Synchronous vs. Asynchronous I/O; Controllers. Introduction to VHDL concepts: examples to be taken up from the rest of the course for implementation.	3
	Text Books	
1.	Computer Organization, Hamachar, Vranesic & Zaky.	
2.	Circuit Design with VHDL, Volnei Pedroni.	
	References	
1.	Vincent. P. Heuring, Harry F. Jordan ―Computer System design and Architecture 2nd edition,Pearson, 2003.	
2.	Apman, Gabriele Jost, Ruud van van der Pas, ―Using OpenMP: Portable Shared Memory ParallelProgramming (Scientific and Engineering Computation), 1st edition, MIT Press, 2007.	
3.	H. J. Siegel.Interconnection Network for Large Scale Parallel Processing, McGraw Hill, 1990.	

Dep artment of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Design and Analysis of Algorithms	**Semester**	5^{th}	
Department	Computer Science & Engineering	**Course Code**	CST306	
Credits	04	**L**	**T**	**P**
Course Type	Theory	3	1	0

Course Objectives

- To understand asymptotic notations to analyze the performance of algorithms.
- To understand and apply various problem solving techniques such as divide and conquer, greedy algorithm, dynamic programming, etc.
- To solve given problem by selecting the appropriate algorithm design technique and justify the selection.
- To know the concepts of P, NP, NP-hard and NP-complete problems.

Learning Outcomes

This is a first course in algorithm design. Students will:

- Learn good principles of algorithm design;
- Learn how to analyze algorithms and estimate their worst-case and average-case behavior (in easy cases);
- Analyze the asymptotic performance of algorithms.
- Write rigorous correctness proofs for algorithms
- Become familiar with fundamental data structures and with the manner in which these data structures can best be implemented; become accustomed to the description of algorithms in both functional and procedural styles;
- Learn how to apply their theoretical knowledge in practice (via the practical component of the course).

Course Synopsis

Basic strategies of algorithm design: top-down design, divide and conquer, average and worst-case criteria, asymptotic costs. Simple recurrence relations for asymptotic costs. Choice of appropriate data structures: arrays, lists, stacks, queues, trees, heaps, priority queues, graphs, hash tables. Applications to sorting and searching, matrix algorithms, shortest-path and spanning tree problems. Introduction to discrete optimisation algorithms: dynamic programming, greedy algorithms. Graph algorithms: depth first and breadth first search.

Course Outline / Content

Unit	Topics	Week
1.	**Analysis of Algorithms:** Algorithm Design paradigms, motivation. Review of algorithmic strategies, asymptotic analysis: upper and lower complexity bounds. Identifying differences among best, average and worst Case Behaviours. Big O, little O, omega and theta notations, Standard complexity classes. Empirical measurements of performance. Time and space trade-offs in algorithms. Analysing recursive algorithms using recurrence relations.	2
2.	**Divide & Conquer:** Structure of divide and conquer algorithms: examples, Binary search, Quick sort, analysis of divide and conquer run time recurrence relations.	2

	Greedy Algorithms: Overview of the greedy paradigm, examples of exact optimization solution (minimum cost spanning tree), approximate solution (Knapsack problem), single source shortest paths.	
3.	**Dynamic Programming**: Overview, difference between dynamic programming and divide and conquer, applications: shortest path in graph, matrix multiplication, travelling salesperson problem, longest common sequence.	2
4.	**Graph Algorithms:** Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Minimum Spanning Trees (MST), Prim's and Kruskal's algorithms for MST, Connected Components, Dijkstra's Algorithm for Single Source Shortest Paths, Floyd's Algorithm for All-Pairs Shortest Paths Problem.	3
5.	**Back Tracking:** Overview, 8-Queens problem and Knapsack problem. **Branch & Bound:** LC searching, bounding, FIFO branch and bound, Applications: 0/1 Knapsack problem, Travelling salesperson problem.	2
6.	**Computational complexity:** Complexity measures, Polynomial vs non-polynomial time complexity; NP hard and NP complete classes, Examples.	1
	Text Books	
1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", PHI.	
2.	Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Third Edition, Pearson Education, 2006	
3.	Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Second Edition, Universities Press, 2011	
4.	Anany Levitin. "Introduction to the Design and Analysis of algorithms", Pearson.	
	References	
1.	Steven S Skiena, "The Algorithm Design Manual" – Springer Publications	
2.	Knuth, " The Art of Programming", Addison Wesley Vol I and II	
3.	Michael T Goodrich, "Algorithm Design" WILEY Publications.	

<table>
<tr><td colspan="6">Department of Computer Science & Engineering
National Institute of Technology Srinagar</td></tr>
<tr><td>Course Title</td><td>Microprocessor</td><td colspan="2">Semester</td><td colspan="2">5th</td></tr>
<tr><td>Department</td><td>Computer Science & Engineering</td><td colspan="2">Course Code</td><td colspan="2">CST307</td></tr>
<tr><td>Credits</td><td>03</td><td colspan="2">L</td><td>T</td><td>P</td></tr>
<tr><td>Course Type</td><td>Theory</td><td colspan="2">3</td><td>0</td><td>0</td></tr>
</table>

Course Objectives

- To understand the basic Structure and Operations of microcomputer and
- To familiarize basic architecture of 8085 microprocessors and program 8085 Microprocessor using Assembly Level Language.
- To understand the System bus structure and its different operations.
- To understand interfacing of 16 bit microprocessor with memory and peripheral chips involving system design.
- To familiarize basic architecture of 8086 microprocessor

Learning Outcomes

- Write programs to run on 8085 microprocessor based systems.
- Design system using memory chips and peripheral chips for 16 bit 8085 microprocessor.
- Understand and devise techniques for faster execution of instructions, improve speed of operations and enhance performance of microprocessors.
- Distinguish between RISC and CISC processors.
- Understand multi core processor and its advantages.

Course Synopsis

Microcomputer Structure and Operations, Microprocessors and Memory, Assembly Language Programming, Bus System, Microprocessors Interfacing, Introduction to 8086 architecture.

Course Outline / Content

Unit	Topics	Week
1.	**Microcomputer Structure and Operations:** Basic Microcomputer Elements, Typical Microcomputer Structure, CPU, Memory System, Input Output	2
2.	**Microprocessors and Memory:** Typical 8, 16 and 32 bit Microprocessors,8085,Microprocessor Specification, Memory Technologies	2
3.	**Assembly Language Programming:** Programming Model of 8085, Registers, Fetch, Execute Operation of CPU, Instruction Set, Addressing Modes, Basic Operations, Microprocessor Arithmetic, Program Flow, Control Using Looping and Branching, Stack, Subroutines, Interrupts, Resets	3

4.	**Bus System:** System Bus Structure, Bus Operations, Cycle by Cycle Operations, Timing and Control, Priority Management, Address Decoding	2
5.	**Microprocessors Interfacing:** Interfacing concepts, Parallel Input Output, Memory Interfacing, Direct Memory Access. The Serial Subsystems. Programmable Peripheral Interface, Analog Converter Subsystem	3
6.	**Introduction to 8086 architecture**: Main features and addressing modes, difference between 8085 and 8086.	2
Text Books		
1.	Microprocessor by Goankar	
2.	Microprocessor by Douglas Hall	
References		
1.	8086/8088 family: Design Programming and Interfacing: John Uffenbeck .	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Microprocessor Lab	**Semester**	5^{th}	
Department	Computer Science & Engineering	**Course Code**	CST308	
Credits	01	**L**	**T**	**P**
Course Type	Lab	0	0	2

Course Objectives

- To become familiar with the architecture and Instruction set of Intel 8085 microprocessor.
- To expose students, to the operation of typical 8085 microprocessor trainer kit.
- To provide practical hands on experience with Assembly Language Programming.
- Develop and test assembly language programs to use instructions of 8085.
- Get familiarize with interfacing of various peripheral devices with 8085 using 8279 chip.

Learning Outcomes

By the end of this course, the students will be able to run programs on 8085 microprocessor based systems.

Course Synopsis

To enable a student to have a practical command over the concepts learned in the course.

Course Outline / Content

Unit	Topics	Week
1.	• Develop a program to add two double byte numbers. • Develop a subroutine to add two floating point quantities.	1
2.	Develop program to multiply two single byte unsigned numbers, giving a 16 bit product.	1
3.	Develop subroutine which will multiply two positive floating point numbers.	1
4.	Write program to evaluate P* Q*+R* & S are 8 bit binary numbers.	1
5.	Write a program to divide a 4 byte number by another 4 byte number	1
6.	Write a program to divide an 8 bit number by another 8 bit number up to a fractional quotient of 16 bit	1
7.	Write a program for adding first N natural numbers and store the results in memory location X.	1
8.	Write a program which decrements a hex number stored in register C. The Program should half when the program register reads zero.	1
9.	Write a program to introduce a time delay of 100 ms using this program as a subroutine display numbers from 01H to OAH with the above calculated time delay between every two numbers.	1
10.	N hex numbers are stored at consecutive memory locations starting from X. Find the largest number and store it at location Y.	1

11.	Interface a display circuit with the microprocessor either directly with the bus or by using I/O ports. Write a program by which the data stored in a RAM table is displayed.	1
12.	Design and interface a circuit to read data from an A/D converter, using the 8255 A in the memory mapped I/O.	1
13.	• Design and interface a circuit to convert digital data into analog signal using the 8255 A in the memory mapped I/O. • Interface a keyboard with the microprocessor using 8279 chip and transfer the output to the printer.	1
14.	Design a circuit to interface a memory chip with microprocessor with given memory map.	1
	Text Books	
1.	Microprocessor by Goankar	
2.	Microprocessor by Douglas Hall	
	References	
1.	8086/8088 family: Design Programming and Interfacing: John Uffenbeck	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Operating System	**Semester**	5^{th}	
Department	Computer Science & Engineering	**Course Code**	CST309	
Credits	04	**L**	**T**	**P**
Course Type	Theory	3	1	0

Course Objectives

- To understand the services provided by and the design of an operating system.
- To understand the structure and organization of the file system.
- To understand what a process is and how processes are synchronized and scheduled.
- To understand different approaches to memory management.
- Students should be able to use system calls for managing processes, memory and the file system.
- Students should understand the data structures and algorithms used to implement an OS.

Learning Outcomes

On completing this course the students should have acquired the following capabilities:

- An appreciation of the role of an operating system.
- Become aware of the issues in the management of resources like processor, memory and input-output.
- Should be able to select appropriate productivity enhancing tools or utilities for specific needs like filters or version control.
- Obtain some insight into the design of an operating system.

Course Synopsis

The course will provide an introduction to Operating Systems (OS), their design and implementation. We will discuss the goals of an OS, and some successful and not-so-successful OS designs. We will also discuss the following OS services in detail: thread scheduling, security, virtual memory, file system. In this course we will explore the core principles of operating systems design and implementation, including basic operating system structure; process and thread synchronization and concurrency; file systems and storage servers; memory management techniques; process scheduling and resource management; virtualization; and security.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Operating system and function, Evolution of operating system, Batch, Interactive, Time Sharing and Real Time System, System protection.	1
2.	**Operating System Structure:** System Components, System structure, Operating System Services.	1
3.	**Concurrent Processes:** Process concept, Principle of Concurrency, Producer Consumer Problem, Critical Section problem, Semaphores, Classical problems in Concurrency, Inter Process Communication, Process Generation, Process Scheduling.	2
4.	**CPU Scheduling:** Scheduling Concept, Performance Criteria Scheduling Algorithm, Evolution, Multiprocessor Scheduling.	2

5.	**Deadlock:** System Model, Deadlock Characterization, Prevention, Avoidance and Detection, Recovery from deadlock combined approach	2
6.	**Memory Management:** Base machine, Resident monitor, Multiprogramming with fixed partition, Multiprogramming with variable partition, Multiple base register, Paging, Segmentation, Virtual memory concept, Demand paging, Performance, Paged replaced algorithm, Allocation of frames, Thrashing, Cache memory, Organization, Impact on performance.	2
7.	**I/O Management & Disk Scheduling:** I/O devices and organization of I/O function, I/O Buffering, DISK I/O, Operating System Design Issues.	2
8.	**File System:** File Concept, File Organization and Access Mechanism, File Directories, File Sharing, Implementation Issues.	2
Text Books		
1.	J. Peterson, A. Silberschatz, and P. Galvin. Operating System Concepts, Addison Wesley, 3rd Edition, 1989.	
2.	Andrew S. Tannenbaum, “Modern Operating Systems”, Prentice Hall.	
3.	William Stallings “Operating Systems – Internals and design principles”, Prentice Hall	
References		
1.	D.M Dhamdhere: Operating systems - A concept based Approach, 3rd Edition, Tata McGraw- Hill, 2012.	
2.	P.C.P. Bhatt: Introduction to Operating Systems Concepts and Practice, 3rd Edition, PHI, 2010	
3.	Harvey M Deital: Operating systems, 3rd Edition, Pearson Education, 2011.	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Python Programming	**Semester**	5th	
Department	CSE	**Course Code**	CST310	
Credits	04	**L**	**T**	**P**
Course Type	Theory	3	1	0

Course Objectives

- To learn Syntax, Semantics and create Functions and to handle strings and files in Python.
- To understand Lists, Dictionaries, and Regular Expressions in Python.
- To implement OOP concepts in Python.
- To build web services and Introduction to Network and Database Programming in Python.

Learning Outcomes

The students should be able to:

- Understand Python syntax and semantics and be fluent in the use of Python flow control and functions.
- Demonstrate proficiency in handling Strings and File Systems.
- Implement Python Programs using core data structures like Lists, Dictionaries and use Regular Expressions.
- Interpret the concepts of Object-Oriented Programming as used in Python.
- Implement exemplary applications related to Network Programming, Web Services and Databases in Python.

Course Synopsis

Introduction to Python Programming; Building blocks of a python program: Variables, expressions and statements; Functions; Strings; Files; Lists; Dictionaries; Tuples; Regular expressions; Networked Programs; Unix Web Services; OOP; Using Databases

Course Outline / Content

Unit	Topics	Week
1.	Why should you learn to write programs, Variables, expressions and statements, Conditional execution, Functions	3
2.	Iteration, Strings, Files	3
3.	Lists, Dictionaries, Tuples, Regular Expressions	3
4.	Classes and objects, Classes and functions, Classes and methods	2
5.	Networked programs, Using Web Services, Using databases and SQL	3

Text Books

1.	Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck. com/pythonlearn/EN_us/pythonlearn.pdf) (Chapters 1 – 13, 15)
2.	Allen B. Downey, "Think Python: How to Think Like a Computer Scientist”, 2ndEdition, Green Tea Press, 2015. (http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Chapters 15, 16, 17)

References

1.	Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014

2.	Mark Lutz, “Programming Python”, 4th Edition, O’Reilly Media, 2011.ISBN-13: 978-9350232873
3.	Wesley J Chun, “Core Python Applications Programming”, 3rdEdition,Pearson Education India, 2015. ISBN-13: 978-9332555365
4.	Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”,1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126562176
5.	Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”,1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126562176

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Python Programming - Lab	**Semester**	5^{th}	
Department	Computer Science & Engineering	**Course Code**	CST311	
Credits	01	**L**	**T**	**P**
Course Type	Lab	0	0	2

Course Objectives

- To learn Syntax, Semantics and create Functions and to handle strings and files in Python.
- To understand Lists, Dictionaries, and Regular Expressions in Python.
- To implement OOP concepts in Python.
- To build web services and Introduction to Network and Database Programming in Python.

Learning Outcomes

The students should be able to:

- Understand Python syntax and semantics and be fluent in the use of Python flow control and functions.
- Demonstrate proficiency in handling Strings and File Systems.
- Implement Python Programs using core data structures like Lists, Dictionaries and use Regular Expressions.
- Interpret the concepts of Object-Oriented Programming as used in Python.
- Implement exemplary applications related to Network Programming, Web Services and Databases in Python.

Course Synopsis

Introduction to Python Programming; Building blocks of a python program: Variables, expressions and statements; Functions; Strings; Files; Lists; Dictionaries; Tuples; Regular expressions; Networked Programs; Unix Web Services; OOP; Using Databases

Course Outline / Content

Unit	Topics	Week
1.	Implement a sequential search	1
2.	Create a calculator program	1
3.	Explore string functions	1
4.	Implement Selection Sort	1
5.	Implement Stack	1
6.	Read and write into a file	1
7.	Demonstrate usage of basic regular expression	1
8.	Demonstrate use of advanced regular expressions for data validation.	1
9.	Demonstrate use of List	1
10.	Demonstrate use of Dictionaries	1
11.	Create Comma Separate Files (CSV), Load CSV files into internal Data Structure	1
12.	Write script to work like a SQL SELECT statement for internal Data Structure made in earlier exercise	1
13.	Write script to work like a SQL Inner Join for an internal Data Structure made in earlier exercise	1

Text Books

1.	Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck. com/pythonlearn/EN_us/pythonlearn.pdf) (Chapters 1 – 13, 15)
2.	Allen B. Downey, "Think Python: How to Think Like a Computer Scientist”, 2ndEdition, Green Tea Press, 2015. (http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Chapters 15, 16, 17)
References	
1.	Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2.	Mark Lutz, “Programming Python”, 4th Edition, O’Reilly Media, 2011.ISBN-13: 978-9350232873
3.	Wesley J Chun, “Core Python Applications Programming”, 3rdEdition,Pearson Education India, 2015. ISBN-13: 978-9332555365
4.	Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”,1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126562176
5.	Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”,1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126562176

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Data Communication	**Semester**	5^{th}	
Department	Computer Science & engineering	**Course Code**	CST312	
Credits	04	**L**	**T**	**P**
Course Type	Theory	3	1	0

Course Objectives

- To understand the concept of communication engineering, signals, channels and communication systems.
- To understand and analyze the characteristics of various modulation techniques.
- To critically analyze various modulation techniques used in modern communication systems
- To solve basic network design problems using knowledge of common local and wide area network architectures.
- To apply knowledge of computers, software, networking technologies and information assurance to an organization's management, operations, and requirements.

Learning Outcomes

By the end of this course, the student will be able to:

- Identify various components in a data communication system, describe their properties, explain how they work and evaluate their performance;
- Design solutions to solve engineering problems that require the applications of data and computer communication technology.

Course Synopsis

Sampling; Nyquist sampling theorem; Digital modulation Techniques; Line coding techniques; Data transmission; Multiplexing Techniques; Errors in data communication; Basic concept of network; LAN, MAN and WAN.

Course Outline / Content

Unit	Topics	Week
1.	**Data and Signals**: Data, Signals, Types of Signals, Bandwidth, spectrum, Digitization of analog signals, sampling, Nyquist sampling theorem, quantization, quantization noise, Pulse code modulation.	1
2.	**Digital modulation Techniques**: ASK, FSK, PSK, DPSK, M-ary PSK, QAM. Signal constellation.	1
3.	**Line coding techniques**: NRZ, RZ, Biphase, Manchester coding, AMI, HDBn.	2
4.	**Transmission media**: Guided and un-guided media, twisted wire pair, co-axial cable, optical fibre, microwave links, satellite microwave link, their characteristic features and applications for data transmission.	2
5.	**Data transmission**: simplex, half duplex and full duplex, Asynchronous and synchronous data transmission. Carrier, bit and frame synchronization techniques, Phase lock loop.	2
6.	**Multiplexing Techniques:** Frequency Division Multiplexing, Time Division Multiplexing, Wavelength division Multiplexing and Code Division Multiplexing. Spread Spectrum.	2

7.	**Errors in data communication**: Types of errors, error detection and correction techniques, forward error correction, polynomial error detection scheme, computation of CRC. Hardware.	2
8.	**Data communication network:** Basic concept of network, Advantages and applications, Types of networks (LAN, MAN and WAN), Different network topologies like star, ring, hybrid, tree.	2
	Text Books	
1.	William Stallings: Data & Computer Communications, 7th Ed, PHI	
2.	Andrew Tanenbaum, ”Computer Networks” PHI	
	References	
1.	Sklar, “Digital Communications fundamentals & Applications”2nd Ed Pearson Pub	
2.	Keizer, “ Local Area Networks” McGraw Hill	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Artificial Intelligence	**Semester**	6^{th}	
Department	Computer Science & Engineering	**Course Code**	CST352	
Credits	04	**L**	**T**	**P**
Course Type	Theory	3	1	0

Course Objectives

- To understand the fundamentals of computational intelligence
- To know about the various knowledge representation methods
- To understand the features of neural network and its implementation
- To study about various data clustering methods
- To gain knowledge in evolutionary computation and neuro – fuzzy systems

Learning Outcomes

- Implement computational intelligence through applications
- Understand knowledge representation methods and apply approximate reasoning
- Apply evolutionary algorithm to solve the optimization problem
- Gain research Knowledge to develop applications using hybrid systems
- Able to Model Flexible Fuzzy Inference systems for dynamic nonlinear data sets.

Course Synopsis

Introduction and history of AI; Knowledge representation; Inference mechanisms; Machine Learning and Expert systems.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to AI And Production Systems** : Introduction to AI-Problem formulation, Problem Definition - Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized production system- Problem solving methods - Problem graphs, Matching, Indexing and Heuristic functions - Hill Climbing-Depth first and Breath first, Constraints satisfaction - Related algorithms, Measure of performance and analysis of search algorithms.	2
2.	**Representation of Knowledge**: Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge.	3
3.	**Knowledge Inference**: Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.	3

4.	**Planning and Machine Learning**: Basic plan generation systems - Strips -Advanced plan generation systems – K strips -Strategic explanations -Why, Why not and how explanations. Learning- Machine learning, adaptive Learning.	3
5.	**Expert Systems**: Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.	3

Text Books

1.	Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013
2.	Stuart Russell and Peter Norvig.ArtificialIntelligence: A Modern Approach, 3rd Edition, Prentice Hall, 2009.

References

1.	Stefan Edelkamp and Stefan Schroedl. Heuristic Search: Theory and Applications, Morgan Kaufmann, 2011.
2.	John Haugeland,Artificial Intelligence: The Very Idea, A Bradford Book, The MIT Press, 1985
3.	Pamela McCorduck, Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence, A K Peters/CRC Press; 2 edition, 2004.
4.	Zbigniew Michalewicz and David B. Fogel. How to Solve It: Modern Heuristics. Springer; 2nd edition, 2004.
5.	Judea Pearl. Heuristics: Intelligent Search Strategies for Computer Problem Solving, Addison-Wesley, 1984.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Artificial Intelligence Lab	**Semester**	6^{th}	
Department	CSE	**Course Code**	CST353	
Credits	01	**L**	**T**	**P**
Course Type	Lab	0	0	2

Course Objectives

- To understand the concepts of Artificial intelligence and machine learning.
- To understand and practice prolog and python.
- To understand and practice various classifiers like SVM and neural networks.
- To understand and practice logic and reasoning through logic programming.

Learning Outcomes

- Develop the basic logic programs.
- Understanding the implementation of various machine learning libraries like torch, tensor flow.
- Hands on experience on applying various classifiers on MNIST dataset.

Course Outline / Content

Unit	Topics	Week
1.	Study of PROLOG.	1
2.	Write a program to solve 8 queens' problem	1
3.	Solve any problem using depth first search.	1
4.	Solve any problem using best first search.	1
5.	Solve 8-puzzle problem using best first search	2
6.	Solve Robot (traversal) problem using means End Analysis	2
7.	Solve traveling salesman problem.	2
8.	Implementation of Linear and Logistic regression.	2
9.	Implementing classifiers on MNIST Data set.	2

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Computer Networks	**Semester**	6^{th}	
Department	Computer Science &Engineering	**Course Code**	CST354	
Credits	04	**L**	**T**	**P**
Course Type	Theory	3	1	0

Course Objectives

- Understand network models and architectures.
- Specify and identify deficiencies in existing protocols and then go on to formulate new and better protocols.
- Analyse, specify and design the topological and routing strategies for an IP based networking infrastructure.
- Explain concepts and theories of networking and apply them to various situations, classifying networks

Learning Outcomes

Upon completion of the course the student will be able to:

- Describe and analyse the hardware, software, components of a network and the interrelations.
- Explain networking protocols and their hierarchical relationship
- Compare protocol models and select appropriate protocols for a particular design.
- Develop solutions for networking
- Explain concepts and theories of networking and apply them to various situations, classifying networks

Course Synopsis

The course aims to familiarise the student with networking concepts, protocols and the internet.

Course Outline / Content

Unit	Topics	Week
1.	**Basic concept of network:** Advantages and applications, Types of networks (LAN, MAN and WAN), Different network topologies like star, ring, hybrid, tree.	1
2.	**Network Protocol Architecture**: OSI Reference model, Layers of the OSI model. Physical, Data-link, Network, Transport, Session, Presentation and Application layer.	1
3.	**Network Switching Techniques:** Circuit switched, message switching and packet switched networks, Datagram and virtual circuit services, Frame relay, ATM	2
4.	**Flow and Error Control:** Stop and wait flow control, Sliding window flow control, error control protocols, ARQ techniques, Stop-&-wait ARQ, Go back by N ARQ, Selective repeat ARQ.	2
5.	**Routing algorithms:** Routing tables, features of a routing algorithm, classification, optimality principle, sink tree, shortest path algorithm, Dijkstra algorithm, flooding, fixed routing, random routing, adaptive routing, distance vector and link state algorithm. **Congestion Control:** Congestion in networks and quality of service.	2

6.	**Medium Access Control Protocols**: TDMA, FDMA, CDMA, ALOHA, Slotted ALOHA, CSMA, CSMA/CD, Ethernet, Token Ring network	2
7.	**Network security:** Need for network data security, plaintext, cyphertext, encryption techniques, substitution, transposition, DES encryption standard, Private key, public key, Authentication.	2
8.	**Internetworking and Internet fundamentals:** Network Interconnections, Bridges, Routers, Internet Concepts, Brief concepts about common Channel signalling and Integrated DigitalNetworking.	2
	Text Books	
1.	William Stallings: Data & Computer Communications, 7th Ed, PHI	
2.	Andrew Tanenbaum, ―Computer Networks, PHI	
3.	Peterson and Davie, "Computer Networks, A Systems Approach", 5th ed., Elsevier, 2011	
	References	
1.	Keizer, ― Local Area Networks, McGraw Hill	
2.	Sklar, ―Digital Communications fundamentals & Applications‖ 2nd Ed Pearson Pub.	
3.	Ying-Dar Liu, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw-Hill, 2011.	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Computer Networks Lab	**Semester**	6^{th}	
Department	Computer Science & Engineering	**Course Code**	CST355	
Credits	01	**L**	**T**	**P**
Course Type	Lab	0	0	2

Course Objectives

- To gain a firm understanding of networking concepts learned in the course work by practical demonstration.
- Have working knowledge of the protocols to be used at various levels of the architecture

Learning Outcomes

The student should be able to:

- Set up LAN for home, office and similar configurations
- Secure the network by installing of firewalls and other security measures.

Course Synopsis

The objective of the lab course to familiarise students with networking concepts from a practical perspective.

Course Outline / Content

Unit	Topics	Week
1.	Introduction & Network Wire Crimping	1
2.	Ethernet	1
3.	Token Ring	1
4.	Switched LANs	1
5.	Network Design	1
6.	ATM	1
7.	RIP: Routing Information Protocol	1
8.	OSPF: Open Shortest Path First	1
9.	TCP: Transmission Control Protocol	1
10.	Queuing Disciplines	1
11.	RSVP: Resource Reservation Protocol	1
12	Firewalls and VPN	1
1.	Applications	2

Text Books

1.	William Stallings: Data & Computer Communications, 7^{th} Ed, PHI
2.	Andrew Tanenbaum, —Computer Networks, PHI
3.	Peterson and Davie, "Computer Networks, A Systems Approach", 5th ed., Elsevier, 2011

References

1.	Keizer, — Local Area Networks, McGraw Hill
2.	Sklar, —Digital Communications fundamentals & Applications‖ 2^{nd} Ed Pearson Pub.
3.	Ying-Dar Liu, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw-Hill, 2011.

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Theory of Computation	**Semester**	6^{th}	
Department	Computer Science & Engineering	**Course Code**	CST356	
Credits	04	**L**	**T**	**P**
Course Type	Theory	3	1	0

Course Objectives

- Classify machines by their power to recognizelanguages.
- Employ finite state machines to solve problems incomputing.
- To design grammars and recognizers for different formal languages
- Comprehend the hierarchy of problems arising in the computersciences.

Learning Outcomes

After completing this course, the student should be able to:

- Understand various Computing models like Finite State Machine, Pushdown Automata, and Turing Machine;
- Understand Decidability and Undecidability of various problems.

Course Synopsis

Complexity of computations; theorems and proofs; Finite Automata; context free grammar; pushdown automata; concepts in parsing; Turing machines; Complexity theory.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Complexity of computations, automata, computability, complexity, mathematical notions and terminology, definitions, theorems and proofs, types of proofs.	3
2.	**Automata & Languages:** Finite Automata, Non-determinism, regular expressions, non-regular expressions	3
3.	**Context free languages:** context free grammar, pushdown automata, non-context free languages, equivalences, closure properties, concepts in parsing.	3
4.	**Computability theory:** Turing machines, variants of Turing machines, the definition of Algorithm, Decidability, reducibility, advanced topics in computability theory- recursion theorem etc.	3
5.	**Complexity theory-** time complexity, space complexity, intractability.	2

Text Books

1.	C. Papadimitrou and C. L. Lewis. Elements of Theory of Computation, Prentice-Hall,1981.
2.	J.E. Hopcroft and J.D. Ullman. Introduction to Antomata Theory

References

1.	Languages of Computations, Addison-Wesley, 1979. (Indian edition available from Narosa.)
2.	Michael Sipser, “Theory of Computation” , Cengage Learning.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Computer Graphics	**Semester**	6^{th}	
Department	Computer Science & Engineering	**Course Code**	CST357	
Credits	04	**L**	**T**	**P**
Course Type	Theory	3	1	0

Course Objectives

- Students will demonstrate an understanding of contemporary graphics hardware and of basic terminology, scope and techniques of Computer Graphics.
- Demonstrate and implement the 2D primitive drawing algorithms
- Demonstrate area filling algorithms, line/ Polygon clipping along with various 2D transformations2D viewing and Coordinate representations.
- Understand the 3D graphic primitives along with various Transformations and Other algorithmsand Projection Techniques for representing 3D graphic objects

Learning Outcomes

- Students will have an understanding of 2D graphics and algorithms including: line drawing, polygon filling, clipping, and transformations.
- Students will understand the techniques used in 3D computer graphics, including viewing transformations, hierarchical modelling, colour, lighting and texture mapping.

Course Synopsis

Introduction to graphics primitives; geometric transformation; parallel and perspective projection; Shading models; picture synthesis and analysis.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction**: Co-ordinate representation, Pixel, Raster Scan & Random Scan methods, colour CRT Raster scan basics, video basics, interactive devices, graphics input and output devices, mouse, track ball, light pen, digitizer, thumb wheel, raster scan graphics.	2
2.	**Graphics Primitives**: 2D Primitives - Output primitives – Line, Circle and Ellipse drawing algorithms - Attributes of output primitives – Two dimensional Geometric transformation - Two dimensional viewing –Line, Polygon, Curve and Text clipping algorithms.	3
3.	**Parallel and Perspective projections**:Three dimensional object representation –Polygons, Curved lines, Splines, Quadric Surfaces- Visualization of data sets - 3D transformations – Viewing -Visible surface identification. Basic Raster Graphics Algorithms. Geometric Modelling in 3-D. Viewing in 3-D. Concept of Synthetic Camera. Dialogue Design. Graphics User Interfaces. Windowing Systems.	3
4.	**Rendering**: Introduction to Shading models – Flat and Smooth shading – Adding texture to faces – Adding shadows of objects	

	– Building a camera in a program – Creating shaded objects – Rendering texture – Drawing Shadows, Graphical Modelling of Discrete events.	3
5.	**Introduction to Picture Synthesis and Analysis**: Conceptual Framework of an Interactive Graphical Simulation System. Simulation of Discrete Event Displays, Animation Techniques, Basic Rules for Animation. Graphical Simulation of continuous motion. Role of Virtual Reality in Graphical Simulation.	3
	Text Books	
1.	Computer Graphics by Hearn and Baker, PHI	
2.	Preparata, Shamos, Computational Geometry- An Introduction.	
	References	
1.	Procedural Elements for Computer Graphics by Rogers, TMH.	
2.	Mathematical Elements for Computer Graphics by Rogers and Adams, Mac Graw Hills	
3.	Computer Graphics: Schaum's Outline of Computer Graphics by Roy A Plastock	
1.	Research papers/Journal Articles from Standard Sources	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Computer Graphics Lab	**Semester**	6th	
Department	Computer Science & Engineering	**Course Code**	CST358	
Credits	01	**L**	**T**	**P**
Course Type	Lab	0	0	2

Course Objectives

- Implement the 2D primitive drawing algorithms
- Demonstrate and Implement the 2D transformation techniques
- Demonstrate and implement the 3D transformation techniques
- Implement Animation scenes

Learning Outcomes

By the end of this course, the students will beable to:

- Implement the algorithms for drawing the basic graphic primitives.
- Apply different kinds of transformations.
- Draw three dimensional objects.
- Generate fractal images.

Course Synopsis

Bresenham's algorithms for drawing line, circle and ellipse; Two dimensional transformations, Three dimensional transformations, Composite transformations.

Course Outline / Content

Unit	Topics	Week
1.	Implementation of Bresenham's Algorithm – Line, Circle, Ellipse. Implementation of Line, Circle and ellipse Attributes.	2
2.	Two Dimensional transformations - Translation, Rotation, Scaling, Reflection, Shear.	2
3.	Composite 2D Transformations.	2
4.	Cohen Sutherland 2D line clipping and Windowing	1
5.	Sutherland – Hodgeman Polygon clipping Algorithm.	1
6.	Three dimensional transformations - Translation, Rotation, Scaling.	2
7.	Composite 3D transformations.	2
8.	Drawing three dimensional objects and Scenes.	1
9.	Generating Fractal images.	1

Text Books

1.	Computer Graphics by Hearn and Baker, PHI
2.	Preparata, Shamos, Computational Geometry- An Introduction.

References

1.	Procedural Elements for Computer Graphics by Rogers, TMH.
2.	Mathematical Elements for Computer Graphics by Rogers and Adams, Mac Graw Hills.
3.	Computer Graphics: Schaum's Outline of Computer Graphics by Roy A Plastock.

4.	Research papers/Journal Articles from Standard Sources.

Department of Computer Science & Engineering **National Institute of Technology Srinagar**				
Course Title	JAVA Programming	**Semester**	6th	
Department	Computer Science & Engineering	**Course Code**	CST359	
Credits	03	**L**	**T**	**P**
Course Type	Theory	2	0	2

Course Objectives

- The Students will learn to create Classes and their Objects.
- Learn and implement principles and concepts of Object Orientation such as Abstraction, Data Hiding, Polymorphism.
- Develop programs by using inbuilt libraries and importing Packages. The students will learn to create and handle threads, interfaces and applets.

Course Synopsis

On completion of the course the student should be able to: Use an integrated development environment to write, compile, run, and test simple object-oriented **Java** programs. Read and make elementary modifications to Java programs that solve real-world problems.

Course Outline / Content

Unit	Topics	Week
1.	**Overview of Basic OOP Concepts:** Need for object-oriented paradigm: Agents, responsibility, messages, methods, classes and instances, class hierarchies (Inheritance), method binding, datatypes, variables, scope and life time of variables, arrays, operators, expressions, control statements, type conversion and casting, classes and objects, constructors, methods, access control, this keyword, garbage collection, overloading methods and constructors, parameter passing, recursion, string handling, inheritance, super keyword, polymorphism- method overriding, abstract classes.	2
2.	**Packages and Interfaces:** Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, differences between classes and interfaces, defining an interface, implementing interface, applying interfaces, variables in interface and extending interfaces. Exploring packages – Java.io, Java.util.	2
3.	**Exception handling and multithreading:** Concepts of exception handling, benefits of exception handling, Termination or resumptive models, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes. Differences between multi	2

	threading and multitasking, thread life cycle, creating threads, synchronizing threads, daemon threads, thread groups.	
4.	**Event Handling:** Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes, inner classes.The AWT class hierarchy, user interface components- labels, button, canvas, scrollbars, text components, check box, check box groups, choices, lists panels – scrollpane, dialogs, menubar, graphics, layout manager – layout manager types – boarder, grid, flow, card and grib bag.	1
5.	**Applets:** Concepts of Applets, differences between applets and applications, life cycle of an applet, types of applets, creating applets, passing parameters to applets.	2
6.	**Swing:** Introduction, limitations of AWT, MVC architecture, components, containers, exploring swing-JApplet, JFrame and JComponent, Icons and Labels, text fields, buttons – The JButton class, Check boxes, Radio buttons, Combo boxes, Tabbed Panes, Scroll Panes, Trees, and Tables.	2
7.	**JDBC**: JDBC Drivers, JDBC API,Executing statements, prepared statements and callable statements	1
Text Books		
1.	An Introduction to programming and OO design using Java, J.Nino and F.A. Hosch, John wiley& sons.	
2.	An Introduction to OOP, second edition, T. Budd, pearson education.	
References		
1.	Introduction to Java programming 6th edition, Y. Daniel Liang, Pearson education.	
2.	An introduction to Java programming and object oriented application development, R.A. Johnson-Thomson.	
3.	. Core Java 2, Vol 1, Fundamentals, Cay.S.Horstmann and Gary Cornell, seventh Edition, Pearson Education.	

Department of Computer Science & Engineering National Institute of Technology Srinagar					
Course Title	Compiler Design	**Semester**	7th		
Department	Computer Science & Engineering	**Course Code**	CST415		
Credits	03	**L**	**T**	**P**	
Course Type	Theory	3	0	0	

Course Objectives

The objective of this course is to provide To understand different phases of compilation process.

- To analyse and implement various parsing techniques.
- To understand and analyse intermediate code.
- To realize the importance of code optimization and code generation

Learning Outcomes

After completion of this course the students should be able to have a basic understanding required for design of compilers.

Course Synopsis

Structure of compiler, Lexical analysis, Syntax analysis, Bottom up and top down evaluation of attributes, type checking, storage organization, intermediate code generation, basic blocks and flow graphs, register allocation, code generation, peep hole optimization, code generator generators.

Course Outline / Content

Unit	Topics	Week
1.	**Compiler structure:** analysis-synthesis model of compilation, various phases of a compiler, tool based approach to compiler construction.	1
2.	**Lexical analysis:** Interface with input, parser and symbol table, token, lexeme and patterns. Difficulties in lexical analysis, Error reporting and Implementation. Regular definition, Transition diagrams, LEX.	1
3.	**Syntax analysis:** CFGs, ambiguity, associativity, precedence, top down parsing, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence grammars, LR parsers (SLR, LALR, LR), YACC.	2
4.	**Syntax directed definitions**: inherited and synthesized attributes, dependency graph, evaluation order, bottom up and top down evaluation of attributes, L- and S-attributed definitions.	2
5.	**Type checking:** type system, type expressions, structural and name equivalence of types, type conversion, overloaded functions and operators, polymorphic functions.	2
6.	**Run time system:** storage organization, activation tree, activation record, parameter passing, symbol table, dynamic storage allocation.	2
7.	**Intermediate code generation:** intermediate representations, translation of declarations, assignments, control flow, Boolean expressions and procedure calls and Implementation issues.	2
8.	**Code generation and instruction selection:** issues, basic blocks and flow graphs, register allocation, code generation, dag representation of programs, code generation from DAGs, peep hole optimization, code generator generators, specifications of machine.	2
Text Books		
1.	A. V. Aho, R. Sethi, and J. D. Ullman. Compilers: Principles, Techniques and Tools, Addison-Wesley, 1988.	
2.	C. Fischer and R. LeBlanc. Crafting a Compiler, Benjamin Cummings, 1991.	

References	
1.	A. C. Holub. Compiler Design in C, Prentice-Hall Inc., 1993. Appel. Modern Compiler Implementation in C: Basic Design, Cambridge Press.
2.	Fraser and Hanson. A Retargetable C Compiler: Design and Implementation , Addison-Wesley.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Compiler Design Lab	**Semester**	7^{th}	
Department	Computer Science & Engineering	**Course Code**	CSL416	
Credits	01	**L**	**T**	**P**
Course Type	Lab	0	0	2
Course Objectives				
• To understand the implementation of lexical analyser, parser and other compiler design aspects. • To write codes for various top-down and bottom-up parsers and verify them for correctness. • To understand Linux Utility Lex and Yacc tools.				
Learning Outcomes				
After completing this course the students should be able to understand the compiler coding and working in detail.				
Course Synopsis				

The Lab intends to make students implement lexical analysers and code for each of the following phases of a compiler:

- Syntax Analysis
- Semantic Analysis
- Intermediate Code Generation
- Code Optimization
- Code Generation

Course Outline / Content

Unit	Topics	Week
1.	Design a lexical analyzer for given language and the lexical analyzer should ignore redundant spaces, tabs and new lines.	2
2.	Simulate First and Follow of a Grammar	2
3.	Develop an operator precedence parser for a given language.	1
4.	Construct a recursive descent parser for an expression.	1
5.	Construct a LL(1) parser for an expression	2
6.	Design predictive parser for the given language	1
7.	Implementation of shift reduce parsing algorithm.	1
8.	Design a LALR bottom up parser for the given language.	1
9.	Implement the lexical analyzer using JLex, flex or lex or other lexical analyzer generating tools	1

Text Books

1.	A. V. Aho, R. Sethi, and J. D. Ullman. Compilers: Principles, Techniques and Tools , Addison-Wesley, 1988.
2.	C. Fischer and R. LeBlanc. Crafting a Compiler, Benjamin Cummings, 1991.

References

1.	A. C. Holub. Compiler Design in C, Prentice-Hall Inc., 1993. Appel. Modern Compiler Implementation in C: Basic Design, Cambridge Press.
2.	Fraser and Hanson. A Retargetable C Compiler: Design and Implementation, Addison-Wesley.

Department of Computer Science & Engineering **National Institute of Technology Srinagar**				
Course Title	Network Security	**Semester**	7th	
Department	Computer Science & Engineering	**Course Code**	CST417	
Credits	04	**L**	**T**	**P**
Course Type	Theory	3	1	0

Course Objectives

- To help the students to understand important security goals in the networks- Confidentiality, Integrity, Authenticity, Non-repudiation and Availability and cryptographic techniques to implement these security goals.
- To provide a necessary review of mathematical concepts to implement different cryptographic techniques to achieve the network security goals and then provides a deeper dive to the field of cryptography- symmetric and asymmetric key cryptography and methods to implement them.
- The course provides a top down approach to explore the security implementations in different network layers-application, transport and network.

Learning Outcomes
After completion of this course the students should be able to: • Visualize the security goals clearly in the networks. • Analyse the basic concepts of network security to predict and classify attacks on a system/network. • Understand and apply authentication techniques to provide secure communication. • Assess the security threats to ICT infrastructure using modern tools such as firewalls, UTMs, etc.
Course Synopsis
Cryptography, classical encryption, Divisibility, Modular Arithmetic,Random Numbers.
Course Outline / Content

Unit	**Topics**	**Week**
1.	**Introduction** Review of Layered Architecture of the Network - the OSI Reference Model, Computer Security Concepts, The OSI Security Architecture, Security - Attacks, Services and Mechanism**s.**	1
2.	**Cryptography Introduction: Classical Encryption Techniques** Techniques for Implementing Security Goals: An Overview of Cryptography and Steganography, A brief recap of cryptographic principles and motivations for secure network, General thoughts on breaking the cryptosystems.	1
3.	**Review & Self Study - Mathematics for Symmetric Key Cryptography** Review of important mathematical concepts: Divisibility, Modular Arithmetic, Groups and Rings. Classical Encryption Techniques - Substitution and Transposition	2
4.	**Random Number (PRN) Generation and Stream Cipher**	2

	Random Numbers, True Random Number Generators, Pseudo Random Numbers - principles and generators, Cryptographically Secure Random Number Generators, One Time Pad, Stream Cipher- RC4	
5.	**Block Ciphers - Data Encryption Standard (DES) and Advanced Encryption Standard (AES)** Block Cipher Structure, Introduction to Data Encryption Standard, Triple DES - introduction, structure & implementation, Fields, Finite Fields - GF(p), GF(2n) and polynomial arithmetic. Advanced Encryption Standard (AES) - Introduction, structure & implementation.	2
6.	**Block Cipher Operations** Modes of Operations, Electronic Code Book Mode, Cipher Block Chaining Mode, Output Feedback Mode, Cipher Feedback Mode, Counter Mode, Enhancing the Security of Block Ciphers: Multiple Encryption, 3DES and DESX, Meet-in-the Middle Attack.	2
7.	**Data Integrity** Introduction & Motivation, Hash Functions from Block Cipher, Message Digest (MD) Hash Family, Secure Hash Algorithm (SHA-1 and SHA-3), Message Authentication Codes (MAC).	2
8.	**Review & Self Study - Mathematics for Asymmetric Key Cryptography** Review of important mathematical concepts used in asymmetric key cryptography – Euclidean and Extended Euclidean Algorithm, Euler’s Phi Function, Prime Numbers and Primality Testing, Euler's and Fermat's Theorem.	2
9.	**Asymmetric Key Cryptography** Introduction & Principles of Asymmetric Key Cryptography, Different Public Key Algorithms, Introduction to RSA, RSA in Practice and Attacks, Diffe-Hellman Key Exchange.	1
10.	**Digital Signatures**	1

	Introduction & Motivation, Principles and Applications, RSA based Digital Signature, RSA Probilistic Signature Scheme.	
11.	**Mutual Trust - Key Management and User Authentication** Introduction and challenges in key distribution, Symmetric Key Distribution and Agreement, Public Key Distribution, Principles of user authentication, User Authentication Protocol – Kerberos, Public-Key Infrastructure.	1
12.	**Security at the Application Layer** Application Layer Security - Objectives, Issues and Need, Email Security, Pretty Good Privacy, Secure/Mulitpurpose Internet Mail Extension, Domain Keys Identfied Mail.	1
13.	**Security at the Transport Layer** Web Security: Threats and Challenges, Securing Web-based transactions at the transport layer, Secure Socket Layer, Transport Layer Security, HTTPS, Combining HTTP and SSL/TLS - the secure HTTPS, Remote login, Challenges, One Possible Solution Approach – SSH, Wireless Security – TLS and WAP End-to-End Security.	1
14.	**Security at the Network Layer** IP Security: Overview and Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange, Cryptogaphic Suites.	1
15.	**System Security** Malwares – Virus, Worms, etc, Malicious Software and Anti-malwares, Distributed Denial of Service Attacks, Intruders and Intrusion Detection, Firewall Need and Characteristics, Types of Firewalls and Biasing, Firewall Location and Confgurations.	2
	Text Books	
1.	Stallings William: Cryptography and Network Security - Principles and Practice, Pearson India, 6th Edition, 2014.	
	References	
1.	ChristofPaar and Jan Pelzl: Understanding Cryptography - A Textbook for	

	Students and Practitioners, Springer, 1st Edition, 2010.
2.	SchneierBruice: Applied Cryptography : Protocols, Algorithms And Source Code In C, Wiley India, 2nd Edition, Reprint - 2013.
3.	Kurose James F and Keith W. Ross: Computer Networking: A Top-Down Approach, Pearson India, 5th Edition, 2012.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Network Security Lab	**Semester**	7^{th}	
Department	Computer Science & Engineering	**Course Code**	CSL418	
Credits	01	**L**	**T**	**P**
Course Type	Lab	0	0	2
Course Objectives				

- To understand principles of web security and to guarantee a secure network by monitoring and analysing the nature of attacks through cyber/computer forensics software/tools
- Exhibit knowledge to secure corrupted systems, protect personal data, and secure computer networks in an Organization.
- To have the ability to compare merits and demerits of different Cryptographic techniques and take decisions while securing a network

Learning Outcomes

At the end of the Lab, students should be able to:

- Analyse and evaluate the cyber security needs of an organization.
- Determine and analyse software vulnerabilities and security solutions to reduce the
- risk of exploitation.
- Measure the performance and troubleshoot cyber security systems

Course Synopsis

Implementation of Cryptography; Threats and Vulnerabilities; Understand the Tools and Techniques.

Course Outline / Content

Unit	Topics	Week
1.	Setting Up the System for testing purpose: Learning Basic Commands.	1
2.	Software Requirements. Security Attacks : ARP Attacks (ARP Cache Poisoning, ARP Man in the Middle Attack).	2
3.	IP Attacks (IP Fragmentation Attack, IP Teardrop Attack)	2
4.	ICMP Attacks(Ping of Death, Smurf Attack, ICMP Destination Unreachable, ICMP Redirect, ICMP Source Quench)	2
5.	TCP Attacks (SYN Flooding Attack, TCP RST Attack), UDP Attack.	3
6.	Understand the Tools and Techniques: IEXPRESS 2.0, CAY KARAT, Damm Web Application Vulnerabilities (DWAV), WebGoat, ProRat Trojan, Key Logger, Steganographer etc.	3

7.	Nmap Port Scanning: TCP Port Scanning (TCP Connect () Scanning, TCP SYN Scan, TCP FIN Scan, XMAS Scan, TCP NULL Scan)	3
8.	UDP Port Scanning, Performing Stealth Scan of a Selected Computer.	2
	Books	
1.	SchneierBruice: Applied Cryptography : Protocols, Algorithms And Source Code In C, Wiley India, 2nd Edition, Reprint - 2013.	

Department of Computer Science & Engineering **National Institute of Technology Srinagar**					
Course Title	Pre-Project	**Semester**	7^{th}		
Department	Computer Science & Engineering	**Course Code**	CSP419		
Credits	02	**L**	**T**	**P**	

Course Type	Practical	0	0	6

Course Objectives
• To enhance the student's knowledge and skills in solving problem through structured project research in order to produce a competent and productive engineer.
Learning Outcomes
Upon completion of Pre-Project, student should be able to: • Identify and describe the problem and scope of project clearly. • Collect, analyze and present data into meaningful information using relevant tools. • Select, plan and execute a proper methodology in problem solving. • Work independently and ethically. • Present the results in written and oral format effectively. • Identify basic entrepreneurship skills in project management
Course Synopsis
Final Year Project (FYP) is the individual project, which takes place over the two semesters. It is a mandatory subject for students to be awarded with Bachelor Degree. In the FYP, students are expected to undergo research studies which relate to the major course offered in the faculty. The final year project consists of two parts; the first part FYP 1 is a prerequisite to the second part, FYP 2. These two parts of FYP are under subject code CSE-705 and CSE-801 respectively.

Department of Computer Science & Engineering **National Institute of Technology Srinagar**			
Course Title	Seminar	**Semester**	7^{th}
Department	Computer Science & Engineering	**Course Code**	CSS420

Credits	01	**L**	**T**	**P**
Course Type	Theory	0	0	2
Course Objectives				
Each and every student has to deliver a seminar on recent research/technical topics related to CSE through power point presentations. Duration of presentation should be minimum of 30 minutes. Detailed breakup of marks to be decided by the course instructor depending on quality of content, presentation, answer to queries, communication skills etc.				
Learning Outcomes				
To promote further development of student success skills, such as reading and speaking; help students gain intellectual confidence; build in the expectation of academic success; have insight into latest research topics.				

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Internet & Web Design	**Semester**	MTech	
Department	Computer Science & Engineering	**Course Code**	CSL501	
Credits	02	**L**	**T**	**P**
Course Type	Theory	1	0	2
Course Objectives				

1. The aim of this course is to provide you the conceptual and technological developments in the field of Internet and web designing with the emphasis on comprehensive knowledge of Internet,
2. Its applications and the TCP/IP protocols widely deployed to provide Internet connective worldwide.
3. The World Wide Web with its widespread usefulness has become an integral part of the Internet. Therefore, this course also puts emphasis on basic concepts of web design.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Internet** Internet, Growth of Internet, Owners of the Internet, Anatomy of Internet, ARPANET and Internet history of the World Wide Web, basic Internet Terminology, Net etiquette. Internet Applications – Commerce on the Internet, Governance on the Internet, Impact of Internet on Society – Crime on/through the Internet.	3
2.	**TCP/IP – Internet Technology and Protocol** Packet switching technology, Internet Protocols: TCP/IP, Router, Internet Addressing Scheme: Machine Addressing (IP address), E-mail Addresses, Resources Addresses	1
3.	**Internet Connectivity** Connectivity types: level one, level two and level three connectivity, Setting up a connection: hardware requirement, selection of a modem, software requirement, modem configuration, Internet accounts by ISP: Telephone line options, Protocol options, Service options, Telephone line options – Dialup connections through the telephone system, dedicated connections through the telephone system, ISDN, Protocol options – Shell, SLIP, PPP, Service options – E-mail, WWW, News Firewall etc.	2
4.	**Internet Network** Network definition, Common terminologies: LAN, WAN, Node, Host, Workstation, bandwidth, Interoperability, Network administrator, network security, Network Components: Severs, Clients, Communication Media, Types of network: Peer to Peer, Clients Server, Addressing in Internet: DNS, Domain Name and their organization, understanding the Internet Protocol Address. Network topologies: Bust, star and ring, Ethernet, FDDI, ATM and Intranet. Services on Internet (Definition and Functions) 04 Hrs.	2
5.	**Electronic Mail** Email Networks and Servers, Email protocols –SMTP, POP3, IMAp4, MIME6, Structure of an Email – Email Address, Email Header, Body and Attachments, Email Clients: Netscape mail Clients, Outlook Express, Web based E-mail. Email encryption- Address Book, Signature File.	1

6.	**Current Trends on Internet** Languages, Internet Phone, Internet Video, collaborative computing, e-commerce. Web Publishing and Browsing 10 Hrs. Overview, SGML, Web hosting, HTML. CGL, Documents Interchange Standards, Components of Web Publishing, Document management, Web Page Design Consideration and Principles, Search and Meta Search Engines, WWW, Browser, HTTP, Publishing Tools	1
7.	**HTML Programming Basics** HTML page structure, HTML Text, HTML links, HTML document tables, HTML Frames, HTML Images, multimedia, Interactivity Tools 08 Hrs. 33 ASP, VB Script, JAVA Script, JAVA and Front Page, Flash	1
8.	**Internet Security Management Concepts** Information Privacy and Copyright Issues,Overview of Internet Security, Firewalls, Internet Security, Management Concepts and Information Privacy and Copyright Issues, basics of asymmetric cryptosystems.	1

Text Books

1. Greenlaw R and Hepp E "Fundamentals of Internet and www" 2nd EL, Tata McGrawHill,2007.

2. . Ivan Bayross, "HTML, DHTML, JavaScript, Perl CGI", 3rd Edition, BPB Publications.

3. D. Comer, "The Internet Book", Pearson Education, 2009.

References

1. M. L. Young,"The Complete reference to Internet", Tata McGraw Hill, 2007.

2. Godbole AS & Kahate A, "Web Technologies", Tata McGrawHill,2008.

3. Jackson, "Web Technologies", Pearson Education, 2008. 4. B. Patel & Lal B. Barik, " Internet & Web Technology ", Acme Learning

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	RDBMS	**Semester**	MTech
Department	Computer Science & Engineering	**Course Code**	CST502

Credits	03	**L**	**T**	**P**
Course Type	Theory	2	0	2

Course Objectives

1. Understand functional components of the DBMS.
2. Devise queries using Relational Algebra, Relational Calculus and SQL.
3. Develop E-R model and design database schema
4. Understand transaction processing, concurrency control and recovery techniques.

Learning Outcomes

The student should develop skills and understanding in:

- the design methodology for databases and verifying their structural correctness
- implementing databases and applications software primarily in the relational model
- applying the theory behind various database models and query languages
- implementing security and integrity policies relating to databases

Course Synopsis

The **course** emphasizes the understanding of the fundamentals of relational systems including data models, database architectures, and database manipulations.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to databases**: What is database system, purpose of database system, view of data, relational databases, database architecture, transaction management,	1
2.	**Data models**: The importance of data models, Basic building blocks, Business rules, The evolution of data models, Degrees of data abstraction.	1
3.	**Database design and ER Model**: overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas,	1
4.	**Relational database model**: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain and Normalization (1NF, 2NF, 3NF, BCNF).	2
5	**Relational Algebra and calculus**: Relational algebra: introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	2
6	**Constraints, Views and SQL**: What is constraints, types of constrains, Integrity constraints, Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers.	1

7	**Transaction management and Concurrency control**: Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.	2
	Text Books	
1.	Elamsri, Navathe, Somayajulu and Gupta, Fundamentals of Database Systems, 6th Edition, Pearson Education, 2011.	
2.	Rob, Coronel, “Database Systems”, Seventh Edition, Cengage Learning.	
	References	
2.	A Silberschatz, H Korth, S Sudarshan, “Database System and Concepts”, fifth Edition McGraw-Hill ,	

National Institute of Technology Srinagar				
Course Title	Project	**Semester**	8^{th}	
Department	Computer Science & Engineering	**Course Code**	CSP460	
Credits	12	**L**	**T**	**P**
Course Type	Practical	0	0	12

Course Objectives

The aim of the Final Year Project is to enhance the student's knowledge and skills in solving problem through structured project research in order to produce a competent and productive engineer.

Learning Outcomes

Upon completion of Final Year Project, student should be able to:

- Identify and describe the problem and scope of project clearly.
- Collect, analyze and present data into meaningful information using relevant tools.
- Select, plan and execute a proper methodology in problem solving.
- Work independently and ethically.
- Present the results in written and oral format effectively
- Identify basic entrepreneurship skills in project management

Course Synopsis

Final Year Project (FYP) is the individual project, which takes place over the two semesters. It is a mandatory subject for students to be awarded with Bachelor Degree. In the FYP, students are expected to undergo research studies which relate to the major course offered in the faculty.

The final year project consists of two parts; the first part FYP 1 is a prerequisite to the second part, FYP 2.

These two parts of FYP are under subject code CSE-705 and CSE-801 respectively.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Practical Training & Tour	**Semester**	8^{th}	
Department	Computer Science & Engineering	**Course Code**	CSI461	
Credits	01	**L**	**T**	**P**
Course Type	Lab	0	0	2

Course Objectives

Practical training - is defined as an integrative hands-on learning experience in a supervised setting aimed at the professional preparation and training of a student. Students should be exposed to various areas of the organization in which they work. Practical training provides learning opportunities related to all parts of the curriculum. The student always works with the support and appropriate help from the field instructor. However, the student is engaged in carrying out a particular activity, so the responsibility is the student's.

Field courses (practical trainings) take place away from the College, usually at an industry, research institution or any other company.

Learning Outcomes

The overall goal of the practical training is:

- To get the field experience, to deepen professional education,
- To bring the theory to life (apply the knowledge, concepts and skills in a real working environment)
- To provide students with practice experience out of college, in organizational setting.
- To gain additional insight into the realistic work situations
- To apply knowledge and skill in practice
- To integrate classroom experience with work experience
- To increase the student´s professional self-awareness
- To gain practical work experience
- To complement the knowledge and skills learned in classes
- To provide opportunity to apply the knowledge and the skills in a practice-based setting
- To assist / carry out real tasks and duties
- Provide career guidance to the students
- To allow students to participate in practical lab work, meetings, conferences, trainings or other learning opportunities
- To experience responsible interaction with professionals
- To get feedback from field to class.

Computer Science & Engineering

Detailed Syllabus

Electives

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Simulation and Modelling	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST001	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

The objectives of this course are to:

- Introduce students to the simulation and modelling techniques
- Provide students with opportunities to develop basic simulation and modelling skills with respect to carrying out research projects using any simulation method on the computer.

Learning Outcomes

After the course the student should be able to

- Define basic concepts in modelling and simulation
- Classify various simulation models and give practical examples for each category
- Construct a model for a given set of data and motivate its validity
- Analyze output data produced by a model and test validity of the model

Course Synopsis

In this course students study the representation and simulation of physical systems using a range of mathematical formulations. Case studies are used to illustrate a variety of modelling techniques. The students learn to develop typical mathematical models and utilise them to predict the behaviour of common industrial and engineering systems.

Course Outline / Content

Unit	Topics	Week
1.	Mathematical Model, types of Mathematical models and properties	1
2.	Procedure of modeling, Graphical method: Barterning model	1
3.	Basic optimization, Basic probability: Monte-Carlo simulation	1
4.	Approaches to differential equation: Heun method	1
5.	Local stability theory: Bernoulli Trials, Classical and continuous models	1
6.	Case studies in problems of engineering and biological sciences	1
7.	General techniques for simulating continuous random variables	2
8.	simulation from Normal and Gamma distributions	2
9.	simulation from discrete probability distributions	2
10.	simulating a non – homogeneous Poisson Process and queuing system	2

Text Books

1.	Frank R. Giordano, William P. Fox,First Course in Mathematical Modeling, Cengage Learning
2.	1. A.M.Law and W.D.Kelton, Simulation Modeling and Analysis, T.M.H. Edition.

References

1.	A. C. Fowler, Mathematical Models in Applied Sciences, Cambridge University Press.
2.	S.M. Ross, Simulation, India Elsevier Publication

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	**Graph Theory**	**Semester**		
Department	CSE	**Course Code**	CST002	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

- To learn the basic terminology and results concerning graphs.
- To learn proof techniques and algorithms involving graphs.
- To learn how to apply computer programs to study graphs.
- To provide an acquaintance with mathematical notation used to express physical and Natural laws.
- To learn about open problems in graph theory.

Learning Outcomes

Upon completion of this course, students will be able to do the following:

- Have a strong background of graph theory which has diverse applications in the areas of computer science.
- Solve problems using basic graph theory.
- Determine whether graphs are Hamiltonian and/or Eulerian.
- Solve problems involving vertex and edge connectivity, planarity and crossing numbers.
- Model real world problems using graph theory.

Course Synopsis

Graph Terminology; Types of graphs; Trees and its types; Spanning Trees ; Algorithms for MST; Planar and Dual Graphs; Matrix representation of Graphs; Coloring, Covering and partitioning; Graph theoretic Algorithms.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Graph Terminology, Incidence and Degree**,** Isolated vertex, pendant vertex and Null Graph, Isomorphism, Walks, Paths and Circuits, Connected Graphs, Disconnected graphs and Components, Euler Graphs, Operations on graphs, Hamiltonian paths and circuits, The Travelling salesman problem, Konigsberg bridge problem**,** Three utility problem.	2
2.	**Trees:** Properties of Trees**,** Distance and Centres in a tree**,** Rooted and Binary Trees**,** Spanning Trees. Algorithms for finding minimal spanning tree: Kruskal’s algorithm, Prim’s algorithm. **Cut-sets and Cut-Vertices:** Cut-sets, All cut-sets in a graph, Fundamental Circuits and cut-sets, connectivity and separability, Network Flows, 1-isomorphism, 2-isomorphism.	3
3.	**Planar and Dual Graphs:** Planar Graphs, Kuratowski’s two graphs, Kuratowski's Theorem, Detection of planarity, Geometric dual, Combinatorial dual.	3

	Matrix Representation of Graphs: Incidence matrix, Circuit matrix, Cut-set matrix, path matrix and Adjacency matrix.	
4.	**Coloring, Covering, and Partitioning:** Chromatic number, Chromatic partitioning, Chromatic polynomial, Matching, Coverings, The Four Color problem.	2
5.	**Directed Graphs:** Types of digraphs, Euler Digraphs, Trees with directed edges, Matrix representation of digraphs, Tournaments, Acyclic digraphs and decyclization.	2
6.	**Graph theoretic Algorithms:** Shortest path algorithms, Dijkstra's algorithm, Warshall - Floyd algorithm, Depth-First search in a graph, Breadth – first search in a graph.	2

Text Books	
1.	NarsinghDeo, Graph Theory with Applications to Engineering and Computer Science, PHI.
2.	R.J. Wilson,Introduction to Graph Theory, Fourth Edition, Pearson Education, 2003
References	
1.	Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India, 2005
2.	S.Even. Graph Algorithms, Computer Science Press,1979

<table>
<tr><td colspan="5">Department of Computer Science & Engineering
National Institute of Technology Srinagar</td></tr>
<tr><td>Course Title</td><td>Digital Signal Processing</td><td>Semester</td><td colspan="2"></td></tr>
<tr><td>Department</td><td>Computer Science & Engineering</td><td>Course Code</td><td colspan="2">CST003</td></tr>
<tr><td>Credits</td><td>03</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td>Course Type</td><td>Theory</td><td>3</td><td>0</td><td>0</td></tr>
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Course Objectives

This course includes:

- To develop methods for processing discrete-time signals.
- To understand the processes of A-D and D-A conversion.
- To acquire some familiarity with digital filters in terms design and implementation and to become familiar with how various types of filters affect signal characteristics.
- To understand the discrete Fourier transform and discrete spectral analysis.
- To become familiar with some applications of digital processing.

Learning Outcomes

After completion of course students will be able to:

- Be able to perform FIR AND IIR filters by hand to meet specific magnitude and phase requirements.
- Perform Fourier transform and inverse Fourier transform using definitions, tables of standard transforms and properties.
- Design and implement digital filters by hand and by using Matlab.
- Use computers and Matlab to create, analyse and process signal and to simulate and analyse systems sound and image synthesis and analysis.

Course Synopsis

Digital Signal Processing discusses analysis and representation of discrete-time signal systems, including discrete-time convolution, difference equations, the z-transform, and the discrete-time Fourier transform. The course proceeds to cover digital network and non recursive (finite impulse response) digital filters. Digital Signal Processing focuses on digital filter design and a discussion of the fast Fourier transform algorithm for computation of the discrete Fourier transform.

Course Outline / Content

Unit	Topics	Week
1.	**Discrete Time Signals And Systems :**Representation of discrete time signal – classifications – Discrete time – system – Basic operations on sequence – linear – Time invariant – causal – stable – solution to difference equation – convolution sum – correlation – Discrete time Fourier series – Discrete time Fourier transform.	2

2.	**Fourier And Structure Realization:** Discrete Fourier transform – properties – Fast Fourier transform – Z-transform – structure realization – Direct form – lattice structure for FIR filter – Lattice structure for IIR Filter.	3
3.	**Filters:** FIR Filter – windowing technique – optimum equiripple linear phase FIR filter – IIR filter – Bilinear transformation technique – impulse invariance method – Butterworth filter – Tchebycheff filter.	3
4.	**Multistage Representation:** Sampling of band pass signal – anti aliasing filter – Decimation by an integer factor – interpolation by an integer factor – sampling rate conversion – implementation of digital filter banks – sub-band coding – Quadrature mirror filter – A/D conversion – Quantization – coding – D/A conversion – Introduction to wavelets.	3
5.	**Digital Signal Processors:** Fundamentals of fixed point DSP architecture – Fixed point number representation and computation – Fundamentals of floating point DSP architecture – floating point number representation and computation – study of TMS 320 C 54XX processor – Basic programming – addition – subtraction – multiplication – convolution – correlation – study of TMS 320 F2XXX processor – Basic programming – convolution – correlation.	3

Text Books	
1.	John G. Proakis, Dimitris, G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, PHI.
2.	S.Salivahanan, A.Vallavaraj and C.Gnanapriya, “Digital Signal Processing”, TMH, 2000.
3.	A.V. Oppenheim and R.W.Schafer, Englewood, “Digital Signal Processing”, Prentice-Hall Inc, 1975. 4.
1.	B.Venkatramani&M.Bhaskar, “Digital Signal Processors architecture, programming and applications”,TMH, 2002.
References	
1.	Rabiner L.R and C.B Gold,”Theory and Applications of Digital Signal Processing”, Prentice Hall of India,1987.
2.	Leudeman L.C, “Fundamentals of Digital signal processing”, Harper & Row Publication, 1986.

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Multimedia Technology	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST004	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

- To provide the foundation knowledge of multimedia computing, e.g. media characteristics, compression standards, multimedia representation, data formats, multimedia technology development.
- To provide programming training in multimedia computing, multimedia system design and implementations.

Learning Outcomes

Upon completion of this course, the students will be able to do the following:

- Should be able to take into considerations in multimedia techniques design and implementation.
- Should have understood the characteristics of human’s visual system, human are audio system.
- Should be able to design and develop multimedia systems according to the requirements of multimedia applications.
- Program multimedia data and be able to design and implement media applications.

Course Synopsis

Basics of Multimedia Systems; Architecture and its components; Data acquisition, sampling, quantization and compression of audio and speech; Image and video representation and compression standards; Fundamentals of Multimedia Communication and Networking; Hypermedia Presentation; Multimedia Information Systems.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Multimedia Systems:** Architecture and components, multimedia distributed processing model, synchronization, orchestration and quality of service architecture.	1
2.	**Audio and Speech:** Data acquisition, sampling and quantization, human speech production mechanism, digital model of speech Production, analysis and synthesis, psycho-acoustics, low bit rate speech compression, MPEG audio compression.	2
3.	**Images and Video:** Image acquisition and representation, composite video signal, NTSC, PAL and SECAM video standards; Bi-level image compression standards, JPEG and MPEG.	2

4.	**Multimedia Communication:** Fundamentals of data communication and networking, bandwidth requirements of different media; Real time constraints: Audio latency, video data rate; Multimedia over LAN and WAN, multimedia conferencing.	3
5.	**Hypermedia Presentation:** Authoring and publishing, linear and nonlinear presentation, structuring information, different approaches of authoring hypermedia documents, hypermedia data models and standards.	3
6.	**Multimedia Information Systems:** Operating system support for continuous media applications, limitations of OS, new OS support, media stream protocol, file system support for continuous media, data models for multimedia and hypermedia information, content based Retrieval of unstructured data.	3
	Text Books	
1.	Li, Z.N. and Drew, M.S., "Fundamentals of Multimedia", Pearson Education.	
2.	Hillman, D., "Multimedia Technology and Application", Galgotia Publication.	
	References	
1.	Steinmetz, R., "Multimedia Computing, Communication and Applications", Pearson Education.	
2.	Buford, J., "Multimedia Systems", Addison Wesley.	

Department of Computer Science & Engineering National Institute of Technology Srinagar					
Course Title	Logic Programming.	**Semester**			
Department	Computer Science & Engineering	**Course Code**	CST005		
Credits	03	**L**	**T**	**P**	
Course Type	Theory	3	0	0	

Course Objectives

- To develop an understanding of basic knowledge and practical experience in logic programming.
- To learn about the formal concepts used as a theoretical basis for logic programming.
- To interpret problems in a style that suits logic programming
- To understand principles of declarative specification, and its relation to procedural realisations.

Learning Outcomes

Upon completion of this course, students will be able to do the following:

- List, define and apply the fundamental concepts of logic programming.
- Manually analyze and execute a given simple logic program. The analysis covers correctness and efficiency.
- Formulate simple problems in logic that can be executed as a logic program.
- Implement simple algorithms and data structures as correct logic programs.
- Take advantage of the strengths of logic programming (unification, backtracking and grammar programming) for solving simple combinatorial problems and for natural language processing.
- Explain how logic programming differs from other programming paradigms.

Course Synopsis

Formulation of problems using Proposition Logic; Rules of natural deduction; Properties of Axiomatic systems; Fundamentals of Predicate Logic; Semantic Tableaux and Resolution in Predicate Logic; Programming in Prolog; Meta level programming; Lazy and Eager Evaluation Strategies.

Course Outline / Content

Unit	Topics	Week
1.	**Proposition Logic:** Introduction of logic and functional paradigm, propositional concepts, semantic table, problem solving with semantic table.	2
2.	**Natural Deduction and Axiomatic Propositional Logic:** Rules of natural deduction, sequent calculus, axiomatic systems, Meta theorems. Important properties of AL (Axiomatic Logic), resolution, resolving arguments.	2
3.	**Introduction to Predicate Logic:** Objects, predicates and quantifiers, functions, first order language, quantifiers, scope and binding, substitution. An axiomatic system for first order predicate logic, soundness and completeness, Axiomatic semantics and programming.	3
4.	**Semantic Tableaux & Resolution in Predicate Logic:** Semantic tableaux, instantiation rules, problem-solving in predicate logic, normal forms. Herbrand universes and H-interpretation, resolution, unification, resolution as a computing tool.	2

5.	**Prolog Concepts:** Programming in Prolog (overview), Meta level programming and Meta interpreters. Nondeterministic programming, incomplete data structure, second order programming in Prolog. Logic grammars: definite clause grammar, A grammar interpreter.	2
6.	**Lazy and Eager Evaluation Strategies:** Evaluation strategies, Lazy evaluation: evaluation order and strictness of function, programming with lazy evaluation, interactive functional program, delay of unnecessary computation, infinite data structure, eager evaluation and reasoning.	3
	Text Books	
1.	John Kelly, “The Essence of Logic”, Prentice-Hall India.	
2.	SarojKaushik, “Logic and Prolog Programming”, New Age International ltd.	
3.	TasamiHagiya and Philip waddle, “Functional and Logic Programming”, 8th Edition, 2006.	
	References	
1.	TestsuoIda,Atsushiohori and Masato Takichi, “Functional and Logic Programming”, 2006.	
2.	Chang, C.L and Lee R.C .T, “Symbolic Logic and Mechanical theorem proving”, Academic Press, New York, 2006.	
3.	J.W. Lloyed, Springer Verlog, “Foundation of logic programming”, New York, 2/E, 1987.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Embedded Systems	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST006	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

The aim of this course to provide the student with a detailed understanding of to Microcontrollers and Embedded systems. The course covers fundamentals, The 8051 Architecture, Assembly Language Programming, Instruction set, Serial Communication and Interfacing techniques of 8051 Microcontroller.

Learning Outcomes

- To acquire knowledge about microcontrollers embedded processors and their applications.
- Foster ability to understand the internal architecture and interfacing of different peripheral devices with Microcontrollers.
- Foster ability to write the programs for microcontroller.
- Foster ability to understand the role of embedded systems in industry.
- Foster ability to understand the design concept of embedded systems.

Course Synopsis

Introduction to real time systems, The 8051 Architecture, Memory organization, 8051 Assembly Language Programming, Instruction set, 8051 Serial Communication, Microcontroller Interfacing, Basic concept of PIC microcontroller.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction**: Concept of Real time Systems, Challenges in Embedded System Design. Introduction to Microcontrollers and Embedded Processors, Microcontrollers survey, four bit, eight bit, sixteen bit, thirty two bit Microcontrollers, Comparing Microprocessors and Microcontrollers, Overview of the 8051 family.	2
2.	**The 8051 Architecture**: Hardware, Oscillator and clock, program counter, data pointer, registers, stack and stack pointer, special function registers.	1
3.	**Memory organization**: Program memory, data memory, Input / Output Ports, External memory counter and timer, serial data Input / output, Interrupts.	2
4.	**8051 Assembly Language Programming**: Structure of Assembly language Assembling and running an 8051 program, Addressing modes, Accessing memory using various addressing modes.	2

5.	**Instruction set**: Arithmetic operations and Programs, Logical operations and Programs, Jump and Call instructions and Programs, I /O Pot Programs, Single bit instructions and Programs, Timer and counter and Programs.	2
6.	**8051 Serial Communication**: Connection to RS-232, Serial Communication Programming, Interrupts Programming.	2
7.	**Microcontroller Interfacing**: Key Board, Displays, Pulse Measurement, D / A and A/D conversion, Stepper Motor-	2
8.	**Basic concept of PIC microcontroller**: Microcontroller Architecture, PIC16F.	1
Text Books		
1.	The 8051 Microcontrollers and Embedded Systems : Muhammed Ali Mazidi	
2.	The 8051 Microcontrollers Architecture, Programming & Applications Kenneth J. Ayala.	
References		
1.	Design with PIC Microcontroller: John Petman	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Advanced Java and Android Programming	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST007	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

Build Android apps from scratch using Android Studio and Java Programming Upload your apps to Google Play and reach Millions of Android users Make Money from your apps by displaying ads.

Learning Outcomes

Upon successful completion of this class, student will be able to:

- Use the Java programming language to build Android apps
- Use the development tools in the Android development environment
- Describe the life cycles of Activities, Applications and Fragments
- Utilize Sensors like Gyroscopes, Accelerometers and GPS to add orientation and location to their apps
- Send and receive SMS messages programmatically
- Package and prepare their apps for distribution on the Google Play Store.

Course Synopsis

Collection Interfaces; Multithreading; Networking; Java Database Connectivity (JDBC).

Course Outline / Content

Unit	**Topics**	**Week**
1.	**Collections:** Collection Interfaces, Concrete Collections, The Collections Framework **Multithreading:** Creating thread and running it, Multiple Thread acting on single object, Synchronization, Thread communication, Thread group, Thread priorities, Daemon Thread, Life Cycle of Thread.	2
2.	**Networking:** Internet Addressing, Inet , Factory Methods, Instance Methods, TCP/IP Client Sockets, URL, URL Connection, TCP/IP Server Sockets, Datagram. **Enterprise Java Bean:** Preparing a Class to be a JavaBean, Creating a JavaBean, JavaBean Properties, Types of beans, Stateful Session bean, Stateless Session bean, Entity bean.	3
3.	**Java Database Connectivity (JDBC):** Merging Data from Multiple Tables: Joining, Manipulating Databases with JDBC, Prepared Statements, Transaction Processing, Stored Procedures C. **Servlets:** Servlet Overview and Architecture, Interface Servlet and the Servlet Life Cycle, Handling HTTP get Requests, Handling HTTP post Requests, Redirecting Requests to Other Resources, Session Tracking, Cookies, Session Tracking with HttpSession.	3
4.	Introduction Smart Phone Application Development. Android Architecture, User Interface Architecture, Activities and Intents, Threads, Services, Receivers and Alerts, User Interface layouts, user interface events, UI Widgets, Notification and Toast, Menus, Dialogs, Lists, Locations and Maps.	3

5.	Hardware interface-Camera, Sensors, Telephony, Bluetooth, Near Field communication, Working with Data Storage, Using Google maps, Animation and Content Providers. Network Communication, Services, Publishing your App.	3
	Text Books	
1.	Core and Advanced Java, Black Book, Dreamtech Press	
2.	Java SE8 for Programmers (3rd Edition) (Deitel Developer Series) by Paul Deitel and Harvey Deitel	
3.	Head First Android Development, By Dawn Griffiths and David Griffiths , OReilly.	
	References	
1.	"Advanced Java 2 Platform HOW TO PROGRAM" by H. M.Deitel, P. J. Deitel, S. E. Santry – Prentice Hall	
2.	"Beginning Java™ EE 6 Platform with GlassFish 3 From Novice to Professional" by Antonio Goncalves– Apress publication	
3.	"Android Programming for Beginners", by John Horton.	

<table>
<tr><td colspan="6">Department of Computer Science & Engineering
National Institute of Technology Srinagar</td></tr>
<tr><td>Course Title</td><td>System on Chip</td><td>Semester</td><td colspan="3"></td></tr>
<tr><td>Department</td><td>Computer Science & Engineering</td><td>Course Code</td><td colspan="3">CST008</td></tr>
<tr><td>Credits</td><td>03</td><td>L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td>Course Type</td><td>Theory</td><td>3</td><td colspan="2">0</td><td>0</td></tr>
<tr><td colspan="6">Course Objectives</td></tr>
<tr><td colspan="6">This course will provide an understanding of the concepts, issues, and process of designing highly integrated SoCs following systematic hardware/software co-design & co-verification Principles using state of the art synthesis and verification tools and design flows.</td></tr>
<tr><td colspan="6">Learning Outcomes</td></tr>
<tr><td colspan="6">Upon completion of the course, the student shall be able to:
Understand hardware, software, and interface synthesis with emphasis on issues in interface design.
Describe examples of applications and systems developed using a co-design approach</td></tr>
<tr><td colspan="6">Course Synopsis</td></tr>
<tr><td colspan="6">The incessant drive of Moore's law has created an era where most electronic systems contain chips that integrate various (hitherto discrete) components such as microprocessor, DSPs, dedicated hardware processing engines, memories, and interfaces to I/O devices and off-chip storage. Most electronic systems today - cell phones, iPods, set-top boxes, digital TVs, automobiles - contain at least one such "System-on-chip". Designing System-on-chips is a highly complex process. Before entering the traditional VLSI implementation process (RTL, logic & physical design), design teams need to perform the challenging tasks of developing a functional specification, partitioning and mapping of functions onto hardware components and software, design of communication architecture to interconnect the components, functional/performance/power analysis and validation, and more. This course will present students with an insight into the earlier stages of the System-on-chip design process (what happens before you get down to RTL, gates, transistors, and wires). In addition to the conceptual foundations, this course will also involve significant hands-on assignments and/or a project that will give students an exposure to state-of-the-art design methodologies and platforms. This course is part of a proposed "Embedded Systems" curriculum that is currently being discussed by Purdue ECE and CS.</td></tr>
</table>

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:**Architecture of the present-day SoC - Design issues of SoC- Hardware-Software Codesign – Core Libraries – EDA Tools.	1
2.	**Design Methodology for Logic Cores:** SoC Design Flow – guidelines for design reuse – Design process for soft and firm cores – Design process for hard cores – System Integration.	2

3.	**Design Methodology for Memory and Analog Cores:** Embedded memories – design methodology for embedded memories – Specification of analog circuits – High speed circuits.	2
4.	**Design Validation:** Core-Level validation – Core Interface verification - SoC design validation.	1
5.	**Core and SoC Design Examples :** Microprocessor Cores – Core Integration and On-chip bus – Examples of SoC.	2
6.	**Configurable Processors: A Software View:**Processor Hardware/Software Cogeneration, The Process of Instruction Definition and Application Tuning. The Basics of Instruction Extension d. The Programmer's Model .Processor Performance Factors. Example: Tuning a Large Task, Memory-System Tuning h. Long Instruction Words.	2
7.	**Configurable Processors: A Hardware View**: Application Acceleration: A Common Problem. Introduction to Pipelines and Processors. Hardware Blocks to Processors d. Moving from Hardwired Engines to Processors. Designing the Processor Interface. Novel Roles for Processors in Hardware Replacement, Processors, Hardware Implementation, and Verification Flow	2
8.	**Advanced Topics in SOC Design:** Pipelining for Processor Performance, Inside Processor Pipeline Stalls, Optimizing Processors to Match Hardware d. Multiple Processor Debug and Trace and Issues in Memory Systems.	2
	Text Books	
1.	RochitRajsuman, 'System-on-a-Chip: Design and Test', Artech House, 2000.	
2.	Steve Furber, ARM System-on-Chip Architecture, 2nd ed, Addison-Wesley Professional, 2000.	
3.	D. Black, J. Donovan, SystemC: From the Ground Up, Springer, 2004.	
	References	
1.	Ricardo Reis &Jochen A.G. Jess, 'Design of System on a Chip: Devices & Components', Kluwer, 2004.	
2.	Laung-Terng Wang, Charles E. Stroud, Nur A. Touba, 'System-on-Chip Test Architectures', Morgan Kaufmann, 2007	
3.	Harris, D.M. and Harris S. L., Digital Design and Computer Architecture, Morgan Kaufmann, 2007.	
4.	Pong P. Chu, RTL Hardware Design Using VHDL: Coding for Efficiency, Portability, and Scalability, John Wiley & Sons.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Internet Technologies	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST009	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course includes:

- To provide an in-depth understanding of selected Internet protocols
- To gain more advanced modelling, analysis and programming skills.
- To provide some breadth of understanding of selected computer networking topics.

Learning Outcomes

After completion of course students will be able to:

- Create sophisticated web applications for deployment to production.
- Describe the components that make up a web based application.
- Introduce security features to web applications.

Course Synopsis

The subject provides knowledge and skills in advanced internet technologies particularly related to server-side internet programming and business-to-business systems. It covers topics relevant to advanced internet programming including Web 2.0, HTML, XHTML, CSS, Javascript, Document object modelling, .NET, C#, etc..

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to the Internet:** Brief overview of Internet, Internet and routing protocols, Web Server administration, Client Sever implementation, Cyber law, Search Engine Optimization Techniques, Web Based Systems.	1
2.	**Web 2.0:** Search, content networks, user-generated content, blogging, social networking, social media, tagging, social bookmarking, rich Internet applications, web services, location-based services, Web 2.0 monetization and business models, future of the Web.	1
3.	**Mark up Languages (HTML, XHTML):** HTML, dynamic HTML, XHTML syntax, headings, linking, images, special characters and horizontal rules, lists, tables, forms, internal linking, Meta elements.	1

4.	**Cascading Style Sheets (CSS):** Separation of content and presentation, inline styles, embedded style sheets, conflicting styles, linking external style sheets, positioning elements, backgrounds, element dimensions, box model and text flow, media types, building a CSS drop-down menu, user style sheets.	2
5.	**JavaScript:** Client side scripting, control statements, functions, arrays, objects, events.	1
6.	**Document object model:** Objects and collections, Extensible Markup Language (XML) and RSS: Advantages and applications, structuring data, XML namespaces, Document Type Definitions (DTDs), XML vocabularies, RSS. Other advanced internet technologies: including HTML5, JSON and JQuery.	2
7.	**Introduction to .NET:** Overview of the .NET Framework - Common Language Runtime – Framework Class Library - Understanding the C# Compiler.	1
8.	**Basics of C#:** Working with Variables - Making Decisions. Classes and Objects: Methods – Properties - Interface- Partial class- Null and Casting Handling Exceptions.	1
9.	**Windows and Dialogs:** MDI – Dialogs, Lists: List Box - Tree view control - Menus and Toolbars – Delegates and Events Generics.	1
10.	**Data Access With .Net:** ADO.NET overview - Commands - Data Reader - XML Schemas - Populating a dataset. .Net Programming with SQL Server: Reading and writing streamed Xml - converting ADO.Net to Xml data.	1
11.	ASP.NET Web Forms and Controls: Web Forms Controls -Data Binding and Data Source Controls – Validation, Controls-Master and Content pages. The Asp.Net Application Environment: Configuration Files - ASP.NET, Application Security -Caching.	1
12.	**Website Creation**: Creation and hosting of websites including data connectivity.	1

Text Books

1.	Deitel H.M. and P. J. Deitel, Internet & World Wide Web. How to Program, 4/e, Prentice Hall, ISBN 0131752421, 2008.
2.	J. Miller, V. Kirst and Marty Stepp, Web Programming Step by Step, Step by Step Publishing; 2nd edition (2012).
3.	Stephen C. Perry, Core C# and .NET, Prentice Hall, New Jersey.
4.	Peter Wright, Beginning Visual C# 2005 Express Edition: From Novice to Professional, Apress.

References

1.	http://www2.sta.uwi.edu/~anikov/comp3400/links.htm
2.	http://www.cs.utsa.edu/~cs4413
3.	http://www2.sta.uwi.edu/~anikov/comp3500/lectures.htm
4.	Mastering Computer Networks: An Internet Lab Manual", J. Liebeherr, M. El Zarki, Addison-Wesley, 2003.
5.	A.Rodriguez, J.Gatrell, J.Karas, R.Peschkem, TCP/IP Tutorial and Technical Overview, IBM Redbook (available over the Net)

<table>
<tr><td colspan="6">Department of Computer Science & Engineering
National Institute of Technology Srinagar</td></tr>
<tr><td>Course Title</td><td>Wireless Communication</td><td colspan="2">Semester</td><td colspan="2"></td></tr>
<tr><td>Department</td><td>Computer Science & Engineering</td><td colspan="2">Course Code</td><td colspan="2">CST010</td></tr>
<tr><td>Credits</td><td>03</td><td colspan="2">L</td><td>T</td><td>P</td></tr>
<tr><td>Course Type</td><td>Theory</td><td colspan="2">3</td><td>0</td><td>0</td></tr>
<tr><td colspan="6">Course Objectives</td></tr>
<tr><td colspan="6">An in-depth understanding of the wireless channel and the related impairments (multipath, fading), small-scale and large-scale propagation effects ,Understanding of the design of cellular systems, Detailed discussion of Multiple Access (TDMA/CDMA/OFDM), Antenna diversity, MIMO, Wireless Channel Capacity, Exposure to current and emerging wireless and cellular systems</td></tr>
<tr><td colspan="6">Learning Outcomes</td></tr>
<tr><td colspan="6">Learning outcomes of the course are:
Describe and differentiate four generations of wireless standard for cellular networks.
Determine the type and appropriate model of wireless fading channel based on the system parameters and the property of the wireless medium.
Design wireless communication systems with key 3G and 4G technologies.</td></tr>
<tr><td colspan="6">Course Synopsis</td></tr>
<tr><td colspan="6">The course enables a student to understand various concepts related to antennas, radio propagation, cellular and communication and ad-hoc networks</td></tr>
<tr><td colspan="6">Course Outline / Content</td></tr>
</table>

Unit	Topics	Week
1.	Overview of Cellular Systems and evolution 2g/3G/4G/5G	1
2.	Wireless Propagation effects and Channel Models	1
3.	Multipath fading, Shadowing, Fading margin, Shadowing margin	2
4.	Cellular Concepts – Frequency reuse, Cochannel and Adjacent channel Interference,	2
5.	C/I, Handoff, Blocking, Erlang Capacity	1
6.	Wireless propagation Part 1 - Link budget, Free-space path loss, Noise figure of receiver	2
7.	Wireless propagation	1
8.	Antenna Diversity	1
9.	Wireless Channel Capacity	1
10.	CDMA , MIMO, OFDM	2

Text Books

1.	T. S. Rappaport, “Wireless Communications – Principles and Practice” (2nd edition) Pearson, 2010
2.	Goldsmith, "Wireless Communications," Cambridge Univ Press, 2005
References	
1.	J. G. Proakis, "Digital Communications," McGraw Hill
2.	Haykin&Moher, "Modern Wireless Communications" Pearson 2011
3.	A. Molisch, "Wireless Communications," Wiley, 2005

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Fault Tolerant Computing	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST011	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

- To examine the concepts and techniques for redundant designs, which can make a system fault tolerant.
- To discuss the importance of fault tolerance in the design of safety critical systems.
- To examine testing techniques and algorithms in hardware, software and communications.

Learning Outcomes

After completion of this course the students should be able to:
- Explain the fundamentals and design process of fault tolerant systems,
- Understand the issues of reliability and its evaluation in the design of computer systems.

Course Synopsis

Basic concepts; Fault-Tolerant Design Techniques; reliability and availability models; Architecture of fault tolerant computers; Software fault tolerance; fault tolerance in wireless/mobile networks and Internet.

Course Outline / Content

Unit	Topics	Week
1.	**Fundamental Concepts:** Definitions of fault tolerance, fault classification, fault tolerant attributes and system structure.	2
2.	**Fault-Tolerant Design Techniques:** Information redundancy, hardware redundancy, and time redundancy.	2
3.	**Dependability Evaluation Techniques:** Reliability and availability models: (Combinatorial techniques, Fault-Tree models, Markov models), Performability Models.	3
4.	**Architecture of Fault-Tolerant Computers (case study):** General-purpose systems, high-availability systems, long-life systems, critical systems.	2

5.	**Software Fault Tolerance:** Software faults and their manifestation, design techniques, reliability models. Fault Tolerant Parallel/Distributed Architectures: Shared bus and shared memory architectures, fault tolerant networks.	3
6.	**Recent topics in fault tolerant systems:** Security, fault tolerance in wireless/mobile networks and Internet.	2
Text Books		
1.	Fault Tolerant Systems by I. Koren and C.M. Krishna	
References		
1.	Design and Analysis of Fault-Tolerant Digital Systems Barry W. Johnson	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Image Processing	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST012	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

To learn and understand the fundamentals of digital image processing, and various image Transforms, Image Enhancement Techniques, Image restoration Techniques and methods, image compression and Segmentation used in digital image processing.

Learning Outcomes

Upon completion of this course, students will be familiar with basic image processing techniques for solving real problems. Student will also have sufficient expertise in both the theory of two-dimensional signal processing and its wide range of applications, for example, image restoration, image compression, and image analysis.

Course Synopsis

This course is an introduction to the fundamental concepts and techniques in basic digital image processing and their applications to solve real life problems. The topics covered include Digital Image Fundamentals, Image Transforms, Image Enhancement, Restoration and Compression, Morphological Image Processing, Nonlinear Image Processing, and Image Analysis. Application examples are also included.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Digital Image Processing, Steps in Digital Image Processing, Components of image processing System, Image sensing and acquisition, sampling and quantization, relationships between pixels.	2
2.	**Image enhancement techniques:** Spatial domain, Frequency domain and using Fuzzy techniques. Intensity Transformation	2

	Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters. Filtering in the Frequency Domain.	
3.	**Image Restoration and Reconstruction:** A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering Linear, Position-Invariant Degradations, Inverse Filtering, Wiener Filtering, Constrained Least Squares Filtering, Geometric Mean Filter.	2
4.	**Color Image Processing:** Color Models, Color Transformations, Image Segmentation Based on Color.	2
5.	**Wavelets and Multiresolution Processing:** Background, Multiresolution Expansions, Wavelet Transforms in One Dimension	2
6.	**Image Compression and Segmentation:** Fundamentals, Image Compression Models, Compression Methods, Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation.	2
7.	**Pattern Recognition:** Introduction, importance, Features, Feature vectors, and classifiers,Supervised, unsupervised and semi-supervised Learning, Bayes Decision Theory, Bayesian classification for Normal Distributions, The Naïve - Bayes Classifier, The Nearest Neighbor Rule.	2
	Text Books	
1.	Rafael C.Gonzalez and Richard E.Woods, “Digital Image Processing”, Third Edition,Pearson Education.	
2.	SergiosTheodoridis, KonstantinosKoutroumbas, Pattern Recognition.	
	References	
1.	Pratt, W. K, “Digital Image Processing”.	
2.	Anil K. Jain, “Fundamentals of Digital Image Processing”, Prentice-Hall India, 2007.	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	System Design using HDL	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST013	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course instructs the students in the use of VHDL ((Very High Speed Integrated Circuit Hardware Description Language) for describing the behaviour of digital systems. VHDL is a standardized design language used in computer/ semiconductor industry. This course will teach students the use of the VHDL language for representation of digital signals, use of IEEE standard logic package/library, design description, design of arithmetic, combinational, and synchronous sequential circuits.

Learning Outcomes

- Learn the IEEE Standard 1076 Hardware Description Language (VHDL).
- Be able to model complex digital systems at several level of abstractions; behavioral and structural, synthesis and rapid system prototyping.
- Be able to develop and simulate register-level models of hierarchical digital systems.
- Develop a formal test bench from informal system requirements.
- Be able to design and model complex digital system independently or in a team.

Course Synopsis

Design and evaluation of control and data structures for digital systems. Hardware design languages are used to describe and design both behavioral and register transfer level architectures and control units with a microprogramming emphasis. Cover basic computer architecture, memories, digital interfacing, timing and synchronization, and microprocessor systems.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** VHDL description of combinational networks, Modeling flip-flops using VHDL, VHDL models for a	

	multiplexer, Compilation and simulation of VHDL code, Modeling a sequential machine, Variables, Signals and constants, Arrays, VHDL operators, VHDL functions, VHDL procedures, Packages and libraries, VHDL model for a counter.	2
2.	**Designing With Programmable Logic Devices:** Read-only memories, Programmable logic arrays (PLAs), Programmable array logic (PLAs), Other sequential programmable logic devices (PLDs), Design of a keypad scanner.	2
3.	**Design Of Networks For Arithmetic Operations:** Design of a serial adder with accumulator, State graphs for control networks, Design of a binary multiplier, Multiplication of signed binary numbers, Design of a binary divider.	1
4.	**Digital Design with SM Charts:** State machine charts, Derivation of SM charts, Realization of SM charts. Implementation of the dice game, Alternative realization for SM charts using microprogramming, Linked state machines.	2
5.	**Designing With Programmable Gate Arrays And Complex Programmable Logic Devices:** Xlinx 3000 series FPGAs, Designing with FPGAs, Xlinx 4000 series FPGAs, using a one-hot state assignment, Altera complex programmable logic devices (CPLDs), Altera FELX 10K series COLDs.	2
6.	**Floating - Point Arithmetic:** Representation of floating-point numbers, Floating-point multiplication, Other floating-point operations.	1
7.	**Additional Topics In VHDL:** Attributes, Transport and Inertial delays, Operator overloading, Multi-valued logic and signal resolution, IEEE-1164 standard logic, Generics, Generate statements, Synthesis of VHDL code, Synthesis examples, Files and Text IO.	2
8.	**VHDL Models For Memories And Buses:** Static RAM, A simplified 486 bus model, Interfacing memory to a microprocessor bus.	2
Text Books		
1.	Digital Systems Design Using VHDL by Charles H. Roth, Jr. and Lizy Kurian John, 2nd Edition, Thomson.	
2.	The Student's Guide to VHDL by Peter J. Ashenden, Morgan Kaufmann.	
References		
1.	'Fundamentals of Digital Logic with VHDL Design', by S. Brown and Z. Vranesic, Third edition, McGraw Hill, 2009.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Real Time Systems	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST014	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course includes:

- Abstract models of timed computation and the analysis of scheduling algorithms.
- Understand the motivation, theoretical background, and some of the work that has been done in the field of real-time systems.

Learning Outcomes

After completion of course students will be able to:

- Explain fundamental principles for programming of real time systems with time and resource limitations.
- Describe the foundation for programming languages developed for real time programming.
- Account for how real time operating systems are designed and functions.
- Use real time system programming languages and real time operating systems for real time applications.
- Analyse real time systems with regard to keeping time and resource restrictions.

Course Synopsis

This course includes: Theory, algorithmic and protocol concepts, mechanisms, and implementations of real-time computer systems; Real-time scheduling, real-time synchronization, real-time operating system kernels, and real-time programming languages; Design and analysis of real-time resource management algorithms, their implementations in production operating system kernels, and real-time application development.

Course Outline / Content

Unit	Topics	Week
1.	**Real Time Systems:** Concept of Real Time System, Performance measures of Real Time System, Real Time Application. Real time computing - Concepts; Structure of a real time system – Characterization of real time systems and tasks - Hard and Soft timing constraints - Issues in real time computing, Design Challenges - Performance metrics - Prediction of Execution Time : Source code analysis, Micro-architecture level analysis, Cache and pipeline issues- Programming Languages for Real-Time Systems.	3
2.	**Task Assignment and Scheduling:** Different task model, Scheduling hierarchy, Offline versus Online Scheduling, Clock Drives. Model of Real Time System,	2
3.	**Scheduling:** Hierarchy scheduling of Periodic Task - Assumptions, fixed versus dynamic priority algorithms, schedulability test for fixed priority task with arbitrary deadlines.	3

	Scheduling of A-periodic and Sporadic Tasks. Scheduling for applications having flexible constrains, Scheduling Real Time Tasks in Multiprocessor and Distributed Systems.	
4.	**Resources and Resource Access Control:** Handling Resource sharing and dependency among real time tasks - Assumptions on resources and their usage, resource contention, resource access control (Priority Ceiling Protocol, Priority Inheritance protocol, Slack Based Priority Ceiling Protocol, Pre-emption Ceiling Protocol).	3
5.	**Communication and Databases:** Real Time Communication (hard and soft real time communication, traffic scheduling disciplines, QoS guarantees), Real Time Databases (Optimistic vs Pessimistic concurrency control protocols).	3
Text Books		
1.	C.M. Krishna, Kang G. Shin, Real Time Systems, International Edition, McGraw Hill Companies.	
2.	Jane W.S. Liu, Real-Time Systems, Pearson Education India, 2000.	
References		
1.	Philip A. Laplante and Seppo J. Ovaska, “Real-Time Systems Design and Analysis: Tools for the Practitioner’’ IV Edition IEEE Press, Wiley. 2011	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Unix & Shell Programming	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST015	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

To provide knowledge about Unix operating system working principles, its file system and programming for inter-process communication. It also gives an understanding for using various system calls.

Learning Outcomes

By the end of this course, the student will be able to:

- Develop text data processing applications using Unix commands and filters;
- Design and develop text based user interface components;
- Understand user management, network management and backup utilities.

Course Synopsis

Common commands; Permissions; Command line structure; Trapping exit codes; Catching interrupts; Unix system calls; Signal and Interrupts; Variables and error recovery.

Course Outline / Content

Unit	Topics	Week
1.	File and common commands - Shell - More about files-Directories- Unix system - Basics of file Directories and filenames - Permissions - modes - Directory hierarchy - Devices – the grep family - Other filters - the stream editor sed - the awk pattern scanning and processing language - files and good filters.	3
2.	Command line structure - Metacharacters - Creating new commands - Command arguments and parameters - program output as arguments – Shell variables - More on I/O redirection - loop in shell programs - Bundle - Setting shell attributes, Shift command line parameters - Exiting a command or the shell, evaluating arguments - Executing command without invoking a new process - Trapping exit codes – Conditional expressions.	3
3.	Customizing the cal command, Functions of command, While and Until loops - Traps - Catching interrupts - Replacing a file-Overwrite - Zap - Pick command – News command - Get and Put tracking file changes.	3
4.	Standard input and output – Program arguments - file access - A screen at a time printer - On bugs and debugging - Examples- Zap pick - Interactive file comparison program - Accessing the environment - Unix system calls – Low level I/O, File system Directories and modes, Processors, Signal and Interrupts.	2
5.	Program development - Four function calculator - Variables and error recovery – Arbitrary variable names, Built in functions, Compilation into a machine, Control flow and relational operators, Functions and procedures - Performance evaluation- Ms macro package – Troff level – Tbl and eqnpreprocessors- Manual page - Other document preparation.	3

Text Books	
1.	The Design of the Unix Operating System, Maurice J. Bach, First Edition, Pearson Education, 1999.
2.	Unix and shell Programming Behrouz A. Forouzan, Richard F. Gilberg.Thomson.
3.	Your UNIX the ultimate guide, Sumitabha Das, TMH, 2nd Edition.
References	
1.	UNIX for programmers and users, 3rd edition, Graham Glass, King Ables, Pearson Education.
2.	UNIX programming environment, Kernighan and Pike, PHI. / Pearson Education.
3.	The Complete Reference UNIX, Rosen, Host, Klee, Farber, Rosinski, Second Edition, TMH.

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	High Speed Networks	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST016	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

- To develop an understanding of the basics of high speed networking technologies.
- To apply the concepts learnt in this course to optimize performance of high-speed networks.

Learning Outcomes

After completion of this course, students should be able to:

- Demonstrate the knowledge of network planning and optimization
- Design and configure networks to support number of applications.

Course Synopsis

High speed networks; Frame Relay Networks; High Speed LANs; Queuing Models; TCP and ATM congestion control; protocols for QoS support.

Course Outline / Content

Unit	Topics	Week
1.	High speed networks, Frame Relay Networks, Asynchronous transfer mode, ATM Protocol Architecture, ATM logical Connection, ATM Cell, ATM Service Categories, AAL.	4
2.	High Speed LANs.	2
3.	Queuing Models, Single Server Queues, Effects of Congestion, Congestion Control, Traffic Management, Congestion Control in Packet Switching Networks, Frame Relay Congestion Control.	4
4.	TCP and ATM congestion control, Integrated and Differentiated services, Integrated services architecture approach, components, services, queuing, protocols for QoS support.	4

Text Books

1.	Behrouz A. Forouzan, Data Communication and Networking, Third Edition, Tata McGraw-Hill 2003
2.	William stallings, "ISDN and broadband ISDN with frame relay and ATM", Pearson Education Asia, Fourth Edition, 2001

References

1.	Andrew S. Tanenbaum, Computer Networks, Fourth Edition, Prentice Hall India 2002
2.	Tom Sheldon, Encyclopedia of Networking and Telecommunication, Tata McGraw Hill, 2001

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Advanced Algorithms	Semester		
Department	Computer Science & Engineering	Course Code	CST017	
Credits	03	L	T	P
Course Type	Theory	3	0	0

Course Objectives

This course gives a broad yet deep exposure to algorithmic advances of the past few decades, and brings students up to a level where they can read and understand research papers in algorithms. Thematically, the biggest difference from undergrad algorithms is extensive use of ideas such as randomness, approximation, high dimensional geometry, which are increasingly important in most applications. We will encounter notions such as algorithm design in face of uncertainty, approaches to handle big data, handling intractability, heuristic approaches, etc.

Learning Outcomes

By the end of the course, the student must be able to:

- Use a suitable analysis method for any given algorithm
- Prove correctness and running-time bounds
- Design new algorithms for variations of problems studied in class
- Select appropriately an algorithmic paradigm for the problem at hand
- Define formally an algorithmic problem.

Course Synopsis

Algorithm analysis techniques: worst-case and amortized, average-case, randomized, competitive, approximation. Basic algorithm design techniques: greedy, iterative, incremental, divide-and-conquer, dynamic programming, randomization, linear programming. Examples from graph theory, linear algebra, geometry, operations research, and finance. Approximation Algorithms, Linear Programming, Optimization, P, NP Classes of Complexity.

Course Outline / Content

Unit	Topics	Week
1.	**Analysis of Algorithms :**Review of algorithmic strategies, asymptotic analysis: upper and lower complexity bounds. Identifying differences among best, average and worst Case Behaviours. Big O, little O, omega and theta notations, Standard complexity classes. Empirical measurements of performance. Time and space trade-offs in algorithms. Analysing recursive algorithms using recurrence relations.	3
2.	**Fundamental Computing Algorithms:** Numerical algorithms, Sequential and binary search algorithms. Quadratic sorting algorithms and O (n log n) sorting algorithms. Algorithms on graphs and their complexities using Greedy Approach for – Prim’s and Kruskal’s Algorithm for minimum spanning tree, Single source shortest path Algorithm, all pair shortest paths in Graph – Bellman Ford Algorithm, Floyd Warshall Algorithm.	2
3.	**Approximation Algorithms:** Introduction, Approximation Algorithms for – Vertex Cover, Sum of Subsets, TSP, Job	3

	scheduling, Knapsack Problems. Probabilistically good algorithms, Polynomial Time Approximation.	
4.	**Linear Programming :**Introduction, initial basic feasible solution. Feasibility of a system, Simplex Algorithm. Standard and Slack forms, Formulation of problems as linear programs, Checking Feasibility of System using B – Rule Algorithm. Optimization. KKT Algorithm. Expectations: Introduction, Moments, Expectations of functions of more than one random variable.	4
5.	**Computational complexity:** Complexity measures, Polynomial versus non-polynomial time complexity; NP hard and NP complete classes.	2
Text Books		
1.	Kishore S. Trivedi, “Probability & Statistics with Reliability, Queuing, and Computer Science Applications” PHI	
2.	Cormen, Leiserson, Rivest, “Algorithms”, PHI	
3.	Bressard, “Fundamentals of Algorithms”, PHI	
References		
1.	Steven S Skiena, “The Algorithm Design Manual” – Springer Publications	
2.	Knuth, “ The Art of Programming”, Addison Wesley Vol I and II	
3.	Michael T Goodrich, “Algorithm Design” WILEY Publications.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Reconfigurable Computing	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST018	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

Learning Outcomes

Students will gain fundamental knowledge and understanding of principles and practice in digital design on FPGAs through class lectures. Students will also learn the programming in VHDL.

Course Synopsis

Reconfigurable Computing Hardware; Programming Reconfigurable Systems; Mapping; Designs to Reconfigurable Platforms; Application Development: CORDIC Architectures for; FPGA Computing; FPGA Applications.

Course Outline / Content

Unit	Topics	Week
1.	**Reconfigurable Computing Hardware:** Device Architecture, Reconfigurable Computing Architectures**,** Reconfigurable Computing Systems,Reconfiguration Management.	2
2.	**Programming Reconfigurable Systems:** Compute Models and System Architectures, Programming FPGA Applications in VHDL, Compiling C for Spatial Computing, Stream Computations Organized for Reconfigurable Execution, Programming Data Parallel FPGA Applications Using the SIMD/Vector Model, Operating System Support for Reconfigurable Computing.	3
3.	**Mapping Designs to Reconfigurable Platforms:** Technology Mapping, FPGA Placement Placement for General-purpose FPGAs, Data-path Composition, Specifying Circuit Layout on FPGAs, Retiming, Re-pipelining, and *C*-slow Retiming, Configuration Bit-stream Generation, Fast Compilation Techniques	3
4.	**Application Development:** Implementing Applications with FPGAs, Instance-specific Design, Precision Analysis for Fixed-point Computation, Distributed Arithmetic, CORDIC Architectures for FPGA Computing, Hardware/Software Partitioning	3
5.	**Case Studies of FPGA Applications**: SPIHT Image Compression, Automatic Target Recognition Systems on Reconfigurable Devices, Boolean Satisfiability: Creating Solvers	3

	Optimized for Specific Problem Instances, Multi-FPGA Systems: Logic Emulation, Finite Difference Time Domain: A Case Study Using FPGAs, Network Packet Processing in Reconfigurable Hardware	
Text Books		
1.	Scott Hauck and Andre DeHon, "Reconfigurable Computing – The Theory and Practice of FPGA-based Computation", ELSEVIER 2008	
References		
1.	Christophe Bobda "Introduction to Reconfigurable Computing: Architectures, Algorithms, and Applications" SPRINGER 2007.	
2.	JariNurmi, "Processor Design: System-On-Chip Computing for ASICs and FPGAs". SPRINGER 2008.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Computer Vision	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST019	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

To introduce students the fundamentals of image formation; To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition; To develop an appreciation for various issues in the design of computer vision and object recognition systems; and To provide the student with programming experience from implementing computer vision and object recognition applications.

Learning Outcomes

After completing the course you will be able to:

- Identify basic concepts, terminology, theories, models and methods in the field of computer vision.
- Describe known principles of human visual system.
- Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.
- Suggest a design of a computer vision system for a specific problem.

Course Synopsis

Computer Vision plays a very important role in fields such as Machine and Robot Intelligence. They provide the means for the machine or robot to interact intelligently with the outside world through visual perception. Vision is undoubtedly the most powerful of all senses and enables robots to perform very flexible tasks such as moving around autonomously in a factory floor or outdoors. The applications are plentiful and very challenging. Face recognition, human activity interpretations, human-computer interaction, quality inspection of mass-produced parts, robot/missile/vehicle guidance, medical imaging and computer vision-aided surgery are some of the applications. The objective of this course is to prepare students for working in such intelligent automation fields.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** History about computer vision, introduction to vision, computer graphics, image processing, human and computer vision.	1
2.	**Image Formation Models:**Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems.	1
3.	**Recognition Methodology:** Conditioning, Labeling, Grouping, Extracting and Matching.	1
4.	**Morphological Image Processing:** Introduction, Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Morphological algorithm operations on binary images, Morphological algorithm Operations on gray-scale images, Thinning, Thickening, Region growing, region shrinking.	1
5.	**Image Representation and Description:** Representation schemes, Boundary descriptors, Region descriptors.	1

6.	**Binary Machine Vision:**Thresholding, Segmentation, Connected component labeling, Hierarchal segmentation, spatial clustering, Split & merge, Rule-based Segmentation, Motion-based segmentation.	2
7.	**Area Extraction:** Concepts, Data-structures, Edge, Line-Linking, Hough transform, Line fitting, Curve fitting (Least-square fitting).	
8.	**Region Analysis:** Region properties, External points, spatial moments, mixed spatial gray-level moments, Boundary analysis: Signature properties, Shape numbers.	
9.	**Facet Model Recognition:**Labeling lines, Understanding line drawings, Classification of shapes by labeling of edges, Recognition of shapes, Consisting labeling problem, Back-tracking Algorithm Perspective Projective geometry, Inverse perspective Projection, Photogrammetry - from 2D to 3D.	2
10.	**Image matching:** Intensity matching of ID signals, Matching of 2D image, Hierarchical image matching, 2D representation, Global vs. Local features. **General Frame Works for Matching:** Distance relational approach, ordered structural matching, View class matching, Models database organization.	2
11.	**General Frame Works:** Distance -relational approach, Ordered -Structural matching, View class matching, Models database organization.	1
12.	**Knowledge Based Vision:** Knowledge representation, Control strategies, Information Integration.	1
13.	**Object recognition:**Hough transforms and other simple object recognition methods**,** Shape correspondence and shape matching Principal component analysis**,** Shape priors for recognition	1
	Text Books	
1.	"Computer and Robot Vision", Robert Haralick and Linda Shapiro, Addison Wesley.	
2.	"Computer Vision: A Modern Approach", David A. Forsyth, Jean Ponce.	
3.	"Introductory Techniques for 3D Computer Vision", E.Trucco and A.Verri, PHI.	
	References	
1.	"Image Processing, Analysis, and Machine Vision", Milan Sonka, Vaclav Hlavac, Roger Boyle, Thomson Learning.	
2.	"Robot Vision", by B. K. P. Horn, McGraw-Hill.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Computer Network	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST020	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

The objective for this course is to give students hands-on exposure to emerging networking topics in the context of a number of different tools/environments that might be used for networking research.

Learning Outcomes

In general terms, the course will deliver the following learning outcomes:

- To identify and discuss the concepts underlying IPv6 protocol, and their main characteristics and functionality;
- To understand the principles and functionality of mobile IP, explaining its concretization in IPv6; to understand the needs of optimization of the mobility mechanisms and description of some extensions that aim to reduce handover latency and requirements from terminals;
- To explain and exemplify current QoS architectures and mechanisms, and the QoS support challenges in future networks;
- To understand and explain the design issues in transport services in face of applications and services requirements;
- To understand theoretical and practical concepts behind the design of multiconstained applications and services;
- To discuss relevant management issues and devise adequate network management solutions;
- To identify and assess possible research opportunities and difficulties within the course scope.

Course Synopsis

This course will focus on advanced networking topics by studying a combination of classic research papers as well as current and emerging topics in computer networking and by doing a number of hands-on lab assignments. Specific focus areas will include cloud computing, network management, network measurement, software defined networking and network architectures. As such the course is suitable for Masters and PhD students wishing to explore or engage in networking related research.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Computer Networks** Review – Computer networks and layered architecture. Asynchronous Transfer Mode: ATM layered model, switching and switching fabrics, network layer in ATM, QOS, and LAN emulation.	2
2.	**Transport Layer** Elements of transport protocols; Internet transport protocols: TCP and UDP, TCP connection management, congestion control.	2
3.	**Application Layer**	3

	Network application architectures: Client-server, P2P and hybrid; Application layer protocols: DNS, FTP, TFTP, TELNET, HTTP and WWW, SMTP and electronic mail; Network management and SNMP.	
4.	**Wireless and Mobile:** Wireless and Mobile Networks: Wireless links and network characteristics, 802.11 wireless LANs, mobility management, addressing and routing, mobile IP, WAP, mobility in cellular networks.	3
5.	**Multimedia Networking:** Streaming audio and video, RTSP, jitter removal and recovery from lost packets; Protocols for real-time interactive applications: RTP, RTCP, SIP, H.323; Content distribution networks; Integrated and differentiated services, RSVP.	2
6.	**Introduction to Network Security** Cryptography, symmetric and public-key algorithms, digital signatures, communication security, authentication protocols, E-mail security, PGP and PEM.	2
Text Books		
1.	Kurose, J. F. and Ross, R.W,Computer Networking, Pearson Education	
References		
1.	Comer, D.E. and Droms, R.E, Computer Networks and Internets, Prentice-Hall.	
2.	Walrand, J. and Varaiya, P, High Performance Communication Networks, Morgan Kaufmann.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Computer Graphics	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST021	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course is a computer graphics class at the graduate level. The course mainly consists of lectures covering recent research results, ranging from mesh processing, simulation, to non-photorealistic rendering necessary basic mathematical and computation tools will be introduced when needed. Everyone will be expected to complete one or two individual project(s), present one paper related to a chosen research topic (as a team), and complete a (team) project.

Learning Outcomes

Students completing this course are expected to be able to:

- Understand the basics of geometry processing.
- Understand and work with advanced rendering methods such as radiosity.
- Design programs for advanced animation methods.
- Understand issues of modern graphics research.

Course Synopsis

This course covers advanced topics in computer graphics. We will focus on two specific questions: How to create photo-realistic renderings and how to create physically plausible animations? To answer the first question, we will first discuss and analyze the classical raytracing algorithm. With an understanding of the limitations of raytracing, we will look at a more principled way of image synthesis based on the physics of light transport. After studying the basic physical quantities of light transport and corresponding local illumination models, we will derive the global rendering equation as a model for image synthesis. We then discuss Monte Carlo methods for evaluating this integral equation leading to several Monte Carlo rendering algorithms such as path tracing or photon mapping. In the second part of the course we will study concepts and algorithms for the animation of solids and fluids, and discuss principles of performance-driven character animation. Starting with simple particle systems and mass-spring networks, we will discuss numerical time integration methods commonly applied for computer animation. Rigid body simulation and elastic materials will also be covered. We then look at how the approximate solutions of the Navier-Stokes equations can be computed to simulate fluid flow. Finally, we study advanced methods for animating 3D characters based on recorded performances.

Course Outline / Content

Unit	Topics	Week
1.	**Advanced Rendering Techniques:** Photorealistic rendering, Global Illumination, Participating media rendering, Ray tracing, Monte Carlo algorithm, Photon mapping.	3
2.	**Texture Synthesis and Image Processing:** Environmental mapping, Texture synthesis, anisotropic image smoothing.	2
3.	**Volume Rendering:** Volume graphics overview, Marching cubes, Direct volume rendering.	3
4.	**Surfaces and Meshes:** Subdivision, Distance fields and level sets.	2

5.	**Physically-based Modeling:** Stable fluid solver, Lattice Boltzmann method.	2
6.	**Individual Project**	2
	Text Books	
1.	James D. Foley, Andries van Dam, Steven K. FeinerandJohn F. Hughes, Computer Graphics: Principles & Practices, Addison Wesley, 2nd edition in C, 1995.	
2.	Alan H. Watt and Mark Watt, Advanced Animation and Rendering Techniques: Theory and Practice, Addison-Wesley, 1992.	
	References	
1.	Matt Pharr and Greg Humphreys, Physically based rendering, Morgan Kaufmann, 2004	
2.	Tomas Moller and Eric Haines Real-Time Rendering A K Peters Ltd, 2nd edition, 2002.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Database Management Systems	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST022	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

Effective collection, analysis, and maintenance of data is key to achieve rapid progress in almost all disciplines of science and engineering. In this course, we will cover the core principles and techniques of data and information management. The potential topics covered in class include processing and optimization of declarative queries, transactions, crash recovery, data stream systems, Advanced Application Development, Web data management (e.g., Internet and intranet search engines), information integration (e.g., semi structured data and XML), and data mining.

Learning Outcomes

- Master the basic concepts and appreciate the applications of database systems.
- Master the basics of SQL and construct queries using SQL.
- Be familiar with a commercial relational database system (Oracle) by writing SQL using the system.
- Be familiar with the relational database theory, and be able to write relational algebra expressions for queries.
- Mater design principles for logical design of databases, including the E-R method and normalization approach.
- Be familiar with basic database storage structures and access techniques: file and page organizations, indexing methods including B-tree, and hashing.
- Master the basics of query evaluation techniques query optimization.
- Be familiar with the basic issues of transaction processing and concurrency control.

Course Synopsis

Network, hierarchical, and relational, and entity-relationship models; data definition, manipulation languages, and conversion among these models; relational database design theory, efficient query evaluation, elementary query optimization techniques. Semi-Structured Data, Introduction to XML. Performance Tuning, Performance Benchmarks, Standardization, E-Commerce, HADOOP.

Course Outline / Content

Unit	Topics	Week
1.	**Physical Database Design & Tuning:** Database workloads, physical design and tuning decisions, Need for Tuning Index selection: Guideline for index selection, Clustering & Indexing Tools for index selection Database Tuning: Tuning indexes,	3

	Tuning Conceptual schema Tuning Queries &views, Impact of Concurrency, Benchmarking.	
2.	**Advanced Transaction Processing:** Transaction Processing Monitors, Transactional Workflow, Real time transaction System, Long duration Transactions, Transaction Management in Multi-databases, Distributed Transaction Management, Main Memory Databases, and Advanced Transaction Models.	2
3.	**Semi-Structured Data and XML:** Semi-Structured Data, Introduction to XML, XML hierarchical Model, DTD & XML schema, XML Namespace, XML query & Transformation: Xpath, XSLT, XQuery, Storage of XML data, XML Technologies: DOM &SAX Interfaces X pointer, Xlink, XHTML, SOAP, WSDL, UDDI, XML database Application.	4
4.	**Emerging Trends in Databases:** Introduction, Motivation, Temporal databases, Spatial & geographic databases, Multimedia Databases, Mobility & personal Databases.	2
5.	**Advanced Application Development:** Performance Tuning, Performance Benchmarks, Standardization, E-Commerce, Legacy Systems, Large-scale Data Management with HADOOP, Semi structured database COUCHDB: Introduction, Architecture and principles, features.	3
	Text Books	
1.	Database system Concept by Silberschatz and Korth 6th Edition	
2.	Distributed Databases principles & systems by Stefano Ceri, Giuseppe Pelagatti	
3.	Database Systems, Thomas Connolly, Carolyn Begg, Pearson 4th Edition	
	References	
1.	Web Data Management, Abiteboul, Loana, Philippe et.al Cambridge publication.	
2.	Database Management Systems by Raghu Ramakrishnan and Johannes Gehrke	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Computer Architecture	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST023	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

Basic understanding of Computer Architecture, Multi-Threading and Multi-Core programming concepts. The student should be made to: Understand the micro-architectural design of processors. Learn about the various techniques used to obtain performance improvement and power savings in current processors

Learning Outcomes

At the end of the course, the student should be able to: Evaluate performance of different architectures with respect to various parameters Analyze performance of different ILP techniques Identify cache and memory related issues in multi-processors

Course Synopsis

An overview of computer architecture, which stresses the underlying design principles and the impact of these principles on computer performance. General topics include Thread Level Parallelism & Multi-Core Architecture, memory organization, system organization, thread level parallel processing and Multi-Core Programming.

Course Outline / Content

Unit	Topics	Week
1.	**Modern Computer Architectures** Introduction, Fundamentals of RISC, CISC, Instruction Level Parallelism(ILP) – Concepts and Challenges, Branching with Prediction, Dynamic Scheduling: Hazards and Solutions, Measuring Performance of ILP, Limitations of ILP.	2
2.	**Thread Level Parallelism & Multi-Core Architecture** Thread Level Parallelism, Simultaneous Multi-Threading, Multi-Processor Architecture: Types, Limitations; Evolution of Multi-Core, Architecting with Multi-Core: Homogenous and heterogeneous cores, Shared recourses, shared busses, and optimal resource sharing strategies, Performance Evaluation of Multi-Core Processors.	3
3.	**Memory Module Design** Conceptual view of memory cell, Memory address map, Memory connections to CPU, Cache memory-Cache memory management	3

	techniques. Types of cache's: Look through, look aside, write through, write around, unified Vs Split, multilevel, cache levels. Shared memory multiprocessors, Synchronization, small-scale symmetric multiprocessors on a snoopy bus, cache coherence on snoopy buses, Scalable multiprocessors, Directory-based cache coherence, Interconnection network, Memory consistency models, Software distributed shared memory.	
4.	**Multi-Threading Concepts** Fundamentals of Multi-threaded programming, Concurrency vs Parallelism, Threading design concepts for developing an application, Correctness Concepts: Critical Region, Mutual exclusion, Synchronization, Race Conditions. Performance Concepts: Simple Speedup, Computing Speedup, Efficiency, Granularity, Load Balance. Multithreading in hardware, Chip multiprocessing, current research and future trends.	3
5.	**Multi-Core Programming** Introduction to OpenMP, OpenMP directives, Parallel constructs, Work-sharing constructs, Data environment constructs, Synchronization constructs, Extensive API library for finer control, benchmarking multi-core architecture: Bench marking of processors. Comparison of processor performance for specific application domains.	3
	Text Books	
1.	John L. Hennessy and David A. Patterson – Quantative Approach – Computer Architecture 5th edition,Morgan Kaufmann, 2011.	
2.	Shameem Akhter and Jason Roberts, ―Multi-Core Programming, 1st edition, Intel Press, 2006.	
	References	
1.	Vincent. P. Heuring, Harry F. Jordan ―Computer System design and Architecture 2nd edition,Pearson, 2003.	
2.	Apman, Gabriele Jost, Ruud van van der Pas, ―Using OpenMP: Portable Shared Memory ParallelProgramming (Scientific and Engineering Computation), 1st edition, MIT Press, 2007.	
3.	H. J. Siegel.Interconnection Network for Large Scale Parallel Processing, McGraw Hill, 1990.	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Advanced Compilation Techniques.	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST024	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

Built upon basic compiler knowledge, this course covers compiler architecture and techniques, including control flow analysis, optimization, pipelined architecture, garbage collection etc.

Learning Outcomes

After completion of this course, students will be able to:

- Understanding of the challenges involved in compilation (semantic gap between input and output languages, compiler efficiency and code quality)
- Understanding of the phases involved in compilation, and knowledge of the techniques applied.
- Ability to understand design decisions in modern compilers and to justify these.
- Ability to develop and apply modifications to standard compilation techniques wherever this is necessary.
- Ability to analyse compilation tasks and to apply standard compilation techniques.

Course Synopsis

This course includes the basic concepts related to compiler, its architecture , Control Flow Analysis, Static-single assignment, Scalar optimization, Instruction scheduling, Performance evaluation, Data dependence analysis, Loop transformations, Garbage collection and Advanced Topics.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction**: Compiler structure, architecture and compilation, sources of improvement.	2
2.	**Control flow analysis:** Basic blocks & loops. Data flow analysis and optimizations: bit vectors, iterative frameworks, interval analysis, reaching definitions, liveness, common subexpression elimination, constant propagation. More control flow analysis: dominators, control dependence.	2
3.	**Static-single assignment:** Static-single assignment, constant propagation. Scalar optimization: loop invariant code motion, common subexpression elimination, strength reduction, dead code elimination, loop optimizations, etc.	2
4.	**Instruction scheduling:** Pipelined architectures, delayed-load architectures, list scheduling. Register allocation: coloring, allocation, live range splitting.	2
5.	**Performance evaluation:** Interprocedural analysis: side effects, flow-insensitive, flow-sensitive, constants, inlining. Alias analysis: alias analysis, method resolution. Searching, indexing, and their implications to memory management. Information extraction and feature selection. Points-to Analysis	2

	Supervised, unsupervised-learning, and stream mining.	
6.	**Data dependence analysis:** Dependence testing, dependence graphs.	1
7.	**Loop transformations:** Interchange, tiling, fusion, distribution, splitting Just-in-time compilation: fast global optimization.	1
8.	**Garbage collection:** Automatic memory management and data locality.Optimal Integrated Code Generation with OPTIMIST	2
	Text Books	
1.	Compilers by Alfred V. Aho , Monica S Lam, R Sethi, Jeffrey D. Ullman	
2.	Mapping and Compilation: Methods and Techniques by K. K. Rampal	
	References	
1.	https://www.ece.cmu.edu/~ece447/s13/lib/exe/fetch.php?...advancedcaching...ppt	
2.	David Bacon, Susan Graham, Oliver Sharp: Compiler Transformations for High-Performance Computing. ACM Computing Surveys, December 1994, Volume 26 Issue 4. Preprint	
3.	David A. Padua and Michael J. Wolfe: Advanced compiler optimizations for supercomputers.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Principles of Cryptography	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST025	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course is intended to provide a theoretically sound foundation in cryptography as used in network security. We shall learn about basic cryptographic tool like encryption and message authentication, in the "private-key" and "public-key" settings, with a focus on mathematical definitions of security, "provably secure" constructions based on fundamental cryptographic primitives, and how they are used in higher-level network security protocols.

Learning Outcomes

To provide a basic introduction to central aspects of symmetric and asymmetric cryptography. To establish knowledge and understanding of how cryptographic techniques are used to establish security in modern information- and communication systems.

Course Synopsis

Cryptography provides important tools for ensuring the privacy, authenticity, and integrity of the increasingly sensitive information involved in modern digital systems. Nowadays, core cryptographic tools, including encryption, message authentication codes, digital signature, key agreement protocols, etc., are used behind millions of daily on-line transactions. In this course, we will unveil some of the "magic" of cryptography. Modern Cryptography uses mathematical language to precisely pin down elusive security goals, design primitives and protocols to achieve these goals, and validate the security of designed primitives and protocols using mathematical proofs based on clearly stated hardness assumptions. Therefore, to learn cryptography, it is essential to understand its mathematical underpinning. In this course, students will see the inner-working of cryptography for several core cryptographic tools, from encryption, to message authentication codes, to hash functions, to digital signatures, etc.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to Cryptography: Basics of Symmetric Key Cryptography, Basics of Asymmetric Key Cryptography, Hardness of Functions.	2
2.	Mathematical Background for Cryptography: Number Theory, GCD, Groups, Rings, Fields, Properties, Chinese Remainder Theorem.	2
3.	Classical Cryptography: Introduction to Some simple cryptosystems and their Cryptanalysis. Shannon's Theory, Secret vs. Public Key Cryptography.	2
4.	Stream ciphers and Block Ciphers: DES and Alternatives, AES.	2
5.	Cryptographic Hash Functions and MAC.	2
6.	Public Key Cryptography, RSA Cryptosystem and Factoring Integers.	

		2
7.	Discrete Logarithm Problem in Prime Fields, Generalized Discrete Logarithm Problem. Attacks against Discrete Logarithm Problem. Public Key Cryptosystems based on the Discrete Logarithm Problem.	2
8	Elliptic Curve Cryptosystems. Digital Signatures.	1
	Text Books	
1.	Hans Delfs, Helmut Knebl, "Introduction to Cryptography, Principles and Applications", Springer Verlag.	
2.	Wenbo Mao, "Modern Cryptography, Theory and Practice", Pearson Education	
	References	
1.	A Graduate Course in Applied Cryptography by Dan Boneh and Victor Shoup	
2.	Introduction to Modern Cryptography (2nd edition) by Jonathan Katz and Yehuda Lindell	
3.	Handbook of Applied Cryptography by A. Menezes, P. Van Oorschot, S. Vanstone.	
4.	O. Goldreich, Foundations of Cryptography, CRC Press.	

Department of Computer Science & Engineering

National Institute of Technology Srinagar

Course Title	Neural Networks	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST026	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

- To introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems.
- To understand the role of neural networks in engineering, artificial intelligence, and cognitive modelling.
- To provide knowledge in developing the different algorithms for neural networks

Learning Outcomes

After completion of this course the students should be able to:

- Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
- Implement deep learning algorithms and solve real-world problems.

Course Synopsis

Basics of ANN-Mathematical model-Applications; Single Layer Perceptron; Multi Layer Perceptron; Associative Memory; Recurrent neural networks; Boltzmann machine; Self-organizing feature maps; Fuzzy neural networks,Genetic algorithms.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to neural networks**: Biological and Artificial neurons,McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Network Architectures.	2

2.	**Multilayer networks:**Sigmoid Neurons, Gradient Descent(GD) , Feedforward Neural Networks, Representation Power of Feedforward Neural Networks,Back propagation (BP) , Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Recurrent networks and unsupervised learning, Hopfield network - energy; stability; capacity,Boltzmann machine, Kohonen'sself organizing feature maps.	3
3.	**Associative memory:**Auto associative memories, Hetero associative memories, performance measures, associative memory models, Applications of associative memories.	2
4.	**Convolutional Neural Networks:**Visualizing Convolutional Neural Networks, Guided Backpropagation**,**Fooling Convolutional Neural Networks.	2
5.	**Neuro Evolution:** Introduction to Neuro evolution, Weight evolution, Topology evolution, Learning rule evolution, Deep Neuro Evolution. Neuro evolution uses and introduction to evolutionary algorithms to build Neural networks	3

	Text Books
1.	Limin Fu." Neural Network in Computer Intelligence" , Tata McGraw-Hill 2003 Edition.
2.	Gene Sher, "handbook of Neuro evolution" , Springer , Edition 1.
	References
1.	James A. Freeman David M. Skapura, "Neural Networks: Algorithms, Applications, And Programming Techniques". Pearson Publication ,Edition 1
2.	Ke-lin du, M.N.S Swamy, "Neural networks and statistical learning", Springer 2014 edition.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Pervasive Computing	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST027	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

The course is about the emerging discipline of Pervasive Computing, also known as Ubiquitous Computing, Everywhere Computing and Invisible Computing. The key element here is the omnipresence of information devices. These devices can be embedded into cars, airplanes, ships, bikes, posters, signboards, walls and even clothes. This course focuses on independent information devices including mobile phones, smart phones, and laptops (PCs), and the services made available by them. It includes human-computer interaction using several types of elements including text, speech, and handwriting.

Learning Outcomes

The objective of this course is:

- To study the pervasive computing and its applications.
- To study the pervasive computing web based applications.
- To study voice enabling pervasive computing.
- To study PDA in pervasive computing.
- To study user interface issues in pervasive computing.

Course Synopsis

The course aims at providing a sound conceptual foundation in the area of Pervasive Computing aspects. The course attempts to provide a balanced treatment of the mechanisms and environments of pervasive computing and initiates senior CS students to the state-of-the-art in the area. At the end of this course, students should be able to conceptualize, analyze and design select classes of pervasive computing systems.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Pervasive Computing:** Past, present, future; the pervasive computing market, m-Business, Challenges and future of Pervasive Computing, **Application Examples of Pervasive Computing:** Retail, Airline Check-in and booking, Sales force automation, Healthcare, Tracking, Car Information Systems, Email Access via WAP and voice	3
2.	**DeviceTechnology for PervasiveComputing :** Hardware, Human-machine interfaces, Biometrics, Operating Systems, Java for pervasivedevices, Outlook **Device Connectivity:** Protocols, Security, Device Management	3
3.	**Developing WML Applications:** Developing WML Applications: WML documents, developing a WML application, WML tags, registration WML listing and WML script.	2
4.	**MIDP Programming:** MIDP Programming: J2ME MIDP user interface, MIDP application, developing a MIDP application, MIDP Classes:	2

	MIDlet class, MIDP GUI classes, MIDlet high-level events, low-level APIs and event handling.	
5.	**Advanced MIDP Programming** : Network programming, MIDP database programming, MIDlet provisioning, Bluetooth application.	2
6.	**Developing VoiceXML Applications** Developing VoiceXML Applications: VoiceXML applications, VoiceXML TAGS, ECMAScript – Java Card Application: Java card VM, APDUs, java card API, host applications.	2

Text Books

1.	JochenBurkhardt, Dr. Horst Henn, Stefan Hepper – Pervasive Computing Technology and Architecture ofMobile Internet Applications – Pearson Education, 2005.
2.	JochenBurkhardt, Horst Henn, Stefan Hepper, Thomas Schaec& Klaus Rindtorff: Pervasive Computing: Technology and Architecture of Mobile Internet Applications, Pearson Education, New Delhi, 2006.

References

1.	Dan Harkey, Shan Appajodu, Mike Larkin – Wireless Java Programming for Enterprise Applications WileyPublishing, Inc., 2001.
2.	StefenPoslad: Ubiquitous Computing: Smart Devices, Environments and Interactions, Wiley, Student Edition, 2010.
3.	A. Genco, S. Sorce: Pervasive Systems and Ubiquitous Computing, WIT Press, 2012.
4.	Guruduth S. Banavar, Norman H. Cohen, ChandraNarayanaswami: Pervasive Computing: An Application-Based Approach, Wiley Interscience, 2012.

Department of Computer Science & Engineering National Institute of Technology Srinagar					
Course Title	Distributed and Parallel Computing	**Semester**			
Department	Computer Science & Engineering	**Course Code**	CST028		
Credits	03	**L**	**T**	**P**	
Course Type	Theory	3	0	0	

Course Objectives

To provide knowledge on principles and practice underlying in the design of distributed systems.

Learning Outcomes

By the end of the course, the students will be able to:

- Layout foundations of Distributed Systems;
- Introduce the idea of middleware and related issues;
- Understand in detail the system level and support required for distributed system;
- Understand the issues involved in studying data and design of distributed algorithms.

Course Synopsis

overview of parallel computing; Pipelined computations; communication technologies; clock synchronization; proof of correctness; complexity analysis; Distributed operating systems; algorithms for implementing DSM; load balancing; fault-tolerant models; Research issues in distributed systems.

Course Outline / Content

Unit	Topics	Week
1.	An overview of parallel computing, Languages and programming environments, Message passing computing, Partitioning and divide-and-conquer strategies, Pipelined computations, Synchronous computations, Load balancing and termination detection, Programming with shared memory.	2
2.	Algorithms and applications Components of distributed systems, Communication technologies, communication services.	1
3.	Distributed algorithms and protocols: examples of distributed algorithms, clock synchronization, logical and vector clocks, election algorithms, consensus algorithms, proof of correctness, complexity analysis.	2
4.	Distributed operating systems: system models, file services, name services, process synchronization and coordination, case studies.	2
5.	Distributed shared memory: algorithms for implementing DSM, coherence protocols.	1
6.	Distributed resource management: load sharing, load balancing, resource monitoring	2
7.	Failure recovery and fault tolerance: check-pointing, recovery, fault-tolerant models and protocols	2
8.	Research issues in distributed systems, real-time protocols, standardization issues, cluster and grid computing.	2

Text Books

1.	George Coulouris, Jean Dellimore and Tim KIndberg, “Distributed Systems Concepts and Design”, Pearson Education.
2.	Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet (DCC) by Kai Hwang, Jack Dongarra& Geoffrey C. Fox.
3.	Ajay D. Kshemkalyani and MukeshSinghal, “Distributed Computing – Principles.
4.	Andrew S. Tanenbaum and Maarten van Steen. “Distributed Systems: Principles and Paradigms” (DSPD), Prentice Hall
2.	Principles of Parallel Programming, by Calvin Lin and Larry Snyder, Addison-Wesley.
References	
1.	MukeshSinghal and N. G. Shivaratri, “Advanced Concepts in Operating Systems”
2.	Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, by Barry Wilkinson, Michael Allen. Prentice Hall.
3.	Joshy Joseph and Craig Fellenstein, “Grid Computing”, IBM Press.
4.	Algorithms and Systems”, Cambridge University Press
5.	Nancy A. Lynch, Distributed Algorithms, Morgan Kaufmann Publishers.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Cloud Computing	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST029	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will introduce various aspects of cloud computing, including fundamentals, management issues, security challenges and future research trends. This will help students (both UG and PG levels) and researchers to use and explore the cloud computing platforms.

Learning Outcomes

This course offers a good understanding of cloud computing concepts and prepares students to be in a position to design cloud based applications for distributed systems.

Course Synopsis

The course presents a top-down view of cloud computing, from applications and administration to programming and infrastructure. Its main focus is on parallel programming techniques for cloud computing and large scale distributed systems which form the cloud infrastructure. The topics include: overview of cloud computing, cloud systems, parallel processing in the cloud, distributed storage systems, virtualization, security in the cloud, and multicore operating systems. Students will study state-of-the-art solutions for cloud computing developed by Google, Amazon, Microsoft, Yahoo, VMWare, etc. Students will also apply what they learn in one programming assignment and one project executed over Amazon Web Services.

Course Outline / Content

Unit	Topics	Week
1.	**Cloud Computing Basics:** Cloud Computing Overview; Characteristics; Applications; Internet and Cloud; Benefits; Limitations; Challenges.	1
2.	**Cloud Computing Services and Deployment Models:** Infrastructure as a Service; Platform as a Service; Software as a Service; Private Cloud; Public Cloud; Community Cloud; Hybrid Cloud	2
3.	**Cloud Computing vs Other Computing Technologies:** Overview of Grid, Peer-to-Peer, Pervasive and Utility Computing technologies; their characteristics and comparison between them	1
4.	**Accessing the Cloud:** Hardware and Infrastructure requirements; Access Mechanisms: Web Applications, Web APIs, Web Browsers.	2
5.	**Cloud Storage and Cloud Standards:** Overview; Storage as a Service; Cloud Storage Issues; Challenges; Standards	2
6.	**Security Issues**: Securing the Cloud, Securing Data, Establishing identity and presence.	2
7.	**Developing Applications:**	2

	Major Players in Cloud Business; Overview of Service Oriented Architecture; Tools for developing cloud services and applications.	
8.	**Practice Cloud IT Model:** Analysis of Case Studies when deciding to adopt cloud computing architecture. How to decide if the cloud is right for your requirements. Cloud based service, applications and development platform deployment so as to improve the total cost of ownership (TCO).	2
	Text Books	
1.	Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter: Cloud Computing: A Practical Approach, McGraw Hill, 2010.	
2.	Kai Hwang, Jack Dongarra& Geoffrey C. Fox.:Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet (DCC)	
	References	
1.	RajkumarBuyys, James Broberg, AndrzejGoscinski (Editors) : Cloud Computing: Principles and Paradigms, Wiley, 2011.	
2.	Barrie Sosinsky : Cloud Computing Bible, Wiley, 2011.	
3.	Judith Hurwitz, Robin Bloor, Marcia Kaufman,FernHalper : Cloud Computing for Dummies, Wiley, 2010.	
4.	BorkoFurht, Armando Escalante (Editors) : Handbook of Cloud Computing, Springer, 2010.	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Software Project Management	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST030	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This includes:

- Resolve the process of managing software from conventional to modern.
- Analyze the architecture of a model based software and the process flow.
- Describe the process automation, process management, change management, quality management, monitoring and control.

Learning Outcomes

At the end of the course, the student will be able to:

- Develop the model from the conventional software product to the modern.
- Analyze and design the software architecture.
- Have an exposure for organizing and managing a software project.
- Apply, analyze, design and develop the software project.
- Design various estimation levels of cost and effort.
- Acquire the knowledge of managing, economics for conventional, modern and future software projects.

Course Synopsis

The System Project Management (SPM) is focused on tools for planning and managing complex projects and the issues associated with complex projects. This course discusses the ways in which projects that are already underway can be monitored and tracked in terms of cost, schedule and technical progress. Various risk management techniques for identifying, tracking and mitigating risks are discussed. Further the course discusses pointers to important resources for project management, project management software tools as well as a list of empirical factors that are known to affect project success and failure.

Course Outline / Content

Unit	Topics	Week
1.	**Project Management:** The management spectrum, the people, the product, the process, the project, the W5HH principle, critical practices.	1
2.	**Metrics for Process and Project:** Metrics in the process and project Domains, software measurements, metrics for software quality, integrating metrics within software process, metrics for small organizations, establishing a software metrics program.	1
3.	**Estimation:** Observations, Project planning Process, software scope and feasibility, resources, software project estimation, decomposition techniques, empirical estimation models, estimation for object oriented projects, estimation for Agile	2

	development and web engineering projects, the make/buy decision.	
4.	**Project Scheduling:** Basic concepts, project scheduling, defining a task set and task network, scheduling, earned value analysis. **Risk Management:** Reactive V/S proactive Risk Strategies, software risks, Risk identification, Risk projection, risk refinement, risk mitigation, monitoring and management, the RMMM plan.	2
5.	**Quality Planning:** Quality Concepts, Procedural Approach to Quality Management, Quantitative Approaches to Quality Management, Quantitative Quality Management Planning, Setting the Quality Goal, Estimating Defects for Other Stages, Quality Process Planning, Defect Prevention Planning.	2
6.	**Quality Management:** Quality Concepts, Software Quality assurances, software reviews, formal technical reviews, Formalapproaches to SQA, Statistical Software Quality assurances.	1
7.	**Change Management:** Software Configuration Management, The SCM repository, SCM Process, Configuration Managementfor Web Engineering.	1
8.	**Project Execution And Closure:** Reviews. The Review Process, Planning, Overview and Preparation, Group Review Meeting, Rework and Follow-up, One-Person Review, Guidelines for Reviews in Projects, Data Collection, Analysis and Control Guidelines, Introduction of Reviews and the NAH Syndrome.	2
9.	**Project Monitoring and Control:** Project Tracking, Activities Tracking, Defect Tracking, Issues Tracking, Status Reports, Milestone Analysis, Actual Versus Estimated Analysis of Effort and Schedule, Monitoring Quality, Risk-Related Monitoring. Project Closure: Project Closure Analysis.	2
	Text Books	
1.	Walker Rayce: "Software Project Management A Unified Framework", 1st Edition, Pearson Education, 2005.	
	References	
1.	Richard H.Thayer: "Software Engineering Project Management", 2nd Edition, IEEE Computer Society, 1997.	
2.	Shere K.D: "Software Engineering and Management", 1st Edition, Prentice Hall, 1988.	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Big Data	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST031	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course looks at concepts, technologies for big data. The focus will be on the processing techniques and algorithms that are available for a variety of "analytics". The interconnection of big data with cloud and virtualization will also be studied.

Learning Outcomes

After completion of this course, students will be able to:

- Understand how to process big data on platforms that can handle the variety, velocity, and volume of data by using a family of components that require integration and data governance.
- Familiar with the skills necessary for utilizing to handle a variety of big data analytics, and to be able to apply the analytics techniques on a variety of applications.

Course Synopsis

This course will cover important topics related to big data including Introduction of big data concepts, Examining big data types, Class Model, Study of different patterns, Case studies and memory management, Big Data NFR's, concept of distributed computing and virtualization in big data.

Course Outline / Content

Unit	Topics	Week
1.	Data Economy, Data Analytics ,Data Science, Traditional Data Processing Technologies, Large databases and their evolution. Big Data technology and trends, Big Data Introduction, Characteristics, Methodological Challenges and Problems, Example Applications.	2
2.	Examining Big Data types – Defining structured data – exploring sources and understanding role of relational databases in big data. Defining unstructured data- exploring sources and understanding role of CMS in data management.	2
3.	Providing Structure to Unstructured Data, Identification, De-identification and Reidentification. Ontologies and Semantics - Classification, Classes with Multiple Parents, Choosing a Class Model, extensible Mark-up Language.	2
4.	Introduction to Meaning, Namespaces and the Aggregation of Meaningful Assertions, Data Integration and Software Interoperability, Immutability and Immortality Application Architecture.	2
5.	Ingestion and Streaming Pattern, Storage Patterns, Access Patterns, Discovery and Analysis Patterns, Visualization Patterns, Deployment Patterns. , Case Studies. Special consideration made to the Map-Reduce paradigm. Searching, indexing, and their implications to memory management.	2

	Information extraction and feature selection. Supervised-, unsupervised-learning, and stream mining.	
6.	Big Data Computational limitations, Big Data Emerging technologies.	1
7.	Big Data NFR's., Data Privacy and Ethics, The privacy landscape, Preferences, Personalization and Relationships, Rights and Responsibility, Can data be anonymized.	1
8.	Need of distributed computing for Big Data, Virtualization and how it supports distributed computing, Cloud and Big Data, Introduction to tools used for big data.	2
	Text Books	
1.	Big Data: A Revolution That Will Transform How We Live, Work, and Think by Viktor Mayer-Schönberger, Kenneth Cukier	
2.	Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends. by Michael Minelli, Michele Chambers, AmbigaDhiraj	
	References	
1.	https://www.slideshare.net/nasrinhussain1/big-data-ppt-31616290	
2.	https://www.ntnu.no/iie/fag/big/lessons/lesson2.pdf	
3.	https://www.planet-data.eu/sites/default/files/presentations/Big_Data_Tutorial_part4.pdf	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Cyber Laws & Forensics	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST032	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

To maintain an appropriate level of awareness, knowledge and skill required to minimize the occurrence and severity of incidents related to forensics and cyber law.

Learning Outcomes

After completing the course you will be able to:

- Interpret and appropriately apply the laws and procedures associated with identifying, acquiring, examining and presenting digital evidence.
- Create a method for gathering, assessing and applying new and existing legislation and industry trends specific to the practice of digital forensics.
- Employ fundamental computer theory in the context of computer forensics practices.
- Adhere to the ethical standards of the profession and apply those standards to all aspects of the study and practice of digital forensics.
- Using the scientific process, apply the principles of effective digital forensics investigation techniques.

Course Synopsis

As the name suggests, Cyber Law encapsulates the legal issues related to use of the Internet. IT law covers mainly the digital information (including information security and electronic commerce) aspects and it has been described as "paper laws" for a "paperless environment". India's The Information Technology Act 2000 has tried to assimilate legal principles available in several such laws (relating to information technology) enacted earlier in several other countries, as also various guidelines pertaining to information technology law. The Act gives legal validity to electronic contracts, recognition of electronic signatures. This is a modern legislation which makes acts like hacking, data theft, spreading of virus, identity theft, defamation (sending offensive messages) pornography, child pornography, cyber terrorism, a criminal offence. It is less a distinct field of law than intellectual property or contract law, as it is a domain covering many areas of law and regulation. Some leading topics include internet access and usage, privacy, freedom of expression, and jurisdiction. Our course is specially designed to make the participant an expert of Cyber Law Fundamentals and Digital Forensics. This is made possible by discussing the in-depth concepts of computers and networks, Cyber-crime and Cyber Terrorism, the hacking techniques used by terrorist communities, encryption standards they use and other algorithms as well. Concepts of Internet Security, Digital Signature and Electronic Payment System, Digital Law, Law of Intellectual Property.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction to Forensics and Cyber Crime:** Fundamentals of computer, Internet Technology, E-Governance & E-Business ,crime, criminology, origin, source, recent trends. Emergence of information based society, economic, administration, social, dependence of use of information, accession, threats, civil society and global society, Overview of computer forensics and Investigative Techniques, Computer forensic tools, activities of forensic investigations and testing methodology.	2

2.	**Types and Categories of Cyber Crime:** Personal, Business, Financial, Office Security, Cyber Crime – Complete transparency, hacking/cracking, denial of service, IP piracy, phrasing, hetaerism etc. Cyber Attack – cyber attackers.	2
3.	**Role of Computers and Internet in Cyber crime, penetration testing and auditing :** Computer as witness, evidence, act, defining evidence, computer forensics, computer storage, media of electric record for use of course of law. Customers and legal agreements, Router penetration testing, Firewalls penetration testing, Intrusion detection system penetration testing, Wireless networks penetration testing, Password cracking penetration testing, Social engineering penetration testing, Application penetration testing, Policies and controls testing. Penetration testing report and documentation writing, Policies and procedures Security Policies-checklist.	3
4.	**Cyber Security:** The concept of cyber security , meaning, scope and the frame work, basic structure development and management, Rules, Regulations, Act, Legislation - Meaning, Scope, Difference between Rules.	2
5.	**Need for a Cyber Act:** The Indian Context , Need for a Cyber Act , Information Technology Act , Scope and further Development , Information Technology Act (Amendment) , coverage of Cyber Security and Cyber Crime Indian cyber Laws vs. cyber laws of U.S.A , similarities , scope and coverage , Effectiveness.	3
6.	**Laboratory work:** Consists of gathering information, evidence with tools like WinHex, Metasploit and Social Engineering toolkit.	2

Text Books

1.	Cyber Forensics: from Data to Digital Evidence , Albert J. Marcella Jr., Wiley,1 st Edition,2012
2.	Hack I.T. - Security Through Penetration Testing, T. J. Klevinsky, Scott Laliberte and Ajay Gupta, Addison-Wesley, 1st Edition,2002
3.	Computer Forensics: Cybercriminals, Laws, And Evidence , Marie-Helen Maras, Jones & Bartlett Learn ,1st Edition ,2011.

References

1.	Computer Forensics: Investigating Network Intrusions and Cyber Crime, EC Council Press Series, Cengage Learning , 2010
2.	James, S.H. and Nordby, J. J “Forensic Science – An Introduction to Scientific and Investigative Technique”, CRC Press, USA (2003).

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Expert Systems	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST033	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course deals with concepts, methods, and applications of decision modeling to address various marketing issues. Unlike conventional capstone, business courses that focus on conceptual material this course will attempt to provide skills to translate conceptual understanding into developing specific operational models for improved decision-making - a skill in increasing demand in corporations today. Methodology used to transfer the knowledge of a human expert into an intelligent program that can be used to solve problems or give advice.

Learning Outcomes

After completing this course, the student should be able to:

- Apply the methodology to transfer human knowledge into an expert system.
- Apply knowledge representation.
- Design a knowledge base.
- Implement a rule-based expert system.
- Evaluate Expert System tools.
- Provide you with understanding of the role of Artificial Intelligence, Expert Systems and Decision Models in managerial decision-making.
- Develop abilities to apply, build and modify decision models to solve real problems
- Explore the issues involved in the design and development of Artificial Intelligence Based Decision Support Systems and discuss the role these systems play in the business environment.

Course Synopsis

Introduction to Expert Systems, Knowledge Representation, Inference Methods, Reasoning under Uncertainty, Inexact Reasoning, Design of Expert Systems. Machine learning and database mining.

Course Outline / Content

Unit	Topics	Week
1.	**Overview**: Background, general introduction. Forward and backward chaining, conflict resolution. Uses: structured selection, configuration, diagnosis and business rules.	2
2.	**Rule-based expert systems**: Logic and Inferences: Propositional Logic, First Order Logic, Soundness and Completeness, Forward and backward chaining. Uncertainty, fuzzy logic and belief nets. Expert System Shells.	3
3.	**Other expert system paradigms**: PIES example system (Pan and Tenenbaum) OOPs, frames, Case-based reasoning and help desks, Recommender systems (CDNow Case Study). Scheduling (Steelmaking example: Dorn and Slany).	2
4.	**Building expert systems**: CLUES example system (Talebzadeh, Mandutianu and Winner), Building expert systems Discussion of shells. Knowledge Management (Wiki web case study)	3

5.	**Machine learning and data-base mining**: AI-Agents. State Space Search: Depth First Search, Breadth First Search, DFID. Heuristic Search: Best First Search, Hill Climbing, Beam Search. Randomized Search: Simulated Annealing. Data Mining Decision Trees, Neural Networks, Text Mining, Web mining Current trends in AI.	4
	Text Books	
1.	The Engineering of Knowledge-based Systems, A.J. Gonzalez and D. D. Dankel, Prentice Hall, 1993.	
2.	A Guide to Expert Systems, Donald A. Waterman, Pearson publications.	
3.	Introduction to Knowledge Systems, Stefik M., Morgan Kaufmann.	
	References	
1.	Giarratano J. , Riley G. , Expert Systems, Principles and Programming, PWS Publishing Company	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Mobile Computing	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST034	
Credits	3	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

To study the details of lower layers of mobile architectures in the context of pervasive computing and mobile applications.

Learning Outcomes

By the end of this course, the student will be able to:

- Understand algorithm/protocols, environments and communication systems in mobile computing;
- Have an understanding of MANETs;
- Evaluate the performance of TCP protocols in Wireless Networks with mobile nodes.

Course Synopsis

Introduction to MC; System architecture; Localization and calling; Motivation for a specialized MAC; DHCP; TCP; power aware and context-aware computing; Communications asymmetry; Wireless Application Protocol-WAP.

Course Outline / Content

Unit	Topics	Week
1.	**Mobile Computing (MC):** Introduction to MC, novel applications, limitations, and architecture.	1
2.	**GSM:** Mobile services, System architecture, Radio interface, Protocols, Localization and calling, Handover, Security, and New data services.	2
3.	**Wireless Medium Access Control:** Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), SDMA, FDMA, TDMA, CDMA.	2
4.	**Mobile Network Layer:** Mobile IP (Goals, assumptions, entities and terminology, IP packet delivery, agent advertisement and discovery, registration, tunnelling and encapsulation, optimizations), Dynamic Host Configuration Protocol (DHCP).	2
5.	**Mobile Transport Layer:** Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission /time-out freezing, Selective retransmission, Transaction oriented TCP.	2
6.	**Database Issues:** Hoarding techniques, caching invalidation mechanisms, client server computing with adaptation, power aware and context-aware computing, transactional models, query processing, recovery, and quality of service issues.	2
7.	**Data Dissemination:** Communications asymmetry, classification of new data delivery mechanisms, pushes based mechanisms, pull-based mechanisms, hybrid mechanisms, selective tuning (indexing) techniques.	2
8.	**Mobile Ad hoc Networks (MANETs):** Wireless Application Protocol-WAP.	1

Text Books	
1.	Reza B‟Far, "Mobile Computing Principles and Designing and Developing Mobile Applications with UML and XML", Cambridge University Press, 2004.
2.	JochenBurkhardt, et.al." Pervasive Computing, Technology and Architecture of Mobile Internet Applications", Addison Wesley, 2002.

References	
1.	UweHansmann, LotharMerk, Martin S. Nicklous, Thomas Stober, "Principles of Mobile Computing," Springer International, 2005.
2.	Yi Bing Lin, "Wireless and Mobile Networks Architecture", John Wiley and Sons, 2000.
3.	Tomasz Imielinski et.al, "Mobile Computing", Kluwer Academic Press, 1996.
4.	UweHansmann, "Pervasive Computing Handbook. The Mobile World", IEE publication 2002.

Department of Computer Science & Engineering National Institute of Technology Srinagar					
Course Title	Green Computing	**Semester**			
Department	Computer Science & Engineering	**Course Code**	CST035		
Credits	03	**L**	**T**	**P**	
Course Type	Theory	3	0	0	

Course Objectives

To acquire knowledge to adopt green computing practices to minimize negative impacts on the environment, skill in energy saving practices in their use of hardware, examine technology tools that can reduce paper waste and carbon footprint by user, and to understand how to minimize equipment disposal requirements.

Learning Outcomes

By the end of this course, the student will beable to:

- Give an account of the concept green IT;
- Give an account of environmental perspectives on IT use;
- Give an account of standards and certifications related to sustainable IT products;
- Describe green IT in relation to technology;
- Relate green IT to sustainable development;
- Evaluate IT use in relation to environmental perspectives;
- Discuss how the choice of hardware and software can facilitate a more sustainable operation;
- Use methods and tools to measure energy consumption.

Course Synopsis

Virtualization; Tele-computing; thin clients; Embedded computing and networking; Sustainable technology; Profiling Energy Usages; Green Networking; Data centre management architecture; Green Cellular Networking.

Course Outline / Content

Unit	Topics	Week
1.	**Origins**, Regulations and industry initiatives-Government, Industry. Approaches. **Virtualization**: Green maturity model for virtualization, Virtualization level: Level 0, Level 1, Level 2, Level 3.	3
2.	**Terminal servers**, Power management, Operating system support, Power supply, Storage, video card, Display. Web, temporal and spatial data mining materials recycling, Tele-computing. Thin clients: Introduction of thin clients, Characteristics of thin clients, Thin client variants.	3
3.	**Middleware support** for green computing, Tools for monitoring, HPC computing, Green Mobile, Embedded computing and networking, Management frameworks, Standards and metrics for computing green. **Environmentally Sustainable Infrastructure Design:** Sustainable technology, Sustainable intelligence, decomposing infrastructure environment.	4

	Profiling Energy Usages for Efficient Consumption: Profiling energy usages for the application. Profiling energy usages for the operating system and Extra energy usages profile.	
4.	**Green Networking:** Where to save energy in wired networking, Taxonomy of green networking research: Adaptive link rate, Interface proxying, Energy ware infrastructure, Energy ware application. **Efficient-Efficient Data Canters:** Reason for over power consumption in data centers, Data center management architecture in greener perspective. **Green Cellular Networking:** Survey, Measuring greenness metrics, Energy saving in base stations, Research issues, Challenges, Future generation wireless systems, Wireless sensor network for green networking.	4
	Text Books	
1.	Bud E. Smith, "Green Computing: Tools and Techniques for Saving Energy, Money, and Resources", Auerbach Publications.	
2.	Toby Velte, Anthony Velte, Robert Elsenpeter, "Green IT: Reduce Your Information System's Environmental Impact While Adding to the Bottom Line", MC-Graw Hill.	
3.	Jason Harris , "Green Computing and Green IT Best Practices on Regulations and Industry Initiatives, Virtualization, Power Management, Materials Recycling and Telecommuting", Emereo Publishing.	
	References	
1.	John Lamb, "The Greening of IT-How Companies Can Make a Difference for the Environment", Pearson Education.	
2.	Greg Schulz, "The Green and Virtual Data Center", CRC Press.	
3.	F. Richard Yu, Xi Zhang, Victor C.M. Leung, "Green Communications and Networking", CRC Press.	
3.	Daniel Minoli, "Designing Green Networks and Network Operations: Saving Run-the-Engine Costs", CRC Press.	

Department of Computer Science & Engineering National Institute of Technology Srinagar					
Course Title	Introduction to Robotics	**Semester**			
Department	Computer Science & Engineering	**Course Code**	CST036		
Credits		**L**	**T**	**P**	
Course Type	Theory				

Course Objectives

- To introduce the functional elements of Robotics.
- To impart knowledge on the direct and inverse kinematics.
- To introduce the manipulator differential motion and control.
- To educate on various path planning techniques.
- To introduce the dynamics and control of manipulators.

Course Outline / Content

Unit	Topics	Week
1.	**BASIC CONCEPTS :** Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and control issues- Various manipulators – Sensors - work cell - Programming languages.	3
2.	**DIRECT AND INVERSE KINEMATICS:** Mathematical representation of Robots - Position and orientation – Homogeneous transformation-Various joints- Representation using the DenavitHattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots-Solvability – Solution methods-Closed form solution.	3
3.	**MANIPULATOR DIFFERENTIAL MOTION AND STATICS :** Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.	4
4.	**PATH PLANNING :** Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.	4
5	**DYNAMICS AND CONTROL:** Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.	2

Text Books

1.	R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2.	JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education,
3.	M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
References	
1.	AshitavaGhoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2.	K. K.AppuKuttan, Robotics, I K International, 2007.
3.	Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4.	B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998
5.	R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
6.	S.Ghoshal, " Embedded Systems & Robotics" – Projects using the 8051 Microcontroller", Cengage Learning, 2009.

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Data Analytics	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST037	
Credits		**L**	**T**	**P**
Course Type	Theory			

Course Objectives

- Be exposed to big data.
- Learn the different ways of Data Analysis.
- Be familiar with data streams.
- Learn the mining and clustering.
- Be familiar with the visualization

Course Outline / Content

Unit	Topics	Week
1.	**INTRODUCTION TO BIG DATA:** Introduction to Big Data Platform – Challenges of conventional systems - Web data – Evolution of Analytic scalability, analytic processes and tools, Analysis vs reporting - Modern data analytic tools, Stastical concepts: Sampling distributions, resampling, statistical inference, prediction error..	3
2.	**DATA ANALYSIS:** Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics - Rule induction - Neural networks: learning and generalization, competitive learning, principal component analysis and neural networks; Fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, Stochastic search methods.	3
3.	**MINING DATA STREAMS:** Introduction to Streams Concepts – Stream data model and architecture - Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window - Realtime Analytics Platform(RTAP) applications - case studies - real time sentiment analysis, stock market predictions.	4
4.	**FREQUENT ITEMSETS AND CLUSTERING:** Mining Frequent itemsets - Market based model – Apriori Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent itemsets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and PROCLUS – Frequent	4

	pattern based clustering methods – Clustering in non-euclidean space – Clustering for streams and Parallelism.	
5	**FRAMEWORKS AND VISUALIZATION:** Map Reduce – Hadoop, Hive, Map R – Sharding – NoSQL Databases - S3 - Hadoopistributed file systems – Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications.	2

Text Books	
1.	Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2.	AnandRajaraman and Jeffrey David Ullman, Mining of Massive Datasets,Cambridge University Press, 2012.
References	
1.	Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analystics, John Wiley & sons, 2012.
2.	Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O‟Reilly, 2011.
3.	Jiawei Han, MichelineKamber “Data Mining Concepts and Techniques”, Second Edition, Elsevier, Reprinted 2008.

Department of Computer Science & Engineering National Institute of Technology Srinagar					
Course Title	Computational Biology	**Semester**			
Department	Computer Science & Engineering	**Course Code**	CST038		
Credits	03	**L**	**T**	**P**	
Course Type	Theory	3	0	0	

Course Objectives

- To provide basic introduction to Systems Biology, properties of biological systems and approaches in systems biology to analyze and interpret data
- To give an overview of Synthetic Biology and analytical computational methods discussed with the help of tools and software.
- To understand the recent trends in genomics like toxico-genomics, pharmacogenomics, NGS etc.
- To familiarize the advanced topics in CADD like pharmacodynamics & pharmacokinetics.
- To introduce metabolomics with its profiling and analysis.

Learning Outcomes

By the end of this course, the student will be able to:

- Explain mathematical concepts involved in biology
- Gain basic knowledge of modern molecular biology and genomics
- Develop an algorithm for analysis of biological sequences.
- Gain knowledge to identify and develop in silico models appropriate to the different biological projects.
- Apply molecular methods to study genetic variation within and between species 6) Explain and evaluate different phylogenetic optimal criteria.
- Correctly select systems biology tools that will help them in re-constructing and redefining complex biological processes.

Course Synopsis

System Biology, Gene Regulatory Network, Protein Interaction Network,Sysnthetic Biology, Computational Synthetic biology,Engineering Biology, Toxic-genomics, Pharmacogenomics, Pharmaco-genetics, Molecular dynamics simulations, Metabolome informatics.

Course Outline / Content

Unit	Topics	Week
1.	**Systems biology:** Self-organization, emergence, modularity and abstraction, feedback, control analysis, Enzyme Kinetics and **Thermodynamics:** The Law of Mass Action; Reaction Kinetics, Rate Equation, Michaelis-Menten Equation, Hill Equation, Interaction networks overview- Gene Regulatory Network, Protein – Protein Interaction Network, Signaling Pathways, Metabolic path-ways; network motifs, **Systems Biology tools and standards:** Matlab Systems Biology toolbox; SBML; SBGL (Systems Biology Graphical Language); KEGG; Tools for systems Biology- Cell designer; Cytoscape.	3

2.	**Synthetic Biology:** Engineering Biology; design and construction of novel biological systems; Abstraction hierarchy-Part, Device, Systems; Bio-Bricks - a standard for (physical) DNA composition, Designing a biological system from Bio-bricks; iGEM; SBOL, Computational Synthetic biology: Codon optimization; AND gate and OR gate in biology; Operons; Switches and clocks; Re-pressilator; Applications- Environment, Energy, Pharmaceutical needs, Ethical issues of Synthetic Biology.	3
3.	**Niche areas in Genomics:** Toxic-genomics, Pharmacogenomics, Pharmaco-genetics, SNP, Personalized medicine, Meta-genomics, Comparative genomics, Functional genomics, structural genomics, QTL, HGP. Next Generation Sequencing methods, Overview of data compression, Need for compression, Scope of NGS data compression.	3
4.	**Advanced topics in CADD:** Molecular dynamics simulations, Force fields, Energy minimization, pharmacodynamics & pharmacokinetics, 2D and 3D screening, Identification of targets in silico, GPCRs, Peptides as drugs, introduction to Ayur-informatics.	3
5.	**Metabolomics:** Metabolism, metabolomite, metabolome, metabolomic separation and analysis techniques, metabolic profiling, metabolic fingerprinting, Metabolome informatics. Resources/databases of metabolomics, Applications; Epigenetics	3

	Text Books
1.	Alon, U. (2006). An introduction to systems biology: design principles of biological circuits. CRC press.
2.	Gautham, N. (2006). Bioinformatics: Databases and Algorithms. Alpha Science Int'l Ltd.
3.	Benson, G. (2003). Algorithms in Bioinformatics. Springer Berlin Heidelber
	References
1.	Choi, S. (Ed.). (2007). Introduction to systems biology. New Jersey:: Humana Press.
2.	Demin, O., &Goryanin, I. (2010). Kinetic modelling in systems biology. CRC Press.
3.	Gusfield, D. (1997). Algorithms on strings, trees and sequences: computer science and computational biology. Cambridge University Press.
4.	Iyengar, S. (2010). Symbolic Systems Biology. Jones and Bartlett.

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Special Topics in Computer Science	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST039	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will introduce students to this rapidly growing field and equip them with some of its basic principles and tools as well as its general mindset. Students will learn concepts, techniques and tools they need to deal with various facets of data science practice, including data collection and integration, exploratory data analysis, predictive modeling, descriptive modeling, data product creation, evaluation, and effective communication.

Learning Outcomes

After completion of this course students will be able to:

- Explain what Data Science is and the skill sets needed to be a data scientist.
- Apply basic machine learning algorithms (Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes) for predictive modeling.
- Identify probability distributions commonly used as foundations for statistical modeling. Fit a model to data.
- Explain the significance of exploratory data analysis (EDA) in data science. Apply basic tools (plots, graphs, summary statistics) to carry out EDA.
- Build their own recommendation system using existing components.
- Reason around ethical and privacy issues in data science

Course Synopsis

Data Science is the study of the generalizable extraction of knowledge from data. Being a data scientist requires an integrated skill set spanning mathematics, statistics, machine learning, databases and other branches of computer science along with a good understanding of the craft of problem formulation to engineer effective solutions.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Introduction to Data Science, Steps in doing data Science, Skills needed to do data Science, Datafication	1
2.	**Statistical Inference** Populations and samples, Statistical modelling, probability distributions, fitting a model, Intro to R	1
3.	**Exploratory Data Analysis and the Data Science Process** - Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of	2

	EDA, The Data Science Process, Case Study: RealDirect (online real estate firm)	
4.	**Introduction to Machine Learning**: Linear Regression ,K-Nearest Neighbors (K-NN), k-means, Motivating application: Filtering Spam , Why Linear Regression and k-NN are poor choices for Filtering Spam , Naive Bayes and why it works for Filtering Spam , Data Wrangling: APIs and other tools for scrapping the Web	2
5.	**Feature Generation and Feature Selection (Extracting Meaning From Data)** - Motivating application: user (customer) retention Feature Generation (brainstorming, role of domain expertise, and place for imagination) ,Feature Selection algorithms – Filters; Wrappers; Decision Trees; Random Forests.	2
6.	**Recommendation Systems**: Building a User-Facing Data Product, Algorithmic ingredients of a Recommendation Engine, Dimensionality Reduction, Singular Value Decomposition, Principal Component Analysis, Exercise: build your own recommendation system	2
7.	**Mining Social-Network Graphs:** Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs.	1
8.	**Data Visualization** Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects, Exercise: create your own visualization of a complex dataset.	1
9.	**Data Science and Ethical Issues**: Discussions on privacy, security, ethics, A look back at Data Science , Next-generation data scientists	1

Department of Computer Science & Engineering **National Institute of Technology Srinagar**				
Course Title	System & Network Administration	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST040	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

5. Understand the role and responsibilities of a system administrator
6. Configure the Unix operating system
7. Focuses on the principles and techniques used in the design of networks and development of networked and distributed software.
8. Students will be exposed to standard network design tools, and diagnostic tools, such as packet monitors and performance analysis tools.

Learning Outcomes

- Demonstrate an understanding of system components, the advantages of Unix OS.
- Design and diagnosis of networks will also be covered.
- Systems Administration will also be discussed, especially with respect to Network Management; However, homework and programming assignments will be more focused on Network programming.

Course Synopsis

The maintenance and deployment of computer systems in production environments requires significant effort. This course distils decades of experience into operational principles that apply across technologies.

Course Outline / Content

Unit	Topics	Week
1.	Introduction to Networks, OSI interconnect model, topologies, Internet history and TCP/IP	1
2.	Physical Layer: transmission media, socket programming, UNIX Process Creation and UNIX IPC.	1
3.	Introduction to System administration as a discipline: its goals, philosophy, challenges and common practices, Discussion of computer system components and Operating systems components: Unix-like systems vs Windows systems	1
4.	Data Link Layer: framing, flow control, error control, encoding for local and wide areas, Admin tricks with UNIX shell.	2
5	Medium Access Layer. Broadcast, CSMA/CD, CDMA, FDDI, 802.X, Bluetooth.	1
6	Network Layer: Flow control, congestion control, Routing,. quality of service, switching, CIDRs, mobile IP, WAP	2

7	Finish Routing. Transport Layer: TCP, UDP, IP v 6. CISCO Router IOS.	1
8	Application Layer: httpd, smtp, dns, snmp, ftp, Telnet, streaming video, video compression, multicast, JME. Network Services. Dist Computing, Network Management	2
	Text Books	
1.	Nemeth, Snyder, Hein and Whaley "UNIX and Linux System Administration Handbook", 4th Ed.(Prentice Hall, 2010)	
2.	William Stallings: Data & Computer Communications, 7th Ed,PHI	
	References	
4.	AndrewTanenbaum,–Computer Networks‖PHI	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Pattern Recognition	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST041	
Credits		**L**	**T**	**P**
Course Type	Theory			

Course Objectives

- Understand the concept of a pattern and the basic approach to the development of pattern recognition and machine intelligence algorithms.
- Understand the basic methods of feature extraction, feature evaluation, and data mining.
- Understand and apply both supervised and unsupervised classification methods to detect and characterize patterns in real-world data.
- Develop prototype pattern recognition algorithms that can be used to study algorithm behavior and performance against real-world multivariate data.

Learning Outcomes

After the course the student should be able to

- Define basic concepts in modelling and simulation
- Classify various simulation models and give practical examples for each category
- Construct a model for a given set of data and motivate its validity
- Analyze output data produced by a model and test validity of the model

Course Synopsis

Course Outline / Content

Unit	Topics	Week
1.	Introduction to patterns and pattern recognition application development: Supervised pattern detection I (Bayes classifiers) Feature extraction - multivariate data Feature extraction - image data Supervised pattern detection II (linear classifiers) Unsupervised pattern detection I (clustering) Supervised pattern detection III (non-linear classifiers, neural networks, support vector machines) Supervised pattern detection IV (rule-based classifiers) Unsupervised pattern detection II (self-organization, competitive learning)	2
2.	**Basics of Probability, Random Processes and Linear Algebra (recap)**: Probability: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra.	2
3.	**Bayes Decision Theory**: Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features.	2

4.	**Parameter Estimation Methods**: Maximum-Likelihood estimation: Gaussian case. Maximum a Posteriori estimation. Bayesian estimation: Gaussian case. Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation. Gaussian mixture models, Expectation-Maximization method for parameter estimation. Maximum entropy estimation. Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs. Nonparametric techniques for density estimation. Parzen-window method. K-Nearest Neighbor method	3
5.	**Dimensionality reduction**: Principal component analysis - it relationship to eigen analysis. Fisher discriminant analysis - Generalized eigen analysis. Eigen vectors/Singular vectors as dictionaries. Factor Analysis, Total variability space - a dictionary learning methods. Non-negative matrix factorization - a dictionary learning method.	2
6.	**Linear discriminant functions**: Gradient descent procedures, Perceptron, Support vector machines - a brief introduction.	1
7.	**Artificial neural networks**: Multilayer perceptron - feedforward neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural networks.	2
8.	**Non-metric methods for pattern classification**: Non-numeric data or nominal data. Decision trees: Classification and Regression Trees (CART).	1

Text Books

1.	R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley
2	S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed.
3	C.M.Bishop, Pattern Recognition and Machine Learning, Springer
4	MATLAB latest release full.

Student expectations

This course will aim at basic student requirements:

Case studies - A number of case studies will be assigned to students throughout the term and will provide an opportunity for the student to work with real world data to build realistic pattern recognition applications. Students are also required to select and develop a case study of their own choosing by the end of the semester, and to present their case studies to the rest of the class during the last class of the semester.

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Natural Language Processing	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST042	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

- This course is about a variety of ways to represent human languages (like English and Chinese) as computational systems, and how to exploit those representations to write programs that do useful things with text and speech data, like translation, summarization, extracting information, question answering, natural interfaces to databases, and conversational agents.

- This field is called Natural Language Processing or Computational Linguistics, and it is extremely multidisciplinary. This course will therefore include some ideas central to Machine Learning (discrete classification, probability models) and to Linguistics (morphology, syntax, semantics).

Learning Outcomes

- We'll cover computational treatments of words, sounds, sentences, meanings, and conversations. We'll see how probabilities and real-world text data can help. We'll see how different levels interact in state-of-the-art approaches to applications like translation and information extraction

Course Synopsis

The course is designed for SCS undergraduate students, and also to students in graduate programs who have a peripheral interest in natural language, or linguistics students who know how to pro1 gram. Prerequisite: Fundamental Data Structures and Algorithms (15-211) or equivalent; strong programming capabilities.

Course Outline / Content

Unit	Topics	Week
1.	Introduction- Human languages, models, ambiguity, processing paradigms; Phases in natural language processing, applications. Text representation in computers, encoding schemes. Linguistics resources- Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. Resource management with XML, Management of linguistic data with the help of GATE, NLTK.	2
2.	Regular expressions, Finite State Automata, word recognition, lexicon. Morphology, acquisition models, Finite State Transducer. N-grams, smoothing, entropy, HMM, ME, SVM, CRF. Part of Speech tagging- Stochastic POS tagging, HMM, Transformation based tagging (TBL), Handling of unknown words, named entities, multi word expressions.	3
3.	A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and	4

	mood and agreement, Context Free Grammar, spoken language syntax	
4.	Parsing- Unification, probabilistic parsing, TreeBank. Semantics- Meaning representation, semantic analysis, lexical semantics, WordNet Word Sense Disambiguation- Selectional restriction, machine learning approaches, dictionary based approaches. Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure	3
5.	Applications of NLP- Spell-checking, Summarization Information Retrieval- Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries. Machine Translation– Overview.	3
Text Books		
1.	Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2009	
2.	James A.. Natural language Understanding 2e, Pearson Education, 1994	
References		
1.	Bharati A., Sangal R., Chaitanya V.. Natural language processing: a Paninian perspective, PHI, 2000	

Department of Computer Science & Engineering National Institute of Technology Srinagar					
Course Title	Quantum Computing	**Semester**			
Department	Computer Science & Engineering	**Course Code**	CST043		
Credits	03	**L**	**T**	**P**	
Course Type	Theory	3	0	0	

Course Objectives

This course is designed:

- To enable students with non-physics backgrounds to 'think quantumly'
- To recognize which classical assumptions fall apart at the quantum level
- To begin to reintegrate the strange results of quantum theory into the broader framework of classical computer science

Learning Outcomes

Enable the student to:

- Translate fluently between the major mathematical representations of quantum operations.
- Implement basic quantum algorithms.
- To acquire a working knowledge of quantum information theory.

Course Synopsis

This course is an introduction to quantum information theory (qubits, quantum gates, and qubit systems). It covers a few selected quantum algorithms, yet the emphasis of the course is on quantum simulation (i.e. quantum informational representations of quantum systems and quantum algorithms for computational physics).

Course Outline / Content

Unit	Topics	Week
1.	**Introduction and Background:** Overview, Computers and the Strong Church–Turing Thesis, The Circuit Model of Computation, A Linear Algebra Formulation of the Circuit Model, Reversible Computation, A Preview of Quantum Physics, Quantum Physics and Computation. **Linear Algebra and The Dirac Notation**: The Dirac Notation and Hilbert Spaces, Dual Vectors, Operators, The Spectral Theorem, Functions of Operators, Tensor Products, The Schmidt Decomposition Theorem, Some Comments on the Dirac Notation.	2
2.	**Qubits and The Framework of Quantum Mechanics:** The State of a Quantum System, Time-Evolution of a Closed System, Composite Systems, Measurement, Mixed States and General Quantum Operations. **A Quantum Model of Computation:** The Quantum Circuit Model, Quantum Gates, Universal Sets of Quantum Gates, Efficiency of Approximating Unitary Transformations, Implementing Measurements with Quantum Circuits.	2
3.	**Superdense Coding and Quantum Teleportation:** Superdense Coding, Quantum Teleportation, An Application of Quantum Teleportation.	2

	Introductory Quantum Algorithms: Probabilistic Versus Quantum Algorithms, Phase Kick-Back, The Deutsch Algorithm, The Deutsch–Jozsa Algorithm, Simon's Algorithm.	
4.	**Algorithms With Superpolynomial Speed-Up:** Quantum Phase Estimation and the Quantum Fourier Transform, Eigenvalue Estimation, Finding-Orders, Finding Discrete Logarithms, Hidden Subgroups, Related Algorithms and Techniques. **Algorithms Based on Amplitude Amplification:** Grover's Quantum Search Algorithm, Amplitude Amplification, Quantum Amplitude Estimation and Quantum Counting, Searching Without Knowing the Success Probability, Related Algorithms and Techniques	4
5.	**Quantum Computational Complexity Theory and Lower Bounds:** Computational Complexity, The Black-Box Model, Lower Bounds for Searching in the Black-Box Model: Hybrid Method, General Black-Box Lower Bounds, Polynomial Method, Block Sensitivity, Adversary Methods. **Quantum Error Correction:** Classical Error Correction, The Classical Three-Bit Code, Fault Tolerance, Quantum Error Correction, Three- and Nine-Qubit Quantum Codes, Fault-Tolerant Quantum Computation.	4
	Text Books	
1.	Eleanor G. Rieffel and Wolfgang H. Polak, "Quantum Computing: A Gentle Introduction"	
	References	
1.	Michael A. Nielsen and Isaac L. Chuang, "Quantum Computation and Quantum Information".	
2.	Phillip Kaye, Raymond Laflamme, and Michele Mosca (2007). An Introduction to Quantum Computing. Oxford University Press.	
3.	Yanofsky, Noson S. and Mirco A. Mannucci (2008). Quantum Computing for Computer Scientists. Cambridge University Press.	
4.	McMahon, David (2008). Quantum Computing Explained. John Wiley & Sons, Inc.	
5.	Mermin, N. David (2007). Quantum Computer Science: An Introduction. Cambridge University Press.	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Deep Learning	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST044	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

- This course is an introduction to deep learning, a branch of machine learning concerned with the development and application of modern neural networks. Deep learning algorithms extract layered high-level representations of data in a way that maximizes performance on a given task. For example, asked to recognize faces, a deep neural network may learn to represent image pixels first with edges, followed by larger shapes, then parts of the face like eyes and ears, and, finally, individual face identities. Deep learning is behind many recent advances in AI.

Learning Outcomes

- This is an upper-level undergraduate/graduate course.
- All students should have the following skills:
- Calculus, Linear Algebra ■ Probability & Statistics ■ Ability to code in Python

Course Synopsis

We will cover a range of topics from basic neural networks, convolutional and recurrent network structures, deep unsupervised and reinforcement learning, and applications to problem domains like speech recognition and computer vision. Prerequisites: a strong mathematical background in calculus, linear algebra, and probability & statistics (students will be required to pass a math prerequisites test), as well as programming in Python and C/C++. There will be assignments and a final project.

Course Outline / Content

Unit	Topics	Week
1.	Feedforward Neural networks. Gradient descent and the back propagation algorithm. Unit saturation, aka the vanishing gradient problem, and ways to mitigate it. RelU Heuristics for avoiding bad local minima. Heuristics for faster training. Nestors accelerated gradient descent. Regularization. Dropout.	2
2.	Convolutional Neural Networks: Architectures, convolution / pooling layers Recurrent Neural Networks: LSTM, GRU, Encoder Decoder architectures	3
3.	Deep Unsupervised Learning: Autoencoders (standard, sparse, denoising, contractive, etc), Variational Autoencoders, Adversarial Generative Networks, Autoencoder and DBM Attention and memory models, Dynamic memory networks. Applications of Deep Learning to Computer Vision: Image	4

	segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models. Attention models for computer vision tasks.	
4.	Applications of Deep Learning to NLP: Introduction to NLP and Vector Space Model of Semantics: Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of Words model (CBOW), Glove, Evaluations and Applications in word similarity, analogy reasoning: Named Entity Recognition, Opinion Mining using Recurrent Neural Networks	3
5.	Named Entity Recognition, Opinion Mining using Recurrent Neural Networks: Parsing and Sentiment Analysis using Recursive Neural Networks: Sentence Classification using Convolutional Neural Networks: Dialogue Generation with LSTMs (1 lecture) Applications of Dynamic Memory Networks in NLP (1 lecture) Recent Reseearch in NLP using Deep Learning: Factoid Question Asnwering, similar question detection, Dialogue topic tracking, Neural Summarization, Smart Reply	3
Text Books		
1.	Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." An MIT Press book in preparation. (2015)	
2.	Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1 (2009): 1127.	
References		
1.	Hochreiter, Sepp, and Jargen Schmidhuber. "Long short-term memory." Neural computation 9.8 (1997): 17351780.	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Introduction to Data Science	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST045	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course will introduce students to this rapidly growing field and equip them with some of its basic principles and tools as well as its general mindset. Students will learn concepts, techniques and tools they need to deal with various facets of data science practice, including data collection and integration, exploratory data analysis, predictive modeling, descriptive modeling, data product creation, evaluation, and effective communication.

Learning Outcomes

After completion of this course students will be able to:

- Explain what Data Science is and the skill sets needed to be a data scientist.
- Apply basic machine learning algorithms (Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes) for predictive modeling
- Identify probability distributions commonly used as foundations for statistical modeling. Fit a model to data.
- Explain the significance of exploratory data analysis (EDA) in data science. Apply basic tools (plots, graphs, summary statistics) to carry out EDA.
- Build their own recommendation system using existing components.
- Reason around ethical and privacy issues in data science

Course Synopsis

Data Science is the study of the generalizable extraction of knowledge from data. Being a data scientist requires an integrated skill set spanning mathematics, statistics, machine learning, databases and other branches of computer science along with a good understanding of the craft of problem formulation to engineer effective solutions

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Introduction to Data Science, Steps in doing data Science, Skills needed to do data Science, Datafication	1
2.	**Statistical Inference** Populations and samples, Statistical modelling, probability distributions, fitting a model, Intro to R	1
3.	**Exploratory Data Analysis and the Data Science Process** - Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA, The Data Science Process, Case Study: RealDirect (online real estate firm)	2
4.	**Introduction to Machine Learning**: Linear Regression ,K-Nearest Neighbors (K-NN), k-means, Motivating application: Filtering Spam , Why Linear Regression and k-NN are poor choices for Filtering Spam , Naive Bayes and why it works for	2

	Filtering Spam , Data Wrangling: APIs and other tools for scrapping the Web	
5.	**Feature Generation and Feature Selection (Extracting Meaning From Data)** - Motivating application: user (customer) retention Feature Generation (brainstorming, role of domain expertise, and place for imagination) ,Feature Selection algorithms – Filters; Wrappers; Decision Trees; Random Forests	2
6.	**Recommendation Systems**: Building a User-Facing Data Product, Algorithmic ingredients of a Recommendation Engine, Dimensionality Reduction, Singular Value Decomposition, Principal Component Analysis, Exercise: build your own recommendation system	2
7.	**Mining Social-Network Graphs:** Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs.	1
8.	**Data Visualization** Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects, Exercise: create your own visualization of a complex dataset.	1
9.	**Data Science and Ethical Issues**: Discussions on privacy, security, ethics, A look back at Data Science , Next-generation data scientists	1
	Text Books	
1.	Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.	
2.	Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014.	
3.	Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.	
	References	
1.	Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Internet Of Things	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST046	
Credits	03	**L**	**T**	**P**
Course Type	Theory			

Course Objectives

This course will enable students to

- •Define and explain basic issues, policy and challenges in the IOT
- •Illustrate Mechanism and Key Technologies in IOT
- •Explain the Standard of the IOT
- •Explain resources in the IOT and deploy of resources into business
- •Demonstrate data analytics for IOT

Learning Outcomes

At the end of this course the students will be able to:

- •Develop schemes for the applications of IOT in real time scenarios
- •Manage the Internet resources
- •Model the Internet of things to business
- •Understand the practical knowledge through different case studies
- •Understand data sets received through IOT devices and tools used for analysis

Course Synopsis

The course deals with all the important aspects of discrete Internet of things and to develop schemes for the applications of IOT in real time scenarios This course is meant for an upper level undergraduate or master's level introduction to manage the internet resources and gain the practical knowledge through different case studies.

Course Outline / Content

Unit	Topics	Week
1.	What is The Internet of Things? Overview and Motivations, Examples of Applications, IPV6 Role, Areas of Development and Standardization, Scope of the Present Investigation. Internet of Things Definitions and frameworks-IOT Definitions, IOT Frameworks, Basic Nodal Capabilities. Internet of Things Application Examples-Overview, Smart Metering/Advanced Metering Infrastructure-Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking, Over-The-Air-Passive Surveillance/Ring of Steel, Control Application Examples, Myriad Other Applications.	2
2.	Fundamental IOT Mechanism and Key Technologies-Identification of IOT Object and Services, Structural Aspects of the IOT, Key IOT Technologies. Evolving IOT Standards-Overview and Approaches, IETF IPV6 Routing Protocol for RPL	3

	Roll, Constrained Application Protocol, Representational State Transfer, ETSI M2M,Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Low power WPAN, Zigbee IP(ZIP),IPSO	
3	Layer ½ Connectivity: Wireless Technologies for the IOT-WPAN Technologies for IOT/M2M, Cellular and Mobile Network Technologies for IOT/M2M, Layer 3 Connectivity: IPv6 Technologies for the IOT: Overview and Motivations. Address Capabilities, IPv6 Protocol Overview, IPv6 Tunnelling, IPSec in IPv6, Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6.	3
4.	Case Studies illustrating IOT Design-Introduction, Home Automation, Cities, Environment, Agriculture, Productivity Applications.	2
5.	Data Analytics for IOT –Introduction, Apache Hadoop, Using Hadoop Map Reduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis, Structural Health Monitoring Case Study.	2
	Text Books	
1.	Daniel Minoli,"Building the Internet of Things with IPv6 and MIPv6:The Evolving World of M2M Communications", Wiley, 2013.	
2.	Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands on Approach" Universities Press., 2015	
	References	
1.	Michael Miller," The Internet of Things", First Edition, Pearson, 2015.	
2.	Claire Rowland,Elizabeth Goodman et.al.," Designing Connected Products", First Edition,O'Reilly, 2015.	

Department of Computer Science & Engineering National Institute of Technology Srinagar					
Course Title	Advanced Cryptography	**Semester**			
Department	Computer Science & Engineering	**Course Code**	CST047		
Credits	3	**L**	**T**	**P**	
Course Type	Theory	3	0	0	

Course Objectives

- To learn fundamental concepts of computer security and cryptography and utilize these techniques in computing systems.
- To learn about Pseudo-random Generators (PRG), building a Pseudorandom Permutation and its applications.
- To develop an understanding of Message Authentication Codes (MACs) and Public Key Signature Schemes.

Learning Outcomes

- The objectives of this course are to:
- 1. To understand the fundamentals of Cryptography
- 2. To acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.
- 3. To understand the various key distribution and management schemes.
- 4. To understand how to deploy encryption techniques to secure data in transit across data networks
- 5. To design security applications in the field of Information technology

Course Synopsis

Fundamentals of Cryptography; Basics of Symmetric and Asymmetric Key Cryptography; Notions of semantic Security and various types of Attacks; Weak and Strong one way functions; Building a Pseudorandom Permutation; Message Authentication Codes (MACs);Various Public Key Signature Schemes.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction** :Attacks on computers and computer security, need for security, approaches , principles, types of attacks ,operational model of network security Cryptography concepts and techniques, substitution, transposition, encryption and decryption, symmetric, Asymmetric key cryptography, key range size, possible type of attacks.	1
2.	Mathematics of cryptography and DES Block ciphers modes, feistel ciphers DES. working of DES ,cracking des ,problems on des., 2DES, 3DES, des design ,Side channel attacks, Differential cryptanalysis.	2

3.	Symmetric-Key Cryptography: Glosis field theory, AES, overview of Rijndael - comparison with others. Symmetric ciphers, Blowfish in practice ,RC4, RC5,RC6,IDEA, RSA	3
4.	Asymmetric-Key Cryptography RSA, Elliptic curve cryptography ECC, Digital certificates and PK	4
5.	Cryptographic Hash Functions Hashing schemes SHA-family, MAC, Digital Signature RSA El Gomel , DSS DSA, Authentication Protocols , applications Kerberos, X.509 Directory services	5
6.	Network Security Internet security protocols , SSL,TLS TSP WAP security, SET Hashing Authentication & Signature Schemes E-mail security, Email architecture SSL, PGP, MIME, S/MIME Internet Protocol Security (IPSec) IPSec architecture, IPSec verses other layers security Mobile IPSec, VPN, Web security SSL, TLS, SET etc	6
7	System Security Intruders, types of attacks, protecting against Intruders honeypots, scanning and analysis tools, Viruses and worms, types of viruses, protection, Firewall architecture implementing firewalls, xml firewalls, trusted systems, trusted system applications, multi-level security, trusted products. Security implementation, wireless security, securities in Adhoc-networks.	7
Text Books		
1.	Cryptography And Network Security Principles and Practices William Stallings, Prentice Hall	
2.	Cryptography and Network Security Atul Kahate, Tata McGraw-Hill	
3.	Cryptography and Network Security Behrouz A. Forouzan, TMH	
4.	Wade Trappe, Lawrence C Washington, “ Introduction to Cryptography with coding theory”, Pearson.	
References		
1.	W. Mao, “Modern Cryptography – Theory and Practice”, Pearson Education	
2.	Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India.	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Data Mining	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST048	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

- To introduce students to the basic concepts and techniques of Data Mining.
- To develop skills of using recent data mining software for solving practical problems.
- To gain experience of doing independent study and research.
- To study the methodology of engineering legacy databases for data warehousing and data mining to derive business rules for decision support systems.

Learning Outcomes

This course has the following program learning outcomes:

- Study the major data mining problems as different types of computational tasks (prediction, classification, clustering, etc.) and the algorithms appropriate for addressing these tasks.
- Learn how to analyze data through statistical and graphical summarization, supervised and unsupervised learning algorithms.
- Systematically evaluate data mining algorithms and understand how to choose algorithms for different analysis tasks.

Course Synopsis

This course introduces basic concepts, tasks, methods, and techniques in data mining. The emphasis is on various data mining problems and their solutions. Students will develop an understanding of the data mining process and issues, learn various techniques for data mining, and apply the techniques in solving data mining problems using data mining tools and systems. Students will also be exposed to a sample of data mining applications.

Course Outline / Content

Unit	Topics	Week
2.	Introduction to Data Mining: Introduction: Scope of Data Mining: What is Data Mining; How does Data Mining Works, Predictive Modelling: Data Mining and Data Warehousing: Architecture for Data Mining: Profitable Applications: Data Mining Tools	1
3.	Business Intelligence: Introduction, Business Intelligence, Business Intelligence tools, Business Intelligence Infrastructure, Business Intelligence Applications, BI versus	2

	Data Warehouse, BI versus Data Mining, Future of BI.	
4.	Data Pre-processing: Introduction, Data Pre-processing Overview, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation.	2
5.	Data Mining Techniques- An Overview: Introduction, Data Mining, Data Mining Versus Database Management System, Data Mining Techniques- Association rules, Classification, Regression, Clustering, Neural networks.	2
6.	Clustering: Introduction, Clustering, Cluster Analysis, Clustering Methods- K means, Hierarchical clustering, Agglomerative clustering, Divisive clustering, clustering and segmentation software, evaluating clusters.	1
7.	Web Mining: Introduction, Terminologies, Categories of Web Mining – Web Content Mining, Web Structure Mining, Web Usage Mining, Applications of Web Mining, and Agent based and Data base approaches, Web mining Software.	2
8.	Applications of Data mining: Introduction, Business Applications Using Data Mining- Risk management and targeted marketing, Customer profiles and feature construction, Medical applications (diabetic screening), Scientific Applications using Data Mining, Other Applications.	2
Text Books		
3.	Kamber and Han, “Data Mining Concepts and Techniques”, Hart Court India P. Ltd. Elsevier Publications Second Edition, 2001	
4.	Paul Raj Poonia, “Fundamentals of Data Warehousing”, John Wiley & Sons, 2004.	
References		
5.	W. H. Inmon, “Building the operational data store”, 2nd Ed., John Wiley, 1999.	
6.	Pang- Ning Tan, Michael Steinbach, Viach, Vipin Kumar, Introduction to Data Mining, Pearson	

Department of Computer Science & Engineering National Institute of Technology Srinagar				
Course Title	Advanced Graph Algorithms	**Semester**		
Department	Computer Science & Engineering	**Course Code**	CST049	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

- To explain the major graph algorithms and their analyses.
- To identify different parameters of graphs and its applications.
- To understand planar graphs and its properties of a given properties to detect planarity of a given graph.
- To apply optimization techniques to construct a minimal spanning tree of a graph, prefix code for a given message.

Learning Outcomes

Students who complete the course will have demonstrated the ability to do the following:

- Argue the correctness of algorithms using inductive proofs and invariants.
- Analyze worst-case running times of algorithms using asymptotic analysis.
- Employ graphs to model engineering problems, when appropriate.
- Synthesize new graph algorithms and algorithms that employ graph computations as key components, and analyze them.
- Compare between different data structures. Pick an appropriate data structure for a design situation.

Course Synopsis

This course covers advanced graph algorithms from various fields.. Fast algorithms for fundamental graph optimization problems, including maximum flow, minimum cuts, minimum spanning trees, nonbipartite matching, planar separators and applications, and shortest paths.

Course Outline / Content

Unit	Topics	Week
1.	**Basics:** Introduction, Machine Model, Graph Data Structures, Bipartite Graphs, Eulerian Graphs, Circuits & Trails, Fleury's Algorithm, Hierholzer's Algorithm	2

2.	**Connectivity:** Top. Sort, Detecting Strong Components, 2-Connectivity / 2-Edge-Connectivity, (Open) Ear Decompositions, Strong Orientations, Testing 2-(Edge-)Connectivity in Linear Time, Bipolar Orientations, s-t-Numberings + Algorithm	3
3.	**Matchings:** Definitions, Hopcroft–Karp algorithm, Edmonds algorithm, Hall's Theorem, Hungarian Method for Bipartite Weighted Matchings, Weighted Matchings in General Graphs, Some approximate approach	2
4.	**Dynamic Algorithms:** Dynamic Connectivity and Spanning Trees in Amortized Poly-log time, Dynamic Connectivity in Worst-case $O(n^{½})$ time	2
5.	**Planar Graphs:** Planar Separator Theorem and its Applications, Embeddings (combinatorial + planar), Euler's Formula, Kuratowski's Theorem, Detour to Platonic Solids, Dual Graphs, Interdigitating Trees, Half-Edge Data Structure, Decremental Dynamic Adjacency Queries, Max-Cut in polynomial time, Minimum Spanning Trees in linear time, Shortest Paths with Matrix Multiplication.	3
6.	**NP-Hard Problems:** Intro (FPT). Vertex Cover: FPT algorithm, Buss' kernel. Feedback Vertex Set: FPT algorithm, Kernels for Vertex Cover by Matching and for Feedback Vertex Set, Hamiltonian Path Problem, k-Path, Chromatic number, FPT Cut Problems: Important separators, Multiway Cut, Treewidth: Tree decompositions, Algorithmic use (dynamic programming), Introduction to Bidimensionality, Planar Graphs: Linear Kernels, Bidimensionality, Subexponential Time Parameterized Algorithms, Problems on Restricted Graph Classes, Combinatorial Algorithms for Linear Fisher Markets	2
	Text Books	
1.	R. Diestel. “Graph Theory”. Springer, 2012.	
2.	Kozen, “Design and Analysis of Algorithms”. Springer	
	References	
1.	Douglas B. West, Introduction to Graph Theory, Second Edition, Prentice-Hall	
2.	Bondy, J. A. and Murty, U.S.R., ‘Graph Theory with Applications’, Springer	

<table>
<tr><td colspan="6">Department of Computer Science & Engineering
National Institute of Technology Srinagar</td></tr>
<tr><td>Course Title</td><td>Advanced Java</td><td>Semester</td><td colspan="3"></td></tr>
<tr><td>Department</td><td>Computer Science & Engineering</td><td>Course Code</td><td colspan="3">CST050</td></tr>
<tr><td>Credits</td><td>03</td><td>L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td>Course Type</td><td>Theory</td><td>3</td><td colspan="2">0</td><td>0</td></tr>
<tr><td colspan="6">Course Objectives</td></tr>
<tr><td colspan="6">A student should be able to increase his depth of knowledge in Java programming and explore the uses of the various advanced packages.</td></tr>
<tr><td colspan="6">Learning Outcomes</td></tr>
<tr><td colspan="6">At the end of the course the participant will:
Develop Swing-based GUI
Develop client/server applications and TCP/IP socket programming
Update and retrieve the data from the databases using SQL
Develop distributed applications using RMI
Develop component-based Java software using JavaBeans
Develop server side programs in the form of servlets</td></tr>
<tr><td colspan="6">Course Synopsis</td></tr>
<tr><td colspan="6">Collection framework, Multithreading, Networking, Enterprise Java Bean, JDBC, Servlets, Java Server Pages, Remote Method Invocation, Common Object Request Broker Architecture.</td></tr>
<tr><td colspan="6">Course Outline / Content</td></tr>
<tr><td>Unit</td><td colspan="4">Topics</td><td>Week</td></tr>
<tr><td>1.</td><td colspan="4">Collections: Collection Interfaces, Concrete Collections, The Collections Framework
Multithreading: Creating thread and running it, Multiple Thread acting on single object, Synchronization, Thread communication, Thread group, Thread priorities, Daemon Thread, Life Cycle of Thread.</td><td>2</td></tr>
<tr><td>2.</td><td colspan="4">Networking:
Internet Addressing, InetAddress, Factory Methods, Instance Methods, TCP/IP Client Sockets, URL, URL Connection, TCP/IP Server Sockets, Datagrams
Enterprise Java Bean: Preparing a Class to be a JavaBean, Creating a JavaBean, JavaBean Properties, Types of beans, Stateful Session bean, Stateless Session bean, Entity bean.</td><td>3</td></tr>
<tr><td>3.</td><td colspan="4">Java Database Connectivity (JDBC):Merging Data from Multiple Tables: Joining, Manipulating Databases with JDBC, Prepared Statements, Transaction Processing, Stored Procedures C.</td><td>3</td></tr>
</table>

	Servlets: Servlet Overview and Architecture, Interface Servlet and the Servlet Life Cycle, Handling HTTP get Requests, Handling HTTP post Requests, Redirecting Requests to Other Resources, Session Tracking, Cookies, Session Tracking with HttpSession.	
4.	**JavaServer Pages (JSP):** Introduction, JavaServer Pages Overview, A First JavaServer Page Example, Implicit Objects, Scripting, Standard Actions, Directives, Custom Tag Libraries Remote Method Invocation: Defining the Remote Interface, Implementing the Remote Interface, Compiling and Executing the Server and the Client.	3
5.	**Common Object Request Broker Architecture (CORBA):** Technical/Architectural Overview, CORBA Basics, CORBA services. Introduction Smart Phone Application Development: Introduction to android platform, Creating application template, adding activity, intent, services to application, receivers and alerts.	3
	Text Books	
1.	Core and Advanced Java, Black Book, Dreamtech Press	
2.	Java SE8 for Programmers (3rd Edition) (Deitel Developer Series) by Paul Deitel and Harvey Deitel.	
	References	
1.	“Advanced Java 2 Platform HOW TO PROGRAM” by H. M.Deitel, P. J. Deitel, S. E. Santry – Prentice Hall	
2.	“Beginning Java™ EE 6 Platform with GlassFish 3 From Novice to Professional” by Antonio Goncalves– Apress publication.	

Department of Computer Science & Engineering
National Institute of Technology Srinagar

Course Title	Numerical Methods	**Semester**		
Department	Computer Science & Engineering	**Course Code**	MTH 707	
Credits	03	**L**	**T**	**P**
Course Type	Theory	3	0	0

Course Objectives

This course is a study of mathematical techniques used to model engineering systems. It involves the development of mathematical models and the application of the computer to solve engineering problems using the following computational techniques: Taylor Series approximation, numerical differentiation, root-finding using bracketing and open methods, linear and polynomial curve fitting, solution methods for matrix equations, numerical integration, and the solution of differential equations

Learning Outcomes

Upon successful completion of this course, the student will:

- Be able to model engineering systems using first and second order differential equations, and solve the equations both analytically and numerically.
- Be able to employ the Taylor Series for approximation and error analysis.
- Be able to formulate and apply numerical techniques for root finding, curve fitting, differentiation, and integration.

Course Synopsis

Numerical analysis is the story of how functions, derivatives, integrals, and differential equations are handled as strings of numbers in the computer. At the heart of numerical analysis is an understanding of the speed of convergence of Taylor, Fourier, and other series expansions. Most scientists and engineers are sooner or later faced with computing tasks that require some knowledge of numerical analysis.

Course Outline / Content

Unit	Topics	Week
1.	Linear Algebra: Matrices, Matrics decomposition: LU decomposition, Cholesky decomposition, spectral decomposition, Matrix Eigen-value problem, Gerchgorin's theorem, Eignen value by iteration, generalized inverse of a matrix, solution of linear system by decomposition method, Jacobi method.	4
2.	Nonlinear system of equations: Newton's method, Powel Hybrid method. Differential equations: Generalised characteristic value	4

	problems, phase plane and critical points, stability and phase plane methods in nonlinear equations. Boundary value problems, mixed boundary conditions, boundary conditions at infinity, nonlinear boundary value problems, linear eigen value problems.	
3.	Differential Equations: Taylor series method, Euler method, Runge-Kutta method. Numerical solutions to Partial Differential Equations: Second order quasi-linear equations, numerical solutions.	3
4.	Approximate Analytic methods: Variational methods, weighted residual methods – Galerkin's method, collocation method, Functional, quadratic functionals. Numerical Integration – Gauss Legendre, Quadrature, Error Analysis, Convergence of solution. Finite element and Boundary element method.	3
	Text Books	
1.	S. S. Sastry, 'Numerical Analysis', Prentice-Hall of India Pvt. Ltd.	
2.	M.K. Jain, et.al., 'Numerical Methods for Scientific and Engineering Computation', New Age International Publishers	
	References	
1.	Applied Numerical Methods with MATLAB for Engineers and Scientists, 2nd Edition. Stephen C. Chapra, McGraw Hill, 2010	
2.	J. H. Mathews and K. D. Fink, Numerical Methods Using MATLAB®, 3rd ed, Upper Saddle River, NJ: Prentice Hall, 2004, ISBN: 0130652482	
3.	A. Gilat and V. Subramaniam, Numerical Methods for Engineers and Scientists, John Wiley & Sons, Inc., 2008, ISBN: 9780471734406	

Scheme of Courses for B.Tech. Electrical Engineering (3rd to 8th Semester

		3rd Semester				
S. No.	Course No.	Subjects	L	T	P	Credits
1.	EET201	Electrical Measurement & Instrumentation.	3	1	0	4
2.	ECT201	Electronics-I	3	1	0	4
3.	ECT202	Network Analysis	3	1	0	4
4.	PHT201	EMF & Waves	3	1	0	4
5.	MMT209	Electrical Engg. Materials	3	1	0	4
6.	MAT204	Mathematics-III	3	1	0	4
7	ECL204	Electronics – I Lab	0	0	2	1
		TOTAL CONTACT HOURS = 18 + 6 + 2 = 26	18	6	2	25
		4th Semester				
S. No.	Course No.	Subjects	L	T	P	Credits
1.	EET250	Electrical Machines-I	3	1	0	4
2.	EET251	Control Systems-I	3	1	0	4
3.	MET257	Thermal Engineering	3	1	0	4
4.	ECT250	Electronics-II	3	1	0	4
5.	CVT259	Hydraulics & Hydraulic Machines	2	1	0	3
6.	MAT253	Mathematics-IV	2	1	0	3
7.	EEL252	Electrical Machines – I Lab.	0	0	2	1
8.	EEL253	Electrical Measurement & Instrumentation-Lab	0	0	2	1
9.	ECL253	Electronics-II Lab	0	0	2	1
		TOTAL CONTACT HOURS = 16 + 6 +6 = 28	16	6	6	25
		5th Semester				
S. No.	Course No.	Subjects	L	T	P	Credits
1.	EET301	Power Systems-I	2	1	0	3
2.	EET302	Electric Machines II	3	1	0	4
3.	EET303	Control System II	3	1	0	4
4.	ECT3xx	Digital Electronics & Logic Design	2	1	0	3
5.	ECT3xx	Communication Systems	2	1	0	3
6.	EEL301	Power Systems I Lab	0	0	2	1
7.	MAT311	Mathematics-V	2	1	0	3
8.	EEL302	Electric Machines II Lab	0	0	2	1
9.	EEL303	Control System II & V.I. Lab	0	0	2	1
10	EEL304	Computer Aided Simulation of Electrical	0	0	2	1
11	ECL3xx	Digital Electronics & Logic Design Lab Logic	0	0	2	1
		TOTAL CONTACT HOURS = 14+6+10 = 30	14	6	10	25
		6th Semester				
S. No.	Course No.	Subjects	L	T	P	Credits
1.	EET350	Power Systems II	3	1	0	4
2.	EET351	Power Electronics	3	1	0	4
3.	EET352	Microprocessors	3	1	0	4
4.	EET353	Digital Signal Processing	3	1	0	4
5.	EET354	Electric Machine Design	3	1	0	4
6.	EEL350	Power Systems II Lab	0	0	2	1
7.	EEL351	Power Electronics Lab	0	0	2	1
8.	EEL352	Microprocessors Lab	0	0	2	1
9.	EEI353	Tour and Training	0	0	8	1
		TOTAL CONTACT HOURS = 15+5+8= 28	15	5	8	25

		7th Semester				
S. No.	Course No.	Subjects	L	T	P	Credits
1.	EES401	Seminar	0	0	2	1
2.	EEP401	Project Preliminary Work	0	0	2	2
3.	EET401	Power System Protection	2	1	0	3
4.	EET402	High Voltage Engineering	2	1	0	3
5.	EET403	Power Systems - III	3	1	0	4
6.	EET404	Advanced Power Electronics	3	1	0	4
7.	ECT404	Electronic Measurements & I	2	1	0	3
8.	EET405	Power Station practice	2	1	0	3
9.	EEL401	Power System Protection Lab	0	0	2	1
10	EEL402	High Voltage Engineering Lab	0	0	2	1
		Total Contact Hours = 14+6+8= 28	14	6	8	25

8th Semester

S. No.	Course No.	Subjects	L	T	P	Credits
1.	EEP450	Project Work	0	0	12	10
2.	HST454	Industrial Organization & Management	3	1	0	4
3.	EET0XX	Elective – I (Swayam Course)	3	1	0	4
5.	EET0XX	Elective – II (Swayam Course)	3	1	0	4
7.	EET0XX	Elective – III (Swayam Course)	3	0	0	3
		TOTAL CONTACT HOURS = 12 + 3 + 12 = 27	12	3	12	25

E-I, II, III: Any three of the following electives

S. No.	Course no.	Elective courses	L	T	P	Credit
1.	EET050	Advanced Control Theory	3	0	0	3
2.	EET051	Mechatronics	3	0	0	3
3.	EET052	Renewable Sources of Electrical Energy	3	0	0	3
4.	EET053	Electric Drives	3	0	0	3
5.	EET054	Microcontroller & their Applications	3	0	0	3
6.	EET055	Maintenance & Design of Electrical Sub	3	0	0	3
7.	EET056	Power Systems Transients	3	0	0	3
8.	EET057	Distribution System Automation	3	0	0	3
9.	EET058	Industrial Process Instrumentation &	3	0	0	3
10.	EET059	Power System Reliability	3	0	0	3
11.	EET060	Utilization & Traction	3	0	0	3
12.	EET061	Advanced Power Systems Control	3	0	0	3
13.	EET062	System planning & Load forecasting	3	0	0	3
14.	EET064	Switched Mode Power Conversion	3	0	0	3

<u>Nomenclature</u>

EE	Electrical Engineering
MT	Mathematics Department subject
HS	Humanities and Social Sciences Department subject
EC	Electronics and Communication Engineering Department subject
T	Theory
L	Lab. course
P	Project/Dissertation
S	Seminar
I	Industrial Training & Presentation
First Numeral	Year of course, Except for Elective courses assigned as "0".
2nd & 3rd Num.	Unique Course Number

*SWAYAM online courses will be floated before the start of semester to be managed by a faculty mentor.

5th Semester

<table>
<tr><td rowspan="3">Course: Power Systems - I
(Code: EET301)</td><td rowspan="3" colspan="2">Year & Semester:
B. Tech Electrical Engineering
3rd Year V Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objective: To understand the structure of Electric power system and its different components.

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO1: Understanding the basics of power system generation, transmission, distribution system.

CO2: Classification of overhead line insulators and evaluation of string efficiency.

CO3: Modeling, Design, and Evaluation of various parameters of transmission lines.

CO4: Acquire knowledge of underground cables: construction, methods of laying, grading, and determination of fault location.

CO5: Investigate the concept of corona and its effect online design.

UNIT-I Power System – Introduction

Introduction to Power System - Generation, Transmission & Distribution. Element of DC & AC distribution system – Radial and ring main distributor - Single fed, double fed.

UNIT-II Insulators for Transmission Line

Overhead line Insulator: need & types - Pin, Suspension, Strain, Shackle, Guy etc. Potential distribution - String efficiency - Methods of equalizing potential drop over string insulators.

UNIT-III Overhead Transmission Line

Overhead Transmission Lines Conductors. Transmission line parameters and their evaluations - Resistance, Inductance & Capacitance. Models of Short, Medium & Long Transmission Lines. Skin, Proximity and Ferranti effect. Power transfer capability of a transmission line.

UNIT-III Design of Transmission Line

Electric Power Transmission Towers. Sag evaluation and their calculations. Corona - Visual & Critical voltages - Corona loss - Effect of corona on line design practical considerations.

UNIT-IV Underground Cable

Classification of cables, Cable conductors, Insulating materials, Insulation resistance, electrostatic stress, grading of cables, capacitance calculation, losses and current carrying capacity. Location of faults, methods of laying of underground cables.

Text Books:

1. B.R. Gupta, “Power System Analysis and Design”, S. Chand publishers.
2. S.N. Singh, “Electrical Power Generation, Transmission & Distribution”, PHI Pvt. Ltd.
3. Weedy and Cory, “Electric Power Systems”, John Wiley & Sons.
4. C.L. Wadhwa, “Electric Power Systems”, New Age Intl. (P) Ltd.

Reference Books:

1. D. Das, “Electrical Power Systems”, New Age Intl. (P) Ltd.
2. Hadi Saadat, “Power System Analysis”, Mc Graw Hill.
3. J.J. Grainger and W.D Stevenson, “Power System Analysis”, McGraw Hill.
4. Kothari and Nagrath, “Power System Engineering”, McGraw Hill Edu. (I) Pvt. Ltd.
5. NPTEL Lecture Series on “Power System Engineering”.

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

<table>
<tr><td rowspan="3" colspan="1">Course: Electric Machines-II
(Code: EET302)</td><td rowspan="3" colspan="2">Year & Semester:
B. Tech Electrical Engineering
3rd Year V Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
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</table>

Course Objective: To study and understand different types of induction machines and synchronous machines, their construction, operating characteristics and applications.

Course Outcomes (COs): Upon successful completion of the course, students should be able to:

CO1: Understand the principle of operation, constructional details, winding layout, nature of magnetic fields produced by the stator and rotor windings, emf induced and torque development in induction and synchronous machines.
CO2: Develop equivalent circuit of a three-phase induction machine and use it to determine the starting and running performance of an induction machine.
CO3: Carry out performance calculations, investigate methods of starting and speed control of three-phase induction motor.
CO4: Study the operating principle and application of various types of single-phase induction motors and some sub-fractional motors.
CO5: Describe the constructional and operating differences, suitability of salient-pole and cylindrical-rotor synchronous machines, develop circuit model of a synchronous machine and use it to determine the operating performance.
CO6: Analyze the effect of load and excitation changes, active and reactive power control, parallel operation of alternators, starting methods of synchronous motors.

UNIT - I Basic Concepts in Rotating Electric Machines:
Operating principles of induction and synchronous machines, Magneto-motive force and flux distribution due to single-phase concentrated and distributed windings, Magnetic field due to three-phase winding-Rotating magnetic field, Flux per pole.

UNIT – II Three Phase Induction Machine:
Construction of 3-phase induction machine, Types, Emf induced in stator and rotor windings, Torque development and power developed, Equivalent circuit, Torque/speed characteristics, Effect of rotor resistance, Induction motor tests, Starting, Speed control, Effect of harmonic torques, Schrage motor

UNIT - III Single-Phase Induction Motors:
Two-revolving field theory, Torque-speed characteristics, Types of split-phase induction motors, shaded-pole motor, universal motor, repulsion motor.

UNIT - IV Synchronous Machines-1:

Constructional features, Types, emf induced, Effect of distributed winding and short-pitched winding, Harmonic elimination, Armature reaction, Circuit model of a cylindrical-rotor synchronous machine, Phasor diagrams, Synchronous reactance, saturation effect, Compounding curves

UNIT - V Synchronous Machines-2:

Steady-state power-angle characteristics, parallel operation, Operation on infinite bus, Effect of varying power and excitation, V-curves, Synchronous compensator,
Salient-pole synchronous machine, Two-axis theory, power-angle characteristics, Reluctance motor, Damper windings, Excitation systems, Starting of synchronous motor, Synchronous-machine transients, Analysis of sudden 3-phase short circuit.

Text Books:

1. Electrical Machines, I.J Nagrath & D.P Kothari, Tata Mc Graw-Hill.
2. Electrical Machines, P.S. Bimbra, Khanna Publishers.

Reference Books:

1. Electric Machinery, Fitzgerald, Kingslay, Umans, Tata McGraw-Hill
2. Electric Machines, Vincent Del Toro, Prentice Hall
3. Electric Machinery and Transformer, Guru, Hiziroglu, Oxford University press
4. Electric Machinery Fundamentals, Chapman, McGraw-Hill.
5. Electric Machines-Direct and Alternating Current, Charles S Siskind, McGraw-Hill.
6. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata McGraw-Hill.

<table>
<tr><td rowspan="3">Course: Control Systems-II
(Code: EET303)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year V Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
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<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

- **CO1:** To understand linear algebra and its applications in modern control theory.
- **CO2:** To represent physical systems in continuous State-Space canonical forms.
- **CO3:** To solve the linear time-invariant (LTI) state equation and to access the controllability and observability of LTI state-space systems for stability analysis.
- **CO4:** To design state-feedback controllers and regulators with specific dynamic performance.

Module 1: Revisiting Linear Algebra:

Vector Spaces, subspaces, linear independence, linear span of a set of vectors, basis and dimension of a vector space. Matrices, determinant and inverse. Row-space, column-space, null-space and rank of a matrix. Change of basis and similarity. Block matrices. Cramer's Rule. Eigen values and eigen vectors, characteristic and minimal polynomials, Caley-Hamilton theorem and its applications. Matrix exponential. Systems of linear equations.

Module 2: Introduction to Modern Control Theory:

Linear Time-Invariant (LTI) systems, Mathematical modelling of LTI systems. Classical versus Modern Control. Examples of Second-Order Systems: Electrical and Mechanical systems. Concept of State, State variable and State model. State variable representations. Conversion of state variable models to transfer function and vice-versa.

Module 3: State Variable Analysis:

Similarity transformations and its properties. First and second companion forms. Jordan's canonical form with state diagrams. Solutions to homogenous and non-homogeneous cases. Computation of matrix exponentials using Laplace transforms and Jordan Normal form, positive definite matrices, quadratic forms.

Module 4: Controllability and Observability

Controllable and reachable subspaces, Physical examples and system interconnection. Controllability matrix (LTI), Eigen vector test of controllability. Stabilizable system. Unobservable and unconstructable subspaces, Physical examples. Duality theorem. Observable decompositions, Detectability, detectability tests.

Module 5: Design using State-Space Analysis:

Introduction to pole placement design. Stability improvements by state-feedback. Necessary and sufficient conditions for arbitrary pole-placement. State-regulator design. Design of state-observers.

Recommended Book:

S. No	Name of Book	Author	Publisher & Edition
1	Linear Control System Analysis and Design	John J. D'Azzo and Constantine H. Houpis	Marcel Dekker, Inc., Fifth edition
2	Control System Engineering	Franklin and Powel	Prentice Hall
3.	Linear System Theory	Joao P. Haspanaha	Princeton University Press,2009.

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

<table>
<tr><td rowspan="3">Course: Digital Electronics and Logic Design (Code: ECT3xx)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year V Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
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</table>

Objectives: To study number systems, simplification and implementation of digital functions, design & analysis of various combinational and sequential circuits, memory organization & its implementations.

Course Outcomes:

CO1 To represent numbers in different number systems, binary codes and to perform their conversions and arithmetic operations.

CO2 To understand the Boolean algebra/theorems, K-Map and Q-M method and minimization of logic function using them, design and analysis of various combinational circuits.

CO3 To understand lathes and flip flops and designing various sequential circuits using various flip flops.

CO4 To understand basic concept of PLA, PAL, ADC, DAC, IEEE standards and notations

Details of the syllabus:

S. No.	Particulars
1	Review of Binary, octal and hexadecimal number systems. Various types of codes
2	Boolean algebra and Boolean theorems
3	Logic gates and implementation of Boolean functions with different types of logic gates. Circuit equivalence
4	Simplification techniques and minimization by map methods. Tabular method
5	Combination logic and arithmetic circuits. Encoders and Decoders, Multiplexers and Demultiplexers
6	Sequential circuits– state diagrams and state tables, design and analysis of flip flops, registers, counters, Synchronous and Asynchronous operation of sequential circuits. State Machines, Analysis and Design using State Machines
7	Analog to Digital converter, Digital to Analog converter
8	Latches and memory organizations. ROM’s, EPROM’s and RAM’s Dynamic and Static
9	Introduction to PLA’s, FPGA
10	IEEE standards and notations

Recommended Books

1	Digital System Design An Integrated Approach	Uyemura
2	Digital Logic & Computer Design	M Morris Mano
3	Digital Electronics	Gupta &Singhal
4	Digital principles and applications	A. P.Malvino
5	Switching Circuits	Marcus

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<table>
<tr><td rowspan="3">Course: Communication Systems
(Code: ECT3xx)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year V Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
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</table>

Objectives: To analyze various analog modulation & demodulation schemes, to understand operation of AM & FM radio receivers, to perform noise analysis of AM & FM systems, to understand the basics of random process.

Course Outcomes:

CO1 Understanding of basic principles of communication system and Fourier analysis of different signals.

CO2 To understand and analyze various analog modulation and demodulation schemes

CO3 To understand the random processes and different sources, classification of noise effecting the communication system.

CO4 To understand various reception techniques and the performance analysis of different radio receivers in presence of Noise

CO5 To have knowledge of digital communication and digital modulation techniques

Details of the syllabus:

S. No	Particulars
1	Fourier Analysis of Signals; Fourier Transform, Fourier Transform, Signal, Bandwidth, Spectrum of a signal, Power spectral density
2	Frequency translation, Modulation, Advantages of modulation,
3	**Amplitude Modulation**: Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations, Frequency discriminator, Demodulation of AM, Diode detector, Monodyne, Homodyne and Super heterodyne receiver
4	**Angle Modulation:** Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Spectral characteristics of angle modulated signals, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing, FM Receiver and Transmitter, Phase-Locked Loop: Nonlinear model of PLL, Linear model of PLL, Nonlinear Effects in FM Systems,
5	**Introduction to Random Process** Random Process, Mean Function, Autocorrelation function, Stationary Process , Wide Sense Stationary Process, White Gaussian Noise (WGN), Random process through LTI (Linear Time Invariant) System.
6	**Noise Analysis**: Signal to Noise Ratio, Noise Figure, Performance of AM &FM Systems in presence of noise, Preemphasis and Deemphasis,
7	**Digital Communication;** Benefits of digital communication, Sampling, quantization, PCM, Digital modulation Techniques viz, ASK, OOK, FSK, QAM .

Recommended Books

1	Principles of Communication Systems	Taub &schling
2	Taub's Principles of Communication Systems	Taub, schling & G Saha
3	Communication systems	Simon Haykins
4	Electronic Communication Systems	G. Kennedy

<table>
<tr><td rowspan="3">Subject: Power Systems-I Lab
(Code: EEL301)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year V Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Class Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
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Course Objective:
The main objective of the course is to understand, examine, and evaluate the electrical power system structure and its components.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Estimate the electrical parameters of A.C. and D.C. distribution system.

CO2: Analyze the Transmission line models.

CO3: Understand the concept of Insulators and underground Cables.

CO4: Perform the power system simulation in software packages.

List of Experiments:

S. No.	Name of the experiment
1	Determine the current and voltage circulating in a D.C. distribution network
2	Evaluate the phasor current and voltage for an A.C. distribution network.
3	Determine the generalized constants (A, B, C, D) of a Transmission line system.
4	Determine the Efficiency, Voltage Regulation of a Transmission line system.
5	Study of different types of Insulators.
6	Study of underground Cables and find the charging current.
7	Computer Simulation of Power System.

***Outdoor Activity* (*Optional*):** Measurement of Earth Resistance using Earth Tester.

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Course: Electric Machines - II Lab (Code: EEL302)	**Year & Semester:** B. Tech Electrical Engineering 3rd Year V Semester	**Total Course Credit: 1**		
		L	T	P
		0	0	2
Evaluation Policy	**Class Assessment** 40 Marks	**End-Term** 60 Marks		

Course Objective:
To familiarize the students with the operation and performance of induction and synchronous machines, and perform various tests on them.

Course Outcomes (COs): Upon successful completion of the course, students should be able to:

CO1: Carry out tests to determine the parameters of the equivalent circuit of a three-phase induction motor and determine losses and efficiency.
CO2: To understand and implement various methods of starting and speed control of induction motors.
CO3: Determine the torque-speed characteristics of a three-phase induction motor and ac series motor.
CO4: Conduct tests on synchronous machine to determine its parameters and voltage regulation
CO5: Determine the compounding and V-curves of synchronous machines.
CO6: Synchronize synchronous generators and control active and reactive power division between them.

List of Experiments: The students will conduct a minimum of 10 experiments out of the following list:

S. No.	Name of the experiment
1	To study the constructional details of an induction machine.
2	To determine the equivalent–circuit parameters of a 3 -phase Induction motor by no-load and blocked rotor tests.
3	To determine the torque- speed characteristics of a 3-phase induction motor.
4	To study the starting of a three-phase SCIM.
5	To study the methods of speed control of a three-phase SCIM.
6	To study the starting and speed control of a WRIM.
7	To study the starting of various types of split-phase motors.
8	To determine the speed characteristics of a Schrage motor.
9	To determine the Torque-speed characteristics of an AC series motor (Universal motor).
10	To study the constructional details of a synchronous machine.

11	To obtain the OCC and SCC of a synchronous machine and determine the synchronous reactance.
12	To determine the voltage regulation of an alternator by actual loading.
13	To obtain the compounding curves of an alternator.
14	To synchronize an alternator with bus bars using lamp method.
15	To synchronize two alternators and study the active and reactive load division between them.
16	To obtain the V-curves of a synchronous motor.

<table>
<tr><td rowspan="3">Subject: Control Systems-II & V.I. Lab (Code: EEL303)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year V Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
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<tr><td>Evaluation Policy</td><td>Class Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective:
To familiarize the students with Control System Analysis and Design on real-life systems.

Course Outcomes (COs):

CO1: To study the performance of relay and combination of P, I and D control schemes in a typical thermal system (oven).

CO2: To obtain the time response of a variety of simulated linear systems.

CO3: To study the role of feedback in DC speed control system and in DC position control system.

List of Experiments:

S.No.	Name of the Experiment
1.	To study the basic functionality of a Digital Storage Oscilloscope.
2.	To study the time-response of a variety of simulated linear systems and to correlate the studies with theoretical results.
3.	To study the performance characteristics of a D.C. motor speed control system.
4.	To study the performance characteristics of a D.C. motor angular position control system.
5.	To study the performance of various types of controllers and to control the temperature of an oven.
6.	To design and study the effects of different cascade compensation networks for a given system.

<table>
<tr><td rowspan="3">Subject: Computer Aided Simulation of Electrical Systems Lab
(Code: EEL304)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year V Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Class Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective:
To familiarize the students with MATLAB/SIMULINK modelling of electrical systems.

Course Outcomes (COs):
Upon successful completion of the course, student should be able to:

CO1: To use MATLAB and SIMULINK Tool Boxes.
CO2: To use Control system (State space), Fuzzy logic & neural network tool boxes.
CO3: To learn the use of MATLAB in analysis of A.C/D.C circuits, Control systems, Electric machines and Transformers.

List of Experiments:

S. No.	Name of the experiment
1	Use of MATLAB and SIMULINK Tool boxes
2	Use of MATLAB in: 1. Analysis of D.C Circuits 2. Transient and steady state analysis of A.C/D.C circuits. 3. Analysis of control systems 4. Analysis of Electric Machines and Transformers
3	Use of Control System (State Space), Fuzzy Logic & Neural Network Tool Boxes

<table>
<tr><td rowspan="3">Course: Digital Electronics & Logic Design Lab
(Code: ECL3xx)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year V Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
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</table>

Objectives: To acquire knowledge and become familiar with the different characterization techniques to analyze, and synthesize the digital logic, combinational and sequential circuits

Course Outcomes:

CO1	Identify relevant information to supplement the Digital Electronics & logic Design course
CO2	Develop competence in Combinational Logic Problem identification and solution
CO3	Develop design capability in the field of combinatorial logic using gates and blocks
CO4	Analysis and design of synchronous and asynchronous sequential circuits

Details of the syllabus:

S. No.	**Particulars**
1	To verify the truth table of following logic gates: d. AND OR and NOT e. NAND, NOR, XOR and XNOR f. To realize the above gates using discrete active and passive components.
2	To implement XOR and XNOR using universal logic gates.
3	**a.** To verify DeMorgans law using logic gates. **b.** To implement typical Boolean expressions and check their equality.
4	To design and realize:- **a.** Half adder and verify its truth table. **b.** Full adder and verifyits truth table. **c.** Half subtractor and verify its truth table **d.** Full subtractor and verify its truth table.
5	To design a multiplexer/demultiplexer using two input NAND gates
6	To designa4 bit binary to decimal converter.
7	To designamodulo-10 counter.
8	Given a frequency f obtain the waveforms with frequencies f/2,f/5&f/10
9	Design and realize the following flip flops using logic gates. **a.** RS flip flop **b.** JK flip flop **c.** D flip flop **d.** T flip flop
10	Use PLL as: **a.** Frequency multiplier. **b.** Frequency demodulator.

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

6th semester

<table>
<tr><td rowspan="3">Course: Power Systems - II
(Code: EET350)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year VI Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
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</table>

Course Objective: The course is introduced to the students to learn one step advance level of power system which assists to enable better understanding of power system operation and performance analysis with basics of advance power electronics devices.

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO1: Acquire and apply the knowledge of Per unit representation of Power system.

CO2: Analysis of balanced faults & unbalanced faults.

CO3: Investigating the concepts of Insulation co-ordination, over voltage, lightning surges, switching surges, and switching operations.

CO4: Analysis of Surge Impedance Loading, performance of transmission lines, interference of power lines with communication circuits.

CO5: Analysis and the basic knowledge of components and operation of power electronics, HVDC & FACTS Technology.

Unit I. Per Unit Representation of Power Systems:
(CO1)(6hr)
Single line diagram, impedance and reactance diagram of a system, per unit calculations, per unit representation of a power system.

Unit II: Fault Analysis (Balanced Faults): (CO2)(6hr)
Faults, types of faults, symmetrical 3-phase balanced faults – calculation of fault currents, Symmetrical fault analysis using bus impedance matrix.

Unit III: Fault Analysis (Un-symmetrical Faults):
(CO2)(8hr)
Symmetrical components, sequence impedances, sequence networks, unsymmetrical faults –single line to ground, line-to-line, double line to ground faults on unloaded alternators and on power systems.

Unit IV: Insulation Co-ordination:
(CO3) (8hr)
Generation of over-voltages in a power system, lightning phenomena, lightning surges, switching surges-interruption of short circuits and switching operations, switching surges – interruption of capacitive circuits, resonance over voltages, protection of power system components against over voltages – ground wires, lightning arrestors. Concept of insulation coordination, Basic impulse insulation level, standard impulse test wave, volt-time curve, location and rating of lightning arrestors.

Unit V: Surge Performance of Transmission Lines:
(CO4)(6hr)
Traveling waves on transmission lines, open-end line, short-circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at a T-junction, line terminated through a capacitance, line terminated through an inductance, Attenuation of traveling waves.

Unit VI: Interference of Power Lines with communication Circuit:
(CO4)(2hr)
Electrostatic and Electromagnetic effects.

Unit VII: High Voltage Direct Current Transmission & FACTS Technology:
(CO5)(6hr)
Comparison of HVAC and HVDC transmission lines. Thyristors (brief revision). Basic converter and D.C system operation – rectification, inversion. Complete direction current link. Objective of FACTS. Basic types of FACTS controllers. Introduction to FACTS Devices.

Total contact hours = 42 hr

Suggested Books:

1	Power System Analysis:	J.J. Grainger and W.D Stevenson, Tata McGraw Hill
2	Electrical Power Systems:	C.L. Wadhwa, New age Publication
3	Power Systems Engineering:	Nagrath and Kothari, Tata McGraw hill
4	Power System Analysis	Hadi Saadat, McGraw Hill College

<table>
<tr><td rowspan="3">Course: Power Electronics
(Code: EET351)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3^{rd} Year VI Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
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</table>

CO1: Understand the need for Power Electronics Devices and Circuits and their basic operation.
CO2: Perform an analysis of driving and control and triggering circuits for Power Electronic converters
CO3: Perform an analysis of AC to DC converters (Single phase and three phase, controlled and uncontrolled), A.C Voltage controllers, DC to DC converters(choppers), and single phase D.C to A.C converters (Inverters) in square wave mode.
CO4: Perform Fourier analysis and knowledge of Power Quality issues associated with power electronic circuits.
CO5: Understand different applications of power electronics.

Module 1:
Introduction to Power Electronics, Power Semi-conductor Devices: Power Diodes, power Transistors, power MOSFETs, IGBTs, GTOs, Thyristors, Basic theory of operation, characteristics, Ratings, Protection and cooling, Recent Advances in Power Semi-conductor Devices, Driving and control circuits

Module 2:
Power Electronic converters: 1-phase / 3 phase rectifier circuits, 1-phase / 3 phase phase-controlled converters (Semi-converters, full–converters and Dual converters). Analysis and performance with passive and active load, Harmonics and power factor, Introduction to power quality.

Module 3:
D.C-to-D.C converters (choppers): Buck, Boost and Buck-Boost type and various chopper configurations.

Module 4:
A.C-to-A.C converters: A.C voltage controllers, Cyclo-converters, Introduction to matrix converters

Module 5:
D.C–to-A.C converters (Inverters): 1-phase VSI in half bridge and full bridge configuration, CSI, Frequency and voltage control, Line-commutated inverters (LCIs). Some typical applications of power Electronics

Text Books

1. Power Electronics by Daniel W Hart, Tata Mc Graw Hill
2. Power Electronic Circuits by IssahBatterseh, Wiley.
3. N. Mohan, T.M. Undeland& W.P. Robbins, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989
4. Power Electronics: Circuits, Devices, and Applications by Muhammad H. Rashid. Pearson, 2009

References

1. Power Electronics: Devices, Drivers, Applications, and Passive Components by Barry Williams

2. Modern Power Electronics and AC motor Drives By Bimal K Bose- Pearson Publishers.
3. Referred Journal/Conference publications.

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

<table>
<tr><td rowspan="3">Subject: Microprocessors (Code: EET352)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year IV Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

CO1: Getting an overview of 8085 Micro-processor and its basic terminology.

CO2: Investigating and understanding of 8085 μp architecture.

CO3: To learn the instruction set, interrupts, and interfacing.

CO4: Introduction to 8086 microprocessor.

Module 1: Overview of Microprocessor:
Basic Terminology, Evolution of Microprocessors, State of Art of μP, Why we study 8085 μP.

Module 2: 8085 μP Architecture, Instruction Set and Programming Techniques:
Pin diagram, Detailed Internal Architecture, State Transition Diagrams, T- states (clock cycles), Machine Cycles, Instruction Cycles, Instruction Formats, Different Addressing Modes, Complete Description of all instructions with macro and micro RTL (Register Transfer language), Programming examples, Simulation of time delays.

Module 3: Interrupts and Serial I/O:
Concept of interrupts, priority of interrupts signals, Software generated interrupts, Hardware generated interrupts, Introduction of Serial I/O with reference to 8085 μP, General concepts.

Module 4: Interfacing and Microprocessor Applications:
Concept of fold back addresses, Memory maps, Memory mapped I/O, Isolated I/O, Interfacing of seven segment LED display, Toggle switches, Keyboard interfacing, Memory interfacing, Simplification of interfacing circuitry with the help of decoders, General purpose programmable peripheral devices, Interfacing of A/D and D/A conversion devices, Some illustrative examples of Microprocessor Applications.

Module 5: Introduction to 8086 μP:
Introduction to 8086 μP.

Recommended Book:

S. No	Name of Book	Author	Publisher & Edition
1	Microprocessor Architecture Programming and Applications with the 8085	Ramesh S. Goankar	Prentice hall
2	Microprocessors and Programmed Logic	K.L. Short	Prentice hall
3	Microprocessors: Theory and Applications (Intel and Motorola)	M. Rafiquzzaman	Prentice hall

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<table>
<tr><td colspan="1" rowspan="2">Course: Digital Signal Processing
(Code: EET353)</td><td colspan="2" rowspan="2">Year & Semester:
B. Tech Electrical Engineering
3rd Year VI Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L
3</td><td>T
1</td><td>P
0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objective: The primary objective of this course is to provide a thorough understanding and working knowledge of the analysis, design and implementation of discrete-time/digital signal processing systems.

Course Outcomes (COs): Upon successful completion of this course the students will have developed following skills/abilities:

CO1: Mathematically interpret, represent and process discrete-time/digital signals and systems
CO2: Thorough understanding of frequency-domain analysis of discrete-time signals.
CO3: Demonstrate and appreciate effect of sampling of continuous-time signals
CO4: Address practical implementation issues such as computational complexity, hardware resource limitations as well as cost of DSP systems
CO5: Ability to analyze and design DSP systems like FIR and IIR Filters.

UNIT - I Discrete Time Signals & Systems
Sequences & sequence operations, Discrete-time systems, Linear time-invariant systems, impulse response, causality, stability. Frequency-domain representation of discrete-time signals and systems, Fourier transforms, properties, theorems.

UNIT – II Sampling of Continuous-Time Signals
Periodic sampling, frequency- domain representation of sampling, reconstruction of signals, discrete-time processing of continuous–time signals, continuous–time processing of discrete-time signals, changing the sampling rate of DT signals.

UNIT - III Transform Analysis of Linear Time-Invariant Systems
Z- transform, Region of convergence, properties, Inverse Z-transform, Frequency response of LTI systems, system functions, linear constant-coefficient difference equations, FIR and IIR systems, Frequency response.

UNIT - IV Structure of Discrete-Time Systems
Block diagram representation of linear constant-coefficient difference equations, signal-flow graph representation, Basic structures for IIR systems, Transposed forms, Basic network structures for FIR systems.

UNIT - V Filter Design Techniques
Design of discrete-time IIR filters from continuous -time filters. Impulse invariance, bilinear transformation, Butterworth, Chebyshev, Elliptic approximation, low-pass, high-pass, band-pass and band-stop filters, design of FIR filters by windowing, Kaiser, Hamming, Hamming windows.

Text Books:

3. Discrete Time Signal Processing, A.V Oppenheim and R. W Schafer; Prentice Hall International
4. Digital Signal Processing Principles, Algorithms and Applications, John G. Proakis and D.G Manolakis; Prentice Hall International

Reference Books:

7. Introduction to Digital Signal Processing, J.R Johnson; Prentice Hall
8. Theory and Application of Digital Signal Processing, L.R Rabinder and B. Gold; Prentice Hall
.

<table>
<tr><td rowspan="3">Subject: Electric Machine Design
(Code: EET354)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year VI Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

- **CO1:** To understand the principles of electrical machine design and magnetic circuit calculations
- **CO2:** To study and design of armature winding and D.C machines.
- **CO3:** To understand the design of induction and synchronous machines.
- **CO4:** To study and design of single-phase and three-phase transformers

Module 1:

Principles of Electrical Machine Design:

Considerations in design, design factors, limitations in design, modern trends in design.

Magnetic Circuit Calculations:

Magnetization curves, Magnetic leakage, calculation of mmf for air gap and teeth, effect of saliency.

Module 2:

Armature Winding Design:

Winding design, integrated approach for windings, A.C armature windings, production of emf in windings, mmf distribution of armature windings, eddy current losses in conductors.

Design of D.C Machines:

Output equation, main dimensions, armature design, armature windings, design of commutator and brushes, design of field systems, design of interpoles.

Module 3:

Design of Induction Motors (1-phase and 3-phase):

Output equation, main dimensions, stator winding, stator conductors, shape of stator slots, number of stator slots, stator core, rotor design.

Module 4:

Design of Synchronous Machines:

Output equation, main dimensions, length of air gap, stator.

Module 5:

Design of Single-phase and Three-phase Transformers:

Output equation, core design, winding design, yoke design, design of transformer tank with tubes, design of insulation.

Recommended Book:

S. No	Name of Book	Author	Publisher& Edition
1	Electric Machine Design	A. K. Sawhney	Dhanpat Rai and Sons
2	Electrical Machine Design	R. K. Agarwal	S. S. Kataria and Sons
3	Design of Electrical Machines	Mittal and Mittal	Standard Publishers and Distributors
4	A Text Book of Machine Design	R. S. Khurmi and J.K. Gupta	S. Chand Publishers
5	Electrical Machine Design	V. Rajini and V.S. Nagarajan	Pearson Publications

<table>
<tr><td rowspan="3">Subject: Power Systems-II Lab
(Code: EEL350)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year VI Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Class Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective: The course is introduced to the students to enable laboratory scale practical knowledge about power system operation and performance analysis both hardware and software.

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO1: Acquire and apply the knowledge of Per unit representation of Power system.

CO2: Analysis of balanced faults & unbalanced faults.

CO3: Investigating the concepts of Insulation co-ordination, over voltage, and switching operations.

Lab. Experiments:

S.No	**Experiments**
1	Per unit representation of a power system.
2	Measurement of positive, negative and zero sequence impedance and currents.
3	Measurement of earth resistance.
4	Measurement of insulation resistance of insulators
5	Transmission line fault analysis
6	Application of software packages in power systems.

<table>
<tr><td rowspan="3">Subject: Power Electronics Lab
(Code: EEL351)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year VI Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Class Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective: The course is introduced to the students to enable laboratory scale practical knowledge about power system operation and performance analysis both hardware and software.

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO1: Understand the basic concepts of device characteristics and triggering techniques

CO2: Understand the operation of different type of rectifier/converter circuits with different loads

CO3: Understand the operation of choppers, AC voltage controllers and inverters

List of Experiments:

1.	To study the characteristics of Silicon Controlled Rectifier (SCR) and to find its holding and latching current.
2.	To study the resistance triggering technique for SCRs.
3.	To study the RC triggering technique of SCRs.
4.	To study the characteristics of Uni-Junction Transistor (UJT) and to determine its peak and valley points.
5.	To study the half-wave converter circuit at different loads and firing angles.
6.	To study the full wave bridge rectifier circuit and understand its effects on power quality.
7.	To study the single phase semi-converter circuit at different loads and firing angles.
8.	To study the single phase full-converter circuit at different loads and firing angles.
9.	To study the single phase AC voltage controller circuit at different loads and firing angles.
10.	To study the performance of DC-DC buck converter circuit at different duty ratios.
11.	To study the performance of single phase full bridge inverter circuit operating in square wave mode.

<table>
<tr><td rowspan="3">Subject: Microprocessor Lab
(Code: EEL352)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd Year VI Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
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<tr><td>Evaluation Policy</td><td>Internal Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective:
To familiarize the students with the architecture, working and programming of microprocessors.

Course Outcomes (COs):	
CO1:	Get started with Microprocessor 8085 training kit.
CO2:	To learn logical, arithmetic, counting and sorting programs on 8085.
CO3:	To learn interfacing with ADC converters.

List of Experiments:

S. No.	**Name of the experiment**
1	Microprocessors (8085) training kit and its working.
2	Programs related to data transfer between registers, between registers and memory
3	Programs related to logic instructions.
4	Programming techniques with additional instructions. Looping, counting and indexing.
5	Programs related to Arithmetic Instructions, 8 bit and 16 bit Addition and Subtraction.
6	Copying Blocks of data from one part of memory to another, conditional copy.
7	Programs related to Counters and time delays
8	Programs related to use of stack and subroutines. Nesting.
9	Interfacing concepts. Switch and LED interfacing. Square wave generation.
10	ADC interfacing.

Subject: Power System Protection (**Code:** EET401)	**Year & Semester:** B. Tech Electrical Engineering 3rd Year VII Semester	**Total Course Credit:** 3		
		L	T	P
		2	1	0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**	
	30 Marks	10 Marks	60 Marks	

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

- **CO1:** Understand the operating principles, functions and characteristics of various types of protective relays.
- **CO2**: Identification and implementation of the transformer protection schemes.
- **CO3**: Gain knowledge about the protection requirements and implementation of appropriate protection schemes for generators
- **CO4:** Identify, apply and calculate settings for over current, directional over current, distance, differential and pilot protection schemes for transmission lines.
- **CO5:** Study the structural and operational features of circuit breakers/fuses.

Module 1:Protective Relaying and Classification of Relays

Function of protective relaying, fundamental principles, primary and backup relaying, functional characteristics**,** Operating principles and characteristics of the following electromechanical relays: Current, voltage, directional, current balance, voltage balance, differential relays, and distance relays.

Module 2: Transformer Protection

Percentage differential relaying for power transformers (Y-Δ, Δ-Δ, Δ-Y configurations), unrestricted/restricted earth fault protection of transformers, transformer leakage protection, Buchholz relay.

Module 3: Generator Protection

Short- circuit protection of stator windings (Y-Δ configuration), protection against turn-to-turn fault, stator ground-fault protection, stator open circuit protection, field ground fault protection, Over-heating protection, Over-voltage protection, Loss of excitation protection, rotor overheating protection, Protection against vibration, protection against motoring over speed protection, protection against unbalancing.

Module 4: Transmission Line Protection and busbar/feeder protection

Transmission line protection using: Over current relays, Distance relays, Pilot relays

Over current relays: selection of time/current settings, protection of radial feeders, parallel feeders and ring mains.

Distance relays: use of impedance, reactance and mho relays for transmission line protection.

Pilot relays: use of wire pilot, carrier current pilot and microwave pilot for the transmission line protection.

Protection of busbars/feeders etc.

Module 5: Fuses and Circuit Breakers

Fusing element, classification of fuses, current carrying capacity of fuses, high rupturing capacity (H.R.C.) cartridge fuses, characteristics of H.R.C. fuses, selection of HRC fuses.

Types of circuit breakers, basic principle of operation, phenomena of arc, initiation of an arc, maintenance of arc, arc extinction, d. c. circuit breaking, a.c. circuit breaking, arc voltage and current waveforms in a.c. circuit breaking, restriking and recovery voltages, de-ionization and current chopping, ratings of circuit breakers, oil circuit breakers, air blast circuit breakers, SF6 Circuit breakers , Vacuum breakers.

Recommended Book:

S. No	Name of Book	Author	Publisher& Edition
1	Art and Science of Protective Relaying	Mason	John Wiley & Sons, 2nd Edition
2	Protective relaying, Principles and Applications	J. L Black Burn	CRC Press, 4th Edition
3	Power System Protection and Switchgear	Badri Ram	Tata McGraw-Hill Education, 2nd Edition

<table>
<tr><td rowspan="3">Course: High Voltage Engineering
(Code: EET402)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objective: To study and understand the complications and problems associated with the generation, measurement and use of high voltages and considerations for design of efficient insulation systems.

Course Outcomes (COs): Upon successful completion of the course, students should be able to:

CO1: Understand the significance of high voltage testing of power system equipment and study the various methods of generation of high ac, dc and impulse test voltages and high impulse test currents.

CO2: Understand the complications involved in the measurement of high voltages and study the various methods of measurement of high ac, dc and impulse test voltages and high impulse currents.

CO3: Describe the mechanisms of conduction and breakdown in gaseous dielectrics; effect of uniform and non-uniform-field gaps, breakdown under dc and ac fields, impulse breakdown.

CO4: Identify the breakdown mechanisms of solid and liquid dielectrics; describe the suitability of these dielectrics in high voltage equipment.

CO5: Understand the significance and procedures of non-destructive testing of HV equipment.

UNIT - I Conduction and Breakdown in Gases:

Insulation breakdown, Electric field and field stress, uniform and non-uniform fields, Ionization in gases, Current in a uniform-field gap, Townsend's criterion for breakdown, Paschen's law, Effect of temperature on breakdown voltage, Electronegative gases, Streamer breakdown mechanism, Corona discharges, Polarity effect, Surge-voltage time lags for breakdown, Breakdown under uniform ac field, Breakdown under impulse voltages, Practical gaseous dielectrics.

UNIT – II Conduction and Breakdown in Solid and Liquid Dielectrics:

Factors affecting breakdown of solid dielectrics, Breakdown mechanisms, Intrinsic breakdown, Electromechanical breakdown, Thermal breakdown, Erosion breakdown, Breakdown due to tracking, Treeing, Conduction and breakdown in pure liquids and commercial liquids, Application of solid and liquid dielectrics.

UNIT - III Generation of High Voltages:

Applications of high voltages, High-voltage tests, Generation of high alternating voltages: High-voltage testing transformers, Transformer cascades, Series resonant circuits. Generation of high direct voltages: Rectifying circuits, Voltage multiplier circuits- Cockcroft-Walton voltage multiplier, Electrostatic generation. Generation of high impulse voltages: Basic impulse generator, Multistage impulse generator circuits-Marx and Goodlet impulse generator, Triggering of impulse generator.

UNIT - IV Measurement of High Voltages:
Measurement of high ac, dc and impulse voltages, High ohmic resistor in series with ammeter, High ohmic resistive voltage divider, Ammeter in series with HV capacitor, Chubb-Fortescue method, Electrostatic voltmeter, Voltage dividing systems, Types of voltage dividers, Signal cable matching, Sphere gap measurement, Measurement of high impulse currents.

UNIT - V Non-Destructive Testing of High-Voltage Equipment:
Measurement of d.c. resistivity, dielectric constant and dissipation factor, Partial discharge measurement.

Text Books:

5. High Voltage Engineering Fundamentals, E. Kuffel, W.S Zaengl; Newnes.
6. High Voltage Engineering, C. L. Wadhwa; New Age International Publishers
7. An Introduction to High Voltage Engineering, Subir Ray; Prentice Hall of India

Reference Books:

9. High Voltage Engineering, M.S. Naidu, V. Karamraju; Tata McGraw-Hill
10. High voltage test techniques, Dieter kind, Kurt Feser; Newnes

<table>
<tr><td rowspan="3">Course: Power Systems - III
(Code: EET403)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
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<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objective: The course is introduced to the students to enable them to give optimal performance and to tackle every challenge during professional experience

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO1: Gain knowledge of load flow techniques, mathematical analysis, and their comparison.

CO2: Develop an overview of power system stability phenomenon.

CO3: Discuss Automatic Generation Control by developing various models and their control strategies

CO4: Understand and evaluation of generation and absorption of reactive power and study various voltage control methods.

CO5: Formulation and analysis of the economic operation of the power system.

Unit 1. Load Flows: (10hr)
(CO1)

Nature and importance of the problem, Network model formulation, Algorithm for the formulation of Y_{bus} matrix, Formulation of Y_{bus} by singular transformation: by graph, by primitive network, and by bus incidence matrix, Load flow problem, Load flow equations, Bus classification – List of variables in load flow equations, Gauss - Seidel & Newton-Raphson method for solving load flow problem, Comparison of load flow methods, De-coupled & Fast de-coupled power flow method, Modeling of tap-changing transformers and phase-shifters.

Unit 2. Power System Stability: (8hr)
(CO2)

Classification of power system stability, Dynamics of the synchronous machine and swing equation, Power angle equation, Node Elimination technique, Steady state and transient stability, Equal-area criterion of stability, Numerical solution of swing equation, Factors affecting transient stability.

Unit 3. Automatic Generation Control: (8hr)
(CO3)

Real power balance and its effect on system frequency, Load frequency control of single area system – Turbine speed governing system, model of speed governing system, turbine and generator load model, Steady state analysis and dynamic response, proportional plus integral control, Economic dispatch control, Two area load frequency control.

Unit 4. Control of voltage and Reactive Power: (8hr) (CO4)

Generation and absorption of reactive power, Relation between voltage and reactive power, Reactive power flow and voltage control, mathematical formulation of voltage stability problem, Methods of voltage control – injection of reactive power, tap changing transformers, booster transformers, phase – shift transformers.

Unit 5. Economic Operation of Power System: (8hr) (CO5)

Introduction, system constraints, economic dispatch neglecting losses, penalty factor, economic dispatch with losses, transmission loss equation, automatic load dispatching.

Total contact hour: 42 hr

Text Books:

1. Power System Analysis J.J. Grainger and W.D Stevenson, Tata McGraw-Hill.
2. Electrical Power Systems B.M. Weedy and Cory John Wiley & sons.
3. Power Systems Engineering Nagrath and Kothari McGraw-Hill Education
4. Electric Power Systems C.L. Wadlhwa New Age Publications
5. Electric Energy System Theory O. I Elgard McGraw-Hill

<table>
<tr><td rowspan="3">Subject: Advanced Power Electronics
(Code: EET405)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Understand three phase voltage source and current source inverters and their modulation strategies.

CO2: Understand the operation of non-isolated DC-DC Converters

CO3: Understand the operation of isolated DC-DC converter.

CO4: Perform comparative assessment of different modulation techniques

CO5: Understand the applications of power electronics in appliances such as Power conditioners and UPS.

Module 1:
Three phase Voltage source inverters in square wave mode. 120 and 180degree modes of conduction. Three phase Current Source Converter

Module 2:
Different modulation strategies- Sine PWM, Hysteresis Current Control Technique, Selective Harmonic Elimination, Space Vector Modulation.

Module 3:
Non Isolated D.C to D.C converters in CCM and DCM, Boundary conditions, Non-Ideal Behavior, Design of Passives for: Buck, Boost, Buck-Boost and Cukconverter circuits.

Module 4:
Isolated DC-DC converters: Flyback converter, Forward converter, Push-Pull converter, Half-Bridge converter and Full-Bridge converter

Module 5:
Power line disturbances and their effect on equipment, Power conditioners, offline and online UPS

Text Books

1. Power Electronics by Daniel W Hart, Tata Mc Graw Hill
2. N. Mohan, T.M. Undeland& W.P. Robbins, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989
3. Fundamentals of Power Electronics, Erickson and Macsimovic

References

4. Power Electronics: Devices, Drivers, Applications, and Passive Components by Barry Williams
5. Modern Power Electronics and AC motor Drives By Bimal K Bose- Pearson Publishers.
6. Referred Journal/Conference publications.

<table>
<tr><td rowspan="3">Course: Electronic Measurements & Instrumentation
(Code: ECT404)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
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</table>

Objectives: To introduce the instrumentation system, to teach the construction, operation of various transducers, sensors, etc, to develop the concept of function generators, frequency counters, data acquisition systems, interfacing of micro controllers and basic GPIB techniques.

Course Outcomes:

CO1	To familiarize with measurement standards and systems with their responses
CO2	To get a detailed understanding of various analog meters
CO3	To introduce transducers, sensors and actuators used in measurements
CO4	To understand the working of wave generators, analyzers and digital meters and to get knowledge about data acquisition system and interfacing with microcontrollers

Details of Syllabus:

S. No.	Particulars
1.	**Measurement System and Standards:** Instrumentation System and its classification, Primary and secondary standards, Standards of various electrical quantities, IEEE standards, Static and Dynamic response, Errors, and accuracy of an instrumentation system.
2.	**Measurement of Basic Parameters:** Galvanometer and its principle, Moving Coil, Moving iron meters, true rms meter, Bridge measurements, Q meters, Measurement of Voltage, Current, Power, Energy. Measurement of Resistance, Capacitance, Inductance.
3.	**Transducers, Sensors, and Actuators:** Active and Passive, Transducers types: Resistive, Inductive, capacitive, Piezoelectric, Optical, Photo diodes; Measurement of Physical, Physiological, And chemical quantities: (Temperature, pH, Luminescence, Flow, Pressure, Torque, Speed, acceleration, Rotation, Stress, Strain, etc,), Sensors for hostile environments, Actuators: Relays, Solenoids, Stepper motors.
4.	**Signal Generators and Analyzers:** Function generators, RF Signal Generator, Sweep Generator, Frequency synthesizer, Wave Analyzers for Audio and radio frequency waves. Measurement of harmonic distortion. Spectrum analysis, RF Power measurement.
5.	**Digital Instrumentation:** Comparison of analog and digital techniques, Digital voltmeter, Digital multimeter, Frequency counter, Measurement of frequency and time interval, extension of frequency range, Measurement errors.
6.	**Data Acquisition System:** Components of data acquisition system, Interfacing of transducers, Single Channel and Multi-channel system, Multiplexing, interfacing with micro controllers, IEEE 488 Bus, Automated data acquisition,

7.	**Advanced topics:** Virtual Instrumentation, Low level measurements and Noise rejection, GPIB based measurement techniques. Measurements using MEMS
8.	**Measurement System and Standards:** Instrumentation System and its classification, Primary and secondary standards, Standards of various electrical quantities, IEEE standards, Static and Dynamic response, Errors, and accuracy of an instrumentation system.

Recommended Books:

1.	**Electronic Measurements**	**W Cooper**
2.	**Electrical & Electronic Measurements**	**A K Sawhney**

<table>
<tr><td rowspan="2">Subject: Power Station Practice
(Code: EET405)</td><td colspan="2" rowspan="2">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L
2</td><td>T
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<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

- **CO1:** To understand the economics of power generation
- **CO2:** To study various power factor improvement methods
- **CO3:** To study different types of tariffs and various types of grounding systems
- **CO4:** To understand an overview of power stations and substations

Module 1: Economic Aspects of Power Generation

Economics of generation, factors affecting the cost of generation, reduction of costs by interconnection of stations, curves useful in system operation, choice of size and number of generating units.

Module 2: Power Factor Improvement

Power factor, disadvantages of low power factor, methods of improving power factor, location of power factor improvement apparatus, economics of power factor improvement.

Module 3: Power Tariff and Neutral Grounding

Cost of generating station, fixed capital, running capital, annual cost, running charges, fixed charges, factors influencing the rate of tariff, designing tariff, different types of tariff, flat rate tariff, block rate tariff, two part tariff, maximum demand tariff, power factor tariff.

Neutral grounding, solid grounding, resistance grounding, reactance grounding, arc suppression coil grounding, earthing transformers

Module 4: Overview of different Types of Power Stations and their Auxiliaries

Thermal power plants, hydroelectric stations, nuclear power stations, diesel power stations, gas turbine plants.

Module 5: Overview of Substations and Substation Equipment

Introduction, type of substation, civil and electrical works in a substation, bus bars, layout, drawings.

Recommended Book:

S. No	Name of Book	Author	Publisher& Edition
1	A Course in Electrical Power	Soni, Gupta and Batnagar	Dhanpat Rai and Sons
2	Elements of Power Station	Deshpande	Prentice hall
3	The Art and Science of Utilization of Electric Energy	H. Pratab	Dhanpat Rai and Sons
4	Substation Design and Equipment	Satnam	Dhanpat Rai and Sons

<table>
<tr><td rowspan="2">Subject: Power System Protection Lab
(Code:EEL401)</td><td rowspan="2">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td></td><td></td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Class Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective:
To familiarize the students about various protection schemes of electrical systems.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Gain the practical knowledge of various types of relays and characteristics of different types of relays.

CO2: Visit to an electric Sub-station to understand various types of protective schemes circuit breakers and differential protection schemes.

CO3: Study of structural and operational characteristics of circuit breakers/fuse wires

List of Experiments:

S. No.	Name of the experiment
1	Study of constructional details of various types of relays.
2	Characteristics of fuse wires of different materials.
3	Time current characteristics of an over current relay.
4	Study/simulation of differential relay.
5	Study of an oil circuit breaker.
6	Time/current grading of an over-current relay for distance protection.
7	Visit to an Electric Sub-station to study various protective schemes.

<table>
<tr><td rowspan="3">Subject: High Voltage Engineering Lab
(Code: EEL402)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Class Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective:
To familiarize the students with the generation and measurement of high voltages, and high voltage testing of power-system equipment.

Course Outcomes (COs): Upon successful completion of the course, students should be able to:

CO1: Handle equipment for generation and measurement of high ac, dc and impulse voltages.

CO2: Carry out breakdown withstand tests and flashover tests on high-voltage equipment according to standards.

CO3: Understand the effect of electrode geometry on the breakdown characteristics of gaseous gaps.

CO4: Determine the breakdown voltage of insulating liquids according to standards.

List of Experiments:

S. No.	Name of the experiment
1	To test the breakdown voltage of insulating liquids according to standards.
2	To carry out one-minute power-frequency withstand test and flashover test on 11kV / 33 kV pin insulator.
3	To determine the string efficiency of a three-unit suspension insulator.
4	To carry out breakdown studies of gaseous gaps using different electrode configurations.
5	To study the polarity effect of the point electrode of a point-plane gap on the breakdown characteristics of the gaseous gap.
6	To study the effect of front resistance, tail resistance, generator capacitance and load capacitance of an impulse generator on the impulse voltage wave shape.
7	To carry out impulse voltage withstand test on a pin insulator /string insulator as per international specifications.
8	To determine the 50% impulse flashover voltage of a pin insulator / suspension insulator.

8th Semester

<table>
<tr><td rowspan="3">Subject: Principles of Management
(Code: HST454)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives:

COB 1: To familiarize students with the basic concepts, principles and definitions of management.
COB 2: To facilitate students in understanding specific theories related to perception, motivation, leadership, job design, and organizational change.
COB 3: To help the student in understanding the contemporary issues in management.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Interpret basic concepts and theories of management.
CO2: Outline plans and different organization structures.
CO3: Classify different leadership styles in cross cultural environment.
CO4: Develop rationale decision making and Problem-solving abilities.
CO5: Cite contemporary issues and approaches to management.

UNIT 1:
Introduction of Management: Management: Definition– Importance– Managerial Roles– Functions of management – Classical theory – Scientific management - Administrative theory – Behavioral Theory – Management science – Integrative perspective – System theory – Socio – technical theory – Contingency theory – Comparing theories

UNIT 2:
Planning and Organizing: Nature and Definition of Planning – Principles of Planning – Objectives of planning – Planning process – Types of plans – Benefits and pitfalls of planning. Principles of organizing – Organization levels – Organizational designs and structure – Line and staff organizations – Approaches – Delegation of authority – Factors affecting delegation of authority – Span of management – Centralization and decentralization of Authority.

UNIT 3:
Directing and controlling: Definition of Co-ordination–Significance and principles of Co-ordination– Leadership behavior and styles – Leadership in cross cultural environment. Nature and importance of controlling– Controlling process– Requirements of effective control– Establishing controlling system – Controlling techniques.

UNIT 4:
Decision making: Meaning of decision – types of decisions – Rationale decision making process –Models of decision making – Problem solving and decision making – increasing participation in decision making – Vroom’s Participative decision-making model – challenges and problems in decision making

UNIT 5:
Contemporary issues in Management: MBO-Management by Walking Around–Out of the Box Thinking– Balanced Score Card –Time Management–BPOs – Stress Management causes and remedies – JIT – TQM – Six Sigma – CMM levels

Relevant cases have to be discussed in each unit, and in examination case is compulsory from any unit.

Suggested Books:

1. Kumar, Rao, Chhalill: Introduction to Management Science. Cengage Publications, New Delhi
2. Dilip Kumar Battacharya, Principles of Management, Pearson, 2012.
3. Harold Koontz, Heinz Weihrich, A.R. Aryasri, Principles of Management, TMH, 2010.
4. V. S. P. Rao, Management Text and Cases, Excel, Second Edition, 2012.
5. K. Anbuvelan, Principles of Management, University Science Press, 2013.
6. Neeta Baporikar, Case Method – Cases in Management, Himalaya Publishing House (HPH) 2009.
7. Deepak Kumar Bhattacharyya, Principles of Management-Text and Cases, Pearson, 2012.

Electives

<table>
<tr><td rowspan="3">Subject: Advanced Control Theory
(Code: ....)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd & 4th Year Semester</td><td colspan="3">Total Course Credit: -
-</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

CO1: To get started with nonlinear systems.
CO2: To obtain linear approximation of a nonlinear system.
CO3: To understand nonlinear phenomenon and stability analysis.
CO4: Extend modelling principles to discrete-time systems.
CO5: Analyze and synthesize discrete-time control systems using the z-transform.

Module 1: Introduction to nonlinear systems:

Nonlinear system behavior. Types of nonlinearities. characteristic features of nonlinear systems, linearization and local stability.

Module 2: Analysis of nonlinear systems:

Phase plane analysis of linear and nonlinear systems, Existence of limit cycles. Describing function analysis, stability analysis using Lyapunov's method. Lyapunov's direct method, Invariant set theorems, Lyapunov analysis of LTI systems.

Module 3: Introduction to Digital Control:

Continuous versus digital control, hardware elements of a digital control system, sampling theorem, ZOH, effect of sampling rate, calculus of difference-equations, modelling discrete-time systems using pulse transfer function.

Module 4: Understanding Z-transform:

Frequency domain analysis, Z- transform, inverse Z-transform, difference equations, Relationship (in frequency domain) between s-plane (continuous-time) and z-plane (discrete-time).

Module 5: State Variable Analysis of Digital Control Systems, State space approach: Controllability, Observability, digital filter properties. PID controller, introduction to reduced order modelling.

Recommended Book:

S. No	Name of Book	Author	Publisher & Edition
1	Digital Control and State Variable Methods	M. Gopal	Tata McGraw-Hill
2	Automatic Control Systems	B. C. Kuo	Prentice-Hall
3	Advanced Control Engineering	R. S. Burns	Butterworth Heinemann
4	Nonlinear Systems	H. K. Khalil	Prentice-Hall
5	Modern Control Engineering	K. Ogatta	Prentice-Hall

<table>
<tr><td rowspan="3">Course: Mechatronics
(Code: EET051)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

- **CO1: Explain the architecture of various mechatronics systems.**
- **CO2: Select and integrate various sensors and actuators to meet a mechatronic product requirement**.
- **CO3: Determine and analyze the dynamic response of the zero, first and second order mechatronic systems**
- **CO4: Understand modern control architectures for Mechatronic systems.**

Module 1: Fundamentals of Mechatronics:

Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. Review of fundamentals of electronics. Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers.

Module 2: **Microprocessor and Microcontrollers:**

Microprocessors controllers and PLCs. 8086 Microprocessor and its Internal Architecture, Pin Configuration and their functions. Introduction to Microcontroller Interfacing and applications

Module 3: Sensors and Actuators:

Brief overview of measurement systems, classification, characteristics and calibration of different sensors. Measurement of displacement, position, motion, force, torque, strain gauge, pressure flow, temperature sensor sensors, smart sensor. Optical encoder, tactile and proximity, ultrasonic transducers, opto-electrical sensor, gyroscope.

Module 4: Modelling and Simulation of Mechatronic Systems:

Mechanical and electrical systems, physical laws. Modelling paradigms for mechatronic system, Block diagrams, mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, mechanical rotational system, electrical-mechanical coupling. Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation. Modelling of sensors and actuators

Module 5: Control of Mechatronic Systems:

Solution-time criterion, control-area criterion, performance indices; zero steady state step error systems; modern control performance index: quadratic performance index, Ricatti equation.

Recommended Book:

S. No	Name of Book	Author	Publisher & Edition
1	Mechatronics	HMT Ltd.	Tata Mcgraw-Hill, New Delhi, 1988
2	Fundamentals of Mechatronics	Musa Jouaneh	Cengage Learning, 2012
3.	Measurement, Instrumentation, and Sensors Handbook	John G. Webster	CRC Press (1999)
4.	Modeling of Dynamical Systems	L. Ljung, T. Glad	Prentice Hall Inc. (1994).

Course: Renewable Sources of Electrical Energy (Code: EET052)	Year & Semester: B. Tech Electrical Engineering 4^{th} Year VIII Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term	Internal Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Objectives:

1. To Understand the Importance, Scope and Potential of Renewable Energy Resources.
2. To Impart Knowledge on the Technology and Applications of Renewable Energy.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Assess different energy resources; Understand energy, environment and need for renewables.

CO2: Understand, analyze and apply the concepts of wind energy, solar energy: solar thermal & solar PV technology.

CO3: Understand and analyze the principle of energy extraction from Ocean energy (Tidal, Wave, OTEC).

CO4: Understand the energy conservation and future energy sources.

Module 1: Introduction

Review of Conventional & Renewable Energy resources, Energy problem, Energy & environment, Need for renewable, Rural Energy.

Module 2: Solar Energy – Basics & Technologies

Solar Energy Basics - Solar radiation and its measurement – Solar collectors – Energy Balance Equation and Collector Efficiency – Solar Cell Principles – Conversion Efficiency and Power Output – Photovoltaic system and Solar-Thermal system for Power Generation – Solar Cell Modules - Solar Energy Storage - Applications of Solar Energy.

Module 3: Wind Energy

Wind Energy profile - Basic Principles - Wind Energy Estimation – WEC System - Basic Components - Collectors - Rotor Types – Wind Turbine Types - Blade Forces – Aerodynamic Force – Braking systems – Tower - Control and Monitoring System – Performance of Wind Machines.

Module 4: Other Renewable Energy sources

Electric Power Generation from Tidal, Ocean Thermal and Geothermal energy. Simple power plant based on Tidal / OTEC / Geothermal.

Module 5: Energy conservation & Hybrid energy system:

Energy conservation in transport sector. Energy efficient buildings. Energy audit.
Concept of hybrid energy systems and explore new energy sources.

Text Books

1. B. H. Khan, "Non-Conventional Energy Resources", Tata McGraw-Hill, 2006.
2. John F. Walker & Jenkins. N, "Wind Energy Technology", John Wiley and Sons, 1997.

Reference

1. G.D. Rai, "Non-Conventional Energy Sources", First Edition, Khanna Publishers, Delhi, 1999.
2. Agarwal M.P., "Future Sources of Electrical Power", S. Chand Co. Ltd., New Delhi, 1999.
3. Van Overstraeton and Mertens R.P., "Physics, Technology and Use of Photovoltaics", Adam Hilger, Bristol, 1996.

<table>
<tr><td rowspan="3">Subject: Electric Drives
(Code: EET053)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

CO1: To understand the operation of AC-DC Converter Controlled DC Motor Drives
CO2: To understand the operation of Chopper Controlled DC Motor Drives
CO3: To understand the operation of Voltage Source Inverter Fed Induction Motor Drives
CO4: To understand the operation of Current Source Inverter Fed Induction Motor Drives
CO5: To understand the Rotor Side Control of Induction Motor Drives

Module 1:
Introduction to Electric Drives, Electric Drive Systems versus Mechanical Drive Systems. **Converter Controlled Dc Motor Drives:** Steady state analysis of semi-controlled and fully controlled converter fed series and separately excited D.C motor drives: Continuous and discontinuous conduction mode, open /closed loop control.

Module 2:
Chopper Controlled Dc Motor Drives: Four quadrant chopper circuit – closed loop control of chopper fed dc drive –Steady state analysis of chopper controlled DC motor drives.

Module 3:
Voltage Source Inverter Fed Induction Motor Drives: Scalar control- Voltage fed Inverter control-Open loop volts/Hz control-Speed control with slip regulation-Speed control with torque and Flux control-Current controlled voltage fed Inverter Drive.

Module 4:
Current Source Inverter Fed Induction Motor Drives: Current-Fed Inverter control-Independent current and frequency control-Speed and flux control in Current-Fed Inverter drive-Volts/Hz control of Current-Fed Inverter drive-Efficiency optimization control by flux program.

Module 5:
Rotor Side Control Of Induction Motor: Rotor resistance control- fixed resistance control, variable resistance control-converter controlled rotor resistance control, Slip power recovery schemes- Static Kramer drive-Phasor diagram-Torque expression-Speed control of a Kramer drive-Static scherbius drive-Modes of operation

Recommended Book:

S. No	Name of Book	Author	Publisher& Edition
1	Modern Power Electronics and AC drives	B.K.Bose	Pearson
2	Control of Electric Drives	Werner Leonhard	Springer
3	Power Electronics and Motor Control	Shepherd, Hulley, Liang	Cambridge University Press
4	Electric Motor Drives Modeling, Analysis and Control	R. Krishnan	Prentice-Hall

<table>
<tr><td rowspan="3">Subject: Microcontroller and their Applications
(Code: EET054)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 03</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

CO1: To get started with Microcontrollers
CO2: To understand the hardware features of 8051 Microcontroller
CO3: To understand the addressing modes and instruction set of 8051 Microcontroller
CO4: To understand memory interfacing and data communication with 8051 Microcontroller
CO5: To understand the basic concepts of embedded systems.

Module 1:
Microcontrollers– Introduction to different types of Microcontrollers, Hardware features, architecture and memory types**.**

Module 2:
Detailed study of 8051 Processor architecture and Memory organization, External memory Interfacing

Module 3:
Addressing modes of 8051 and Instruction Set – Data movement instruction, arithmetic instruction, Logic instruction, Branch group Instruction and Bit manipulation Instructions

Module 4:
8051 software and programming memory interfacing and address decoding, programming Input/ Output port/ timer/ ADC/DAC, interrupts controller and Serial data communication controller for different application with respect to instrumentation & control.

Module 5:
Embedded System Hardware, Embedded system software, Introduction to embedded development tools like cross assembler, simulator, HLL Cross compiler & in circuit emulator for system development

Recommended Book:

S. No	Name of Book	Author	Publisher& Edition
1	The 8051 Microcontroller & Embedded System	M. A. Mazidi& J. G. Mazid	Pearson
2	Design with Micro-controllers	John. B. Pitman	Mc-GrawHill
3	8051 Microcontroller Hardware, software and applications	V Udayashankara and Mallikarjunaswamy	Tata Mc-GrawHill

<table>
<tr><td>Course Code: EET055</td><td colspan="2">Course Title: Maintenance and Design of Electrical Substations</td><td colspan="3">Course Credit: 3</td></tr>
<tr><td>Semester:</td><td colspan="2">Session:</td><td colspan="3" rowspan="1">Contact Hours</td></tr>
<tr><td>Minor Exam</td><td>Class Assessment</td><td>Major Exam</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td>30 (Marks)</td><td>10 (Marks)</td><td>60 (Marks)</td><td>3</td><td>0</td><td>0</td></tr>
</table>

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO:

1. To understand the planning and design of electrical substation.
2. To understand the design considerations of substations.
3. To explain the overall layout of substations.
4. To impart knowledge about the concept of substation grounding.
5. To understand protective relaying, substation automation and auxiliary systems.

UNIT-I Introduction

Purpose and scope; relationship of substation to overall power system; importance of adequate substation planning and engineering; types of substations: general, distribution substations, transmission substations, switching substations.

UNIT-II General design considerations

Initial and ultimate requirements; site considerations; environmental considerations; interfacing considerations; reliability considerations; operating considerations; safety considerations; maintenance considerations.

UNIT-III Physical Layout

Layout considerations; typical bus configuration; protection of substation insulation; substation insulators; electrical clearances; bare conductors; rigid bus design; strain bus design; application of mobile transformers and substations.

UNIT-IV Grounding

Definitions; soil resistivity measurements; area of ground grid; ground fault currents, ground conductor; safety considerations; tolerable touch and step voltages; protective surface material and reduction factor; design of substation grounding.

UNIT-V Protective relaying, substation automation and auxiliary systems

Fundamental considerations; basic relay types; relay schemes, Automation: Introduction; open vs proprietary systems; substation automation architecture; data acquisition and control elements, AC and DC auxiliary systems, Maintenance, uprating and expanding existing substations.

Text Books:

1. United States Department of Agriculture, *Design Guide for Substations,* Issued June 2001
2. The Aluminum Association, *Aluminum Electrical Conductor Handbook*, New York: The Aluminum Association, 1971.

Course Code: EET056	Course Title: Power System Transients		Course Credit: 3		
Semester:	Session:		Contact Hours		
Mid Term	Int. Assessment	End Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	3	0	0

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO:

6. To give overview of nature of power system transients
7. To understand the switching transients
8. To explain the phenomenon of switching surges and lightning surges and its modeling.
9. To impart knowledge about the concept of traveling waves
10. To understand transient in integrated power system

UNIT-I Introduction and survey

Origin and nature of transients and surges, lumped and distributed circuit representations. Line energisation and de-energisation transients, current chopping, short-line faults, trapped charge effects, effect of source, control of transients, Lightening, effect of tower footing resistance, travelling waves, insulation coordination, circuit breakers duty, surge arresters, overvoltage limiting devices, Source of transients, various types of power systems transients, effect of transients on power systems, importance of study of transients in planning.

UNIT-II Switching Transients

Introduction; circuit closing transients: RL circuit with sine wave drive, double frequency transients; observations in RLC circuit and basic transforms of the RLC circuit; Resistance switching: Equivalent circuit for the resistance switching problems, equivalent circuit for interrupting the resistor current; Load switching: Equivalent circuit, waveforms for transient voltage across the load, switch; normal and abnormal switching transients; Current suppression; current chopping; effective equivalent circuit; capacitance switching, effect of source regulation, capacitance switching with a restrike, with multiple restrikes, illustration for multiple restriking transients, ferro resonance.

UNIT-III Lightning Transients

Causes for over voltage, lightning phenomenon, charge formation in the clouds, rate of charging of thunder clouds, mechanisms of lightning strokes, characteristics of lightning strokes; factors contributing to good line design, protection afforded by ground wires, tower footing resistance. Interaction between lightning and power system: Mathematical model for lightning.

UNIT-IV Travelling Waves on Transmission Line Computation of Transients

Computation of transients: Transient response of systems with series and shunt lumped parameters and distributed lines. Travelling wave concept: step response, Bewely's lattice diagram, standing waves and natural frequencies, reflection and refraction of travelling waves.

UNIT-V Transients in Integrated Power System

The short line and kilometric fault, distribution of voltage in a power system: Line dropping and load rejection; voltage transients on closing and reclosing lines; over voltage induced by faults; switching surges on integrated system; EMTP for transient computation.

Text Books:

1. Allan Greenwood, Electrical Transients in Power Systems, Wiley-Blackwell; 2nd Edition edition, 1991.
2. Pritindra Chowdhuri, Electromagnetic Transients in Power Systems (High-Voltage Power Transmission), 2nd edition, PHI Learning.

<table>
<tr><td rowspan="3">Course: Distribution System Automation
(Code: EET057)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4th Year VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Understand and analyses the basic fundamentals and advance terminology for distribution system

CO2: Analyze and evaluate the function of automated distribution system

CO3: Understand and model the modern real time system for distribution system

CO4: Understand and analyze the communication media for automation of distribution systems.

Module 1: Analysis of Distribution Systems (DS)

Distribution substation; Major components of DS: High side and low side switching, voltage transformation, voltage regulation, Protection, Metering; Radial feeder; Definition of nature of loads; Individual customer load: Demand, Maximum demand, Average demand, Load factor; Distribution transformer loading; “K” factor for voltage drop and voltage rise; Load flow analysis of balanced and weakly mesh distribution systems.

Module 2: Distribution Automation Functions:

Concept of distribution automation; Definition of automated devices preparedness; Components in automation systems; Functional scope of distribution management systems (DMS) and energy management systems (EMS); Steady state performance of DMS/EMS; Dynamic performance of DMS/EMS; Distribution topology; Architecture of distribution automation and control.

Module 3: Real Time Control System:

Illustrations of SCADA (Supervisory control and data acquisition); Function of SCADA: Supervisory control, Data acquisition and processing, Sequence of events (SOEs) registry, Mis-operation revision, Tagging, Alarm processing, Historical information system; System architecture.

Synchrophasors: Definition, Application of PMUs (phasor measurement units); Line parameter calculations; State estimation; Transmission line thermal monitoring; Voltage instability.

Module 4: Commination Systems:

Data communication; Type of telecommunication media; Communication modulation indices; Asynchronous and synchronous communications; Communication network; Local area network and metropolitan area network; Interconnection standard and regulation; Distribution network protocols.

Recommended Book:

S. No	Name of Book	Author	Publisher & Edition
1	Electric Power Distribution, Automation, Protection, And Control	James A. Momoh	CRC Press, Tylor and Francis group.
2	Control And Automation Of Electrical Power Distribution Systems	James Northcote-Green and Robert Wilson	CRC Press, Tylor and Francis group
3.	Distribution System Analysis and Automation	Juan M Gers	IET Power And Energy Series 68
4	Distribution System Modeling and Analysis	William H. Kersting	CRC Press, Tylor and Francis group

<table>
<tr><td rowspan="3">Course: Industrial Process Instrumentation & Telemetry (Code: EET058)</td><td colspan="2" rowspan="3">Year & Semester:
B. Tech Electrical Engineering
4Th Year VIII Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

- **CO1:** Understand the meaning and scope of telemetry and remote control systems.
- **CO2:** Learn about the fundamentals, theory and applications of telemetry in real time systems.
- **CO3:** Understand the working principles and design of controllers for industrial process equipment's.
- **CO4:** Develop the comprehensive understanding and applicability of PLCs, distributed and supervisory controls.

Module 1:Introduction to Telemetry

Meaning and importance of telemetry, remote control and remote signaling/supervision, Messages and signals; signal formation, conversion and transmission.

Signal transmission and transmission media: Physical and radio links; communication lines and operational paths of undertakings used for communications; noise in transmission channels, reliability and efficiency of transmission.

Module 2: Telemetry and SCADA system

Telemetry error, dc, pulse and digital telemetry methods and systems: Multichannel telemetry schemes. Remote control and Remote signaling: Principal of independent messages and combinatorial principle; Multi-wire FDM and TDM schemes. Layout, functions and operation of SCADA system.

Module 3:Review of Concepts of system response and control

Response of first order systems involving forcing functions, non-interacting and interacting systems. Basic concepts and working principles of sensors and transducers for various measuring process variables. Controller Principles; process characteristics; control system parameters; Discontinuous, continuous and composite controller modes. Analog and digital controllers; General features and design considerations.

Module 4:Control Characteristics, Equipment and Final Control Elements

Control system configuration; Multivariable control system; Control system quality and stability; Process loop tuning. Details of controllers including measurement unit, comparator, actuator and final control elements; Pneumatic, hydraulic and electric actuators; Control valve characteristics; Pneumatic to electric and electric to pneumatic converters, hydraulic and pneumatic power supply system.

Module 5: PLCs, Distributed and Supervisory Controls

Relays controllers and ladder diagrams; Relay sequences; PLC operation and programming.

Distributed control; Hardware components of distributed control; Introduction and necessity of supervisory control; Master control station and remote terminal units

Recommended Book:

S. No	Name of Book	Author	Publisher& Edition
1	Handbook of Telemetry and Remote Control	Gruenberg E. L	McGraw-Hill International Book Company
2	Electronic Communication Systems: Fundamentals	Tomasi W	5th Ed., Pearson Education
3	Advanced Control System Technology	Chemsmond C. J	Viva Books
4	Process Control Analysis and Control	Coughanowr D. R	2nd Ed., McGraw-Hill International Book Company
5	Process Control Instrumentation Technology	Johnson C. D	8th Ed., Prentice Hall of India

POWER SYSTEM RELIABILITY

Course Code: EET059 **L T P C**

3 0 0 3

Co. No:	Course Outcomes	PO/PSO	BTL
CO 1	Understand the system reliability concepts	a, f, g	2
CO 2	Apply the frequency and duration techniques for component repairable system.	a, f, g	3
CO 3	Apply the network reliability concepts to generation system reliability analysis.	a, f, g	3
CO 4	Apply the network reliability concepts to transmission and distribution system reliability analysis.	a, f, g	3

Module-I

Network Modelling and Reliability Analysis: Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique - Bath tub curve - reliability measures MTTF, MTTR, MTBF.

Module-II

Frequency & Duration Techniques: Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one , two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering of merged states.

Module-III

Generation System Reliability Analysis: Reliability model of a generation system– recursive relation for unit addition and removal – load modeling - Merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE. Transmission System Reliability Analysis**:** System and load point reliability indices – Weather effects on transmission lines – Weighted average rate and Markov model.:

Module IV

Distribution System Reliability Analysis: Basic Techniques – Radial networks – Evaluation of Basic reliability indices, performance indices - Load point and system reliability indices – Customer oriented, loss and energy oriented indices – Examples. Parallel Configuration: Basic techniques – Inclusion of bus bar failures, scheduled maintenance – Temporary and transient failures – Weather effects –Evaluation of various indices – Examples.

Text Books:

1. R. Billinton, R.N.Allan, “Reliability Evaluation of Power systems” second edition, Springer.
2. Charles E. Ebeling, “An Introduction to Reliability and Maintainability Engineering”, TATA Mc Graw - Hill – Edition.

Reference Books:

1. R. Billinton, R.N.Allan, “Reliability Evaluation of Engineering System”, Plenum Press, New York.
2. Eodrenyi, J., “Reliability modelling in Electric Power System”, John Wiley, 1980

Course Code: EET060	**Course Title:** Utilization & Traction		**Course Credit:**3		
Semester: 8th	**Session:** Spring		**Contact Hours**		
Mid Term Exam	**Internal Assessment**	**End Term Exam**	**L**	**T**	**P**
30 (Marks)	10 (Marks)	60 (Marks)	3	0	0

Course Objective: To understand the basic principle and types of lighting schemes, electric heating, electric welding, electric drives and electric traction system.

Course Outcomes (COs): Upon successful completion of the course, student should be able to:

CO1: Select a proper lighting system and implement it in real life applications.

CO2: Recognize different process of utilizing electric energy for heating and welding purposes in commercial and domestic applications.

CO3: Apply the knowledge of drives and use them effectively.

CO4: Choose proper traction systems depending upon application.

CO5: Differentiate between conventional and alternate energy vehicles.

UNIT-I Illumination:

Introduction, terms used in photometry and their units, laws of illumination, various types of lighting scheme, illumination at a point due to one and several points sources, street lighting, flood lighting, various types of lamps: incandescent, fluorescent, vapour, CFL and LED.

UNIT-II Electric Heating & Welding:

Electric heating: Advantages of electric heating, direct and indirect resistance heating, properties and design of heating element, electric oven, induction heating, dielectric heating, high frequency eddy current heating.

Electric welding: Arc welding: metal arc welding and carbon arc welding, welding equipments, welding machine.

UNIT-III Electric Drives:

Definition, advantages of electric drives, components of electric drives, four quadrant operation of Lift, electric braking, characteristic of different types of mechanical load, steady state stability of motor load system.

UNIT-IV Electric Traction:

Advantages and disadvantages of electric traction, types of railway electrification, overhead equipment, speed-time curve, tractive effort, accelerating force, specific energy consumption, specific energy output, types of railway services: urban, sub-urban, and main lines with their speed-time curves.

UNIT-V Electric & Hybrid Electric Vehicles:

Conventional vehicle and its components, concept of electric vehicle and its components, concept of hybrid electric vehicles (HEVs) and its components, architectures of HEVs: series HEVs, parallel HEVs and complex HEVs.

Text Books:

5. H. Partap, Art and Science of Utilization of Electrical Energy, Dhanpat Rai & Sons.
6. J. B. Gupta, Utilization of Electric Power & Electric Traction, S. K. Kataria & Sons.
7. G. K. Dubey, Fundamentals of Electric Drives, Narosa Publications, New Delhi.
8. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals" CRC Press.

Reference Books:

6. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design" CRC Press.

Course Code: EET061	**Course Title:** Advanced Control of Power Systems		**Course Credit:**3
Semester: 8^{th}	**Session:** Spring		**Contact Hours**
Mid Term Exam	**Internal Assessment**	**End Term Exam**	**L** **T** **P**
30 (Marks)	10 (Marks)	60 (Marks)	3 0 0

Module 1:

Automatic Generation Control (AGC): Modes of control viz. Flat frequency – Tie-line control and Tie-line Bias control; Static and Dynamic response of controlled two-area system.

Module 2:

Automatic Voltage Regulator (AVR): Types of alternator exciters, AVR for generator excitation control, static and dynamic performance of AVR loop

Module 3:

Energy Storage Devices and their applications to power system control.

Module 4:

Application of Advanced Control Techniques: Optimal, Adaptive, Intelligent (fuzzy & neural) and predictive control techniques

Text books:

1. Olle I Elgard, "Electric Energy systems Theory - An Introduction" Tata McGraw Hill, 2^{nd} Edition.
2. Roland Burns ,"Advanced Control Engineering" Butterworth-Heinemann,2001
3. Gopal, "Digital control and state variable methods : conventional and intelligent control systems", 2012

References

1. Prabha Kundur, "Power System Stability and Control", McGraw Hill, 2006.
2. Allen J.Wood and Wollenberg B.F, "Power Generation Operation and control", John Wiley & Sons, 2^{nd} Edition, 1996.

Electronics & Communication Engg.

5th Semester

Course Code	Title	L T P	C	Faculty
ECT 301	Microprocessor	3 1 0	4	
ECT 302	VLSI Design	3 1 0	4	
ECT 303	Digital Communication	2 1 0	3	
ECT 304	Applied EMF & Waves	3 1 0	4	
ECT 305	Information Theory & coding	2 1 0	3	
MAT 3xx	Mathematics V	3 1 0	4	
ECL 306	Microprocessor Lab	0 0 2	1	
ECL 307	VLSI Design Lab	0 0 2	1	
ECL 308	Digital Communication Lab	0 0 2	1	
Total		**28**	**25**	

6th semester

Course Code	Title	L T P	C	Faculty
ECT 350	Antenna and Wave Propagation	2 1 0	3	
ECT 351	Electronic Devices	3 1 0	4	
ECT 352	Computer Organization & Architecture	3 1 0	4	
ECT 353	Data Comm. & Networking	3 1 0	4	
ECT 354	Power Electronics	3 1 0	4	
ECT XXX	Elective-I	2 1 0	3	
ECL 355	Electronic DA Tools I (Lab)	0 0 2	1	
ECI 356	Industrial Training		1	
EEL 3xx	Power Electronics Lab	0 0 2	1	
Total		**28**	**25**	

Rather 28/01/2021

7th Semester

Course Code	Title	L T P	C
ECT 401	Embedded Systems	3 1 0	3
ECT 402	Digital Signal Processing	2 1 0	3
ECT 403	Wireless Communication	2 1 0	3
ECT 404	Electronic Measurement & Instrumentation	3 1 0	4
ECT 405	Microwave Engineering	2 1 0	3
ECT 406	Project Pre work & Seminar	0 0 4	3
ECT 4xx	Elective II (Swayam Course)	2 1 0	3
ECL 407	Embedded & Signal Processing Lab	0 0 2	1
ECL 408	EDA Tools II	0 0 2	1

ECL 409	Microwave Engineering Lab	0 0 2	1
Total		**30**	**25**

8^{h} Semester

Course Code	Title	L T P	C	Faculty
ECT 450	Project Major	0 0 16	8	
ECT 451	Optical Fiber Comm.	2 1 0	3	
ECT 452	Computer &Network Security	2 1 0	3	
ECT 4XX	Elective-III	2 1 0	3	
HSL 4xx	Industrial Organization & Management	3 1 0	4	
ECT 4XX	Elective-IV (Swayam Course)	2 1 0	3	
ECT 453	Optical Fiber Comm. Lab.	0 0 2	1	
Total		**34**	**25**	

Rather 28/01/2021

Elective I (3rd Year 6th semester level)

Course Code	Title	L T P	C	Faculty
(ECT 356)	Multimedia Information System	2 1 0	3	
(ECT 357)	Advanced Microprocessor	2 1 0	3	
(ECT 358)	VLSI Technology	2 1 0	3	
(ECT 359)	Network Synthesis	2 1 0	3	
(CST 310)	Python Programming*	2 1 0	3	
(MAT 603)	Numerical Analysis & Techniques#	2 1 0	3	
(ECT 360)	Online Course	2 1 0	3	

Elective II (4thYear 7th semester level)

Course Code	Title	L T P	C	Faculty
(ECT 410)	Radar Systems	2 1 0	3	
(ECT 411)	System Design	2 1 0	3	
(ECT 412)	Analog CMOS Design	2 1 0	3	
EET 3xx)	Advanced Power Electronics	2 1 0	3	

(CST 306)	Design & Analysis of Algorithms*	2 1 0	3
(MAT xxx)	Neural Networks and Fuzzy logic#	2 1 0	3
(ECT 413)	Online Course	2 1 0	3

Elective III (4thYear 8th semester level)

Course Code	Title	L T P	C	Faculty
(ECT 454)	Millimeter wave communications	2 1 0	3	
(ECT 455)	Biomedical & Image Processing	2 1 0	3	
(ECT 456)	Molecular Electronics	2 1 0	3	
(EET 3xx)	Power System@	2 1 0	3	
(CST 352)	Artificial Intelligence & Machine Learning*	2 1 0	3	
(MAT 802)	Optimization Techniques#	2 1 0	3	
(ECT 457)	Online Course	2 1 0	3	

28/01/2021

Elective IV (4thYear 8th semester level)

Course Code	Title	L T P	C	Faculty
(ECT 458)	TV Engineering	2 1 0	3	
(ECT 460)	Telemedicine	2 1 0	3	
(ECT 461)	RF Design	2 1 0	3	
(ECT 462)	Smart Grid Communications	2 1 0	3	
(CST 354)	Computer Networks*	2 1 0	3	
(MAT 801)	Discrete Mathematics#	2 1 0	3	
(ECT 463)	Online Course	2 1 0	3	

28/01/2021

Note: For subjects under Elective head the missing course number have to be provided by the respective departments.

5th Semester B Tech ECE Syllabus

<table>
<tr><td rowspan="3">Subject: Microprocessors (Code:ECT301)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>-</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: To study the basics of microprocessors, programming the microprocessor for different control operations and interfacing it with peripherals. To understand the fundamentals of microcontrollers and using it in the areas of process control, robotics etc.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: To introduce 8085 architecture and programming in assembly language.

CO2: To introduce basic concepts of interfacing memory and peripheral devices to a microprocessor.

CO3: To design real life applications of process control through microprocessors.

CO4: To introduce advanced versions of Microprocessors and peripheral chips like 8255

Details of the syllabus:

S.No.	Particulars
1.	**Microcomputer Structure and Operations:** Basic Microcomputer Elements, Typical Microcomputer Structure, CPU, Memory System, Input Output.
2.	**Microprocessors and Memory:** Typical 8, 16 and 32 bit Microprocessors, 8085 Microprocessor Specification, Memory Technologies.
3.	**Assembly Language Programming I:** Programming Model of 8085, Registers, Fetch, Execute, Operation of CPU, Instruction Set.
4.	**Assembly Language Programming II:** Addressing Modes, Basic Operations, Microprocessor Arithmetic, Program Flow Control Using Looping and Branching.
5.	**Assembly Language Programming III:** Stack, Subroutines, Interrupts, Resets.
6.	**Bus System I:** System Bus Structure, Bus Operations, Cycle by Cycle Operations, Timing and Control, Priority Management, Address Decoding.
7.	**Microprocessors Interfacing I:** Interfacing concepts, Parallel Input Output, Memory Interfacing, Direct Memory Access.
8.	**Microprocessors Interfacing II:** The Serial Subsystems.
9.	**Microprocessor Interfacing III:** Programmable, Peripheral Interface, Analog Converter Subsystem.
10.	**Introduction to INTEL 8086:** Basic features.
11.	**Micro controller:** 8051, 68HC11.
12.	**Application Examples:** Process Control, Robotics, CAI, Medical physics.
13.	**Latest Developments in Microprocessor Technology.**

Recommended Books:

S. No	Name of Book	Author
1.	Microprocessor Architecture, programming and application	Ramesh Goankar
2	Microprocessor and Applications	Leventhal
3.	Microprocessors	Mathur

Subject: VLSI Design		**Total Course Credit: 4**

(Code:ECT302)	**Year & Semester:** B. Tech Electronics & Communication Engineering 3rd Year & 5th Semester		L	T	P
			3	1	-
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: To understand mosfet mechanism as a building block of digital circuits, technology to manufacture them and operation of various logic families.

Course Outcomes: Upon course completion ,the students should familiarize with the following:

CO1: Understand the physics of MOSFET and its operation as a switch and inverter.
CO2: Acquire knowledge about the fabrication processes for MOS devices.
CO3: Design of universal logic gates, compound gates, multiplexers, RAM cell based on CMOS technology and transmission gates.
CO4: Understanding of CMOS logic structures, switching characteristics, transistor sizing and layout.

Details of the syllabus:

S.No.	Particulars
1.	**Review of MOSFET**: Constructional & Operational features of MOSFET, I-V Equation, 2ND Order Effects, MOS Capacitor, C-V Characteristics, MOSFET Switch, Transmission gate, CMOS Inverter (Pull-up & Pull-down), Inverter Static Characteristics, ßn/ ßp Ratio, ?n/ ?p Rtaio, Noise Margin, Switching characteristics of Inverter (Fall Time, Rise Time, Delay Time), Dynamic Characteristics, Power Dissipation
2.	**VLSI Technology:** Wafer Processing, Oxidation, Epitaxy, Deposition, Ion-Implantation & Diffusion, The Silicon gate Process, n-well CMOS Process, p-well Process, Twin-Tub Process, Silicon On Insulator.
3.	**CMOS Logic Design (Gates):** CMOS Logic Gate Design (NAND & NOR Logic), Switching Characteristics (Delay Time, Power, Fan-in, Fan-out), Transistor Sizing, The Compound Gates.
4.	**CMOS Logic Structures:** CMOS Logic, Pseudo-nMOS Logic, Dynamic CMOS Logic, C2MOS Logic, BiCMOS Logic, NP Domino Logic.
5.	**Layout**: Design Rules/Floor planning, Simple Layout Examples**.**
6.	**CMOS Logic Design (Circuits):** Multiplexers, MUX Implementation in CMOS & Transmission Gate , RAM Cell Implementation, Implementation of Flip-Flop, Register/Counter

Recommended Books:

S.No	Name of Book	Author
1	CMOS VLSI Design: A Systems Perspective	N. Weste & K.Eshraghian
2	CMOS VLSI Design: A Circuits & Systems Perspective	N. Weste, D. Harris & A. Bannerjee
3	Digital Integrated Circuits: A Design Perspective	Rabaey

<table>
<tr><td rowspan="3">Subject: Digital communication (Code:ECT303)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: The objective of this course is to provide the student the understanding of fundamental concepts of digital communication starting from sampling theorem to the digital modulation techniques like BPSK, QPSK, M-PSK, M-QAM. In this course the student is supposed to understand the design of digital modulator and demodulator and also to analyze the performance in the presence of noise. Lectures should be supplemented with the hands on sessions of simulation using modern simulation tools like MATLAB/Octave/Scilab. The student should also get the exposure of recent trends in the field of digital communication like understanding of next generation systems like 5G/6G, LTE, WiFi etc.

Course Outcomes: Upon completion of the course, student should be able to:

CO1: To understand how analog signal are converted to digital ones via sampling, quantization and various pulse coded modulation techniques

CO2: To be able to represent signals as vectors in vector space and understand various digital modulation schemes, their modulator and demodulators.

CO3: To analyze and simulate error performance of various digital modulation schemes in the presence of noise

CO4: To get exposure of recent trends in the field of Digital Communication.

Details of the syllabus:

S.No.	Particulars
1.	**Analog to Digital Conversion**: Sampling Theorem, Anti-Aliasing Filters, Pulse Amplitude Modulation (PAM), Quantization, Non-Uniform Quantization, Pulse Coded Modulation (PCM), Delta Modulation, Delta-Sigma Modulation, Differential Pulse Code Modulation**.**
2.	**Digital Modulation Techniques:** Binary Phase Shift Keying (BPSK), Phase Shift Keying (PSK), Frequency Shift Keying (FSK), M-ary Digital Modulation Scheme, M-Quadrature Amplitude Modulation (M-QAM), Signal Space diagram of various modulation schemes
3.	**Noise in Digital Communication Systems:** Bit Error Rate (BER), Q-Function, Optimum Detection of BPSK, QPSK, M-PSK, M-QAM, FSK in presence of Additive White Gaussian Noise (AWGN), Simulation of BER of various digital modulation schemes**.**
4.	**Recent Trends in Digital Communication:** Digital Modulation used in IoTs, Receiver design of modern digital communication system, Other recent trends in digital communication.

Recommended Books:

S. No	Name of Book	Author
1.	An Introduction To Analog And Digital Communications. India, Wiley India Pvt. Limited, 2009.	Haykin, Simon
2.	Modern Digital and Analog Communication Systems. United States: Oxford University Press.	Lathi, B. P., Ding, Z. (2010

References:

S. No	Name of Book	Author
1.	Digital Communication Systems. United Kingdom, Wiley, 2014.	Haykin, Simon
2.	Digital Communications. United States, McGraw-Hill, 2008.	Proakis, John G.& Salehi Masoud
3.	Selected papers from relevant IEEE Journals and other reputed journals/conference papers related to Information Digital Communication.	

<table>
<tr><td rowspan="3">Subject: Applied Electromagnetic Fields and Waves
(Code: ECT304)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credits: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid Term</td><td>Class Assessment</td><td colspan="3">End Term</td></tr>
<tr><td>30</td><td>10</td><td colspan="3">60</td></tr>
</table>

Objectives: To understand EMF in theory and practice, laws governing propagation of EMF in dielectric, transmission lines, standing wave ratios and impedance issues.

Course Outcomes:

CO1	To understand the interaction between electric and magnetic fields
CO2	To understand the basic theory behind Maxwell's equations and electromagnetic waves
CO3	To learn the Propagation behavior of Electromagnetic waves in lossless and lossy media
CO4	To study the behavior of electromagnetic waves at discontinuities of media

Details of the Syllabus:

S No	Particulars
1	**Review of coordinate systems and Vectors**: Cartesian, cylindrical and spherical coordinate systems, Vector operations; Vector calculus; gradient, divergence and curl of a vector function, gradient theorem, divergence theorem and Stokes theorem. Some important identities of vector calculus
2	**Static Electric Field:** Coulomb's law; Electric field and Electric field intensity due to point charge and summation of point charges; Electric scalar potential; Equi-potential surfaces and their properties; Relation between electric potential and electric field intensity; Electric dipole and Electric field due to a dipole; Electric flux and electric flux density; Electric flux over a closed surface: Gauss law, Poisson and Laplace equations Electric field due to linear, surface, spherical and cylindrical charge distributions. Induced charges; Dielectrics and permittivity; Electric field in a dielectric; boundary conditions; Parallel plate capacitor; Dielectric strength; Energy in a capacitor; Capacitance of Co-axial transmission line, two wire transmission line and Single wire transmission line
3	**Electric Charge in motion:** Electric current density; Ohm's Law in point form, Resistivity and conductivity of a medium; Conductor and Insulator; Divergence of J and continuity of current; Current and field at conductor-Insulator boundary;
4	**Magnetic effects of current:** Effect of current on magnet; Effect of magnet on current carrying conductor; Magnetic field due to a current carrying conductor; BiotSavart Law; Magnetic field due to a infinite linear conductor; Force between two linear parallel conductors; Ampere's law, Faradays' law of induction, self and mutual inductance, inductance of two wire transmission line, single wire and coaxial cable, displacement currents, Magnetic vector potential
5	**Maxwell equations and wave equations:** Maxwell's Equations general form, Maxwell equations for free space, Boundary conditions, Wave equation and its solution. Transverse Electromagnetic Waves, Poynting vector, intrinsic impedance of medium, Phase and group velocity, Plane waves in lossless and lossy media.
6	Polarization, reflection and refraction of waves: Polarization of electromagnetic waves and different cases, Normal and oblique incidence at plane conducting boundary, Normal and oblique incidence at plane dielectric boundary.

Recommended Books:

S. No	Name of Book	Author
1.	Electromagnetic Waves & radiating systems, PHI	Jordan E and Balman K
2.	Field and Wave Electromagnetics, Addison Wesley	David K Cheng
3.	Electromagnetics, Mc Graw Hill	Krauss
4.	Introduction to Electrodynamics, PHI	Griffiths

<table>
<tr><td rowspan="3">Subject: Information Theory & Coding (Code:ECT305)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit:3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>-</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: The objective of this course is to understand the notion of information and measures of information. The fundamental quantities of information measure are Entropy and mutual information. The student should understand the notion of source coding for compression and be able to prove that entropy is the fundamental limit for compression. Also student should be able to understand to notion of channel coding for combating errors and prove that mutual information is the upper limit of maximum achievable rate under probability of error constraint. Also in this course the student is expected to learn about various practical source coding and channel coding techniques like Huffman Coding, Shannon-Fano Coding, Linear Block coding, Cyclic codes, Convolutional coding. The student will also be provided the exposure of recent trends in information and coding theory including: Coding for 5G/6G, Information theory and Machine Learning, Polar Coding, LDPC Coding. In this course the instructor is supposed to supplement lectures with demonstrations in MATLAB/Octave/Scilab packages.

Course outcomes	Upon successful completion of the course, the student should be able to :
CO1	To understand the source coding, various techniques for source coding and entropy as fundamental limit for compression.
CO2	To the channel coding, discrete memoryless channel, mutual information, random coding and notion of channel capacity.
CO3	To understand and demonstrate error control coding in particular Linear block codes, Cyclic Codes, Convolutional codes
CO4	To get exposure of recent trends in the field of information and coding theory.

Details of the syllabus:

S.No.	Particulars
1.	**Source Coding:** Entropy and its properties, Relative Entropy, Instantaneous codes, Construction of instantaneous codes, Kraft's inequality, Source coding theorem. Construction of basic source codes – Shannon Fano coding, Shannon Fano Elias coding, Huffman coding.
2.	**Channel Coding:** Mutual information and its properties, information rate, channel capacity, Shannon's Channel Coding Theorem, Discrete channels – Symmetric channels, Binary Symmetric Channel, Binary Erasure Channel, Differential Entropy, Capacity of AWGN Channel.
3.	**Error Control Codes:** Repetition Coding, Linear Block Codes, Cyclic Codes, Syndrome Decoding, Convolutional Codes, Viterbi Decoding.
4.	**Recent Trends in Information and Coding Theory:** Codes for 5G/6G: LDPC Codes, Polar Codes; Information theory for machine learning; Quantum Information and computing.

Recommended Books:

S. No	Name of Book	Author	Publisher & Edition
1.	Elements of Information Theory	Thomas, Joy A., and Cover, Thomas M.	Wiley, 2012.
2.	Digital Communication Systems	Haykin, Simon.	United Kingdom,Wiley

References:

S. No	Name	Author	Publisher & Edition
1.	Digital Communications	Proakis, John G., and Salehi, Masoud	United States, McGraw-Hill, 2008.
2.	Information theory: coding theorems for discrete memoryless systems.	Csiszar, Imre, and János Körner	Cambridge University Press, 2011
3.	Error control coding	Lin, Shu, and Daniel J. Costello	Pearson Education India, 2011.
4.	Selected papers from IEEE Transactions on Information Theory and other reputed journals/conference papers related to Information Theory and Coding		

<table>
<tr><td rowspan="3">Subject: Mathematics-V (Code:MAT3xx)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit:4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: To study complex variables, their functions and theorems, special functions and wavelet transform.

Course Outcomes: Upon successful completion of the course, student should be able to:

CO1: Determine Analytic functions their Harmonic conjugates and Laplace equation.
CO2: Differentiate and Integrate complex functions and develop the concepts of elementary functions in complex domain.
CO3: Expand complex valued functions in terms of Taylor, Laurant series and Classify singularities of a complex function and calculation of residues.
CO4: Learn and Apply Bessel and Legendre functions. Apply the concept of wavelet transform as a two parameter transform and use the methods for generating new wavelets.

Details of the syllabus:

S.No.	Particulars
1.	**Complex Variables:** Analytic functions, Cauchy Riemann equations, complex integration, Cauchy's fundamental theorem, Cauchy's integral theorem, Cauchy's inequality and Liouville's theorem on integral function, Taylor's and Laurent's expansions, Zeroes and poles of analytic functions, Residues and contour integration.
2.	**Special Functions:** Solution of series, Legendres functions, Rodriguess formula, generating functions for Legendres Polynomials and recurrence formulae. Bessel's functions, Recurrence formulae and Bessel's functions of integral order.
3.	**Wavelet Transform:** Continuous wavelet transform, Basic properties of wavelet transform, Discrete wavelet transform, Orthonormal wavelets, multi Resolution analysis, Construction of Orthonormal wavelets, Daubchies wavelets and algorithms. Band limited wavelets, Balian low theorem.

Recommended Books:

S. No	Name of Book	Author
1.	Complex Variables & Applications	R. V. Churchill
2.	Theory of Functions of Complex Variables	E. I. Copson

<table>
<tr><td rowspan="3">Subject: Microprocessors Lab.
(Code:ECL306)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd & 5th Year Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Internal Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective: To develop programs using 8085 instruction set, understanding of usage of microprocessor as an automatic controller. To develop programs for interaction between microprocessor and peripherals, understand usage of PPI-8255.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Assess and solve basic binary arithmetic operations using the microprocessor.

CO2: Apply knowledge and demonstrate programming proficiency using various addressing modes and data transfer instructions of the target microprocessor.

CO3: Demonstrate use of conditional branch and loop instructions.

CO4: Demonstrate use of logical instructions and use of call instructions for implementing stacks and subroutines in a program.

List of Experiments:

S. No.	Name of the experiment
1.	i) To develop a program to add two double byte numbers. ii)To develop a subroutine to add two floating point quantities.
2.	i)To develop program to multiply two single byte unsigned numbers, giving a 16 bit product . ii) To develop subroutine which will multiply two positive floating point numbers.
3.	To write program to evaluate P* Q+R*S where P,Q,R & S are 8 bit binary numbers.
4.	To write a program to divide a 4 byte number by another 4 byte number.
5.	To write a program to divide an 8 bit number by another 8 bit number upto a fractional quotient of 16 bit.
6.	Write a program for adding first N natural numbers and store the results in memory location X.
7.	Write a program which decrements a hex number stored in register C. The Program should half when the program register reads zero.
8.	Write a program to introduce a time delay of 100 ms using this program as a subroutine display numbers from 01H to OAH with the above calculated time delay between every twonumbers.
9.	N hex numbers are stored at consecutive memory locations starting from X. Find the largest number and store it at location Y.
10.	Interface a display circuit with the microprocessor either directly with the bus or by using I/O ports. Write a program by which the data stored in a RAM table is displayed.
11.	To design and interface a circuit to read data from an A/D converter, using the 8255 A in the memory mapped I/O.

12. To design and interface a circuit to convert digital data into analog signal using the 8255 A in the memory mapped I/O.

13. To interface a keyboard with the microprocessor using 8279 chip and transfer the output to the printer.

14. To design a circuit to interface a memory chip with microprocessor with given memory map.

<table>
<tr><td rowspan="3">Subject: VLSI Design Lab. (Code:ECL307)</td><td rowspan="3">Year & Semester:
B. Tech Electrical Engineering
3rd & 5th Year Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Internal Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective: To familiarize the students with the practical aspects of MOS device such as its working, characteristics, application, layout using tool based software.

Course Outcomes:

Upon completion of the course, student should be able to:

CO1: To understand the MOS model parameters using simulation and analysis of the MOS characteristics.
CO2: To understand CMOS based inverter using a tool and analysis of the related parameters.
CO3: To get familiarized with the operation of ring oscillators and the multiplexers .
CO4: To be able to implement the layout of CMOS based inverter and CMOS based gates for detailed analysis of their performances.

List of Experiments:

S. No.	**Name of the experiment**
1.	Familiarization with MOS model parameters in a circuit simulation software
2.	To Plot the transfer characteristics and output characteristics of a MOSFET
3.	Simulation of CMOS Inverter with different loads.
4.	Simulation of CMOS Inverter for different parameters K_n, K_p as a design variable .
5.	Study of the switching characteristics of CMOS Inverter and find out noise margins.
6.	To design and plot the output characteristics of a 3-inverter ring oscillator.
7.	Study of the switching characteristics of 2-input CMOS NAND/NOR gate.
8.	Layout design of a CMOS Inverter using a layout design tool.
9.	Layout design of a 2-input CMOS NAND/NOR gate using a layout design tool and their comparison.
10.	To design and plot the characteristics of a 4x1 digital multiplexer using pass transistor logic.

<table>
<tr><td rowspan="3">Subject: Digital Communication Lab.
(Code:ECL308)</td><td rowspan="3">Year & Semester: B. Tech Electrical Engineering
3rd & 5th Year Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Internal Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Objective:
To familiarize the students with the fundamental concepts on TDM, Pulse modulations, digital modulation techniques, source coding techniques and Error-control coding techniques.

Course Outcomes:
Upon completion of the course, student should be able to:

CO1: To understand how analog signal are converted to digital ones via sampling, quantization and various pulse coded modulation techniques.
CO2: To be able to represent signals as vectors in vector space and understand various digital modulation schemes, their modulator and demodulators.
CO3: To analyze and simulate error performance of various digital modulation schemes in the presence of noise.
CO4: To get exposure of recent trends in the field of Digital Communication

List of Experiments:

S. No.	Name of the experiment
1.	To study the sampling theorem and to plot waveforms for different sampling rates.
2.	To analyze a Pulse amplitude modulation (PAM), Pulse width modulation (PWM) and Pulse position modulation (PPM) modulation system and interpret the modulated and demodulated waveforms.
3.	To analyze a PCM system and interpret the modulated and demodulated waveforms.
4.	To analyze a Delta modulation system and interpret the modulated and demodulated waveforms.
5.	To analyze Amplitude Shift Keying (ASK) modulation system and interpret the modulated and demodulated waveforms.
6.	To analyze a Frequency Shift Keying (FSK) modulation system and interpret the modulated and demodulated waveforms.
7.	To analyze a Binary Phase Shift Keying (BPSK) modulation system and interpret the modulated and demodulated waveforms
8.	To demonstrate Time Division Multiplexing and de-multiplexing process.

6th Semester B Tech ECE,
Syllabus

<table>
<tr><td rowspan="3">Subject: Antenna and Wave Propagation (Code: ECT350)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credits: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid Term</td><td>Class Assessment</td><td colspan="3">End Term</td></tr>
<tr><td>30</td><td>10</td><td colspan="3">60</td></tr>
</table>

Objectives: To understand Propagation of waves in guided and unguided media and Basic theory behind the Antenna theory.

Course Outcomes:
CO1: To understand Propagation of Waves through Transmission lines
CO2: To understand the Propagation of waves through unguided media particularly the free space and atmosphere.
CO3: To understand the antenna basics and theory behind EM radiations
CO4: To have an understanding of different types of antennas and their operations.

Details of the Syllabus:

S No	Particulars
1	Transmission Lines: Transmission Line equations and solutions, Characteristic impedance and propagation constant, Reflection and transmission coefficients, SWR, Open and short circuit lines-their use as circuit elements at UHF, Line impedance and admittance , Smith Chart, Impedance Matching
2	Waveguides and Cavity Resonators: Transverse Electric and Transverse magnetic Waves, Wave propagation through rectangular and circular waveguides, Power transmission and attenuation in waveguides, Electromagnetic Resonators, Rectangular & Circular cavities
3	Strip Lines: Propagation Constant, Characteristic impedance and attenuation characteristics of strip lines and microstrips.
4	Propagation of Waves: Waves in free space, Attenuation, Absorption and polarization, effects of environment, Ground wave propagation, sky wave propagation, space wave propagation, Tropo-spherical propagation and Extra-terrestrial propagation
5	Radiation: Retarded Potential and Electromagnetic field, Radiation from a short current element, Half wave dipole, Radiation Resistance, Effect of ground on radiating elements
6	Antennas: Basic Antenna parameters, Radiation pattern, Directivity and Antenna Gain, Bandwidth and beam-width, Polarization, Folded dipole and applications. Antenna arrays, Parabolic reflector, Properties and feed mechanism, Horn Antenna, Loop Antenna.

1	Electromagnetic Waves and radiating Systems PHI	Jordan and Balman
2	Antennas and Wave Propagation	Krauss

Subject: Electronic Devices (Code: ECT351)	**Year & Semester:** B. Tech Electronics and Communication Engineering 3rd Year & 6th Semester		**Total Course Credits: 4**		
			L	**T**	**P**
			3	**1**	**0**
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: To understand free electron theory, band theory of electronic conduction, semiconductor physics and optical devices.

Course Outcomes:

- **CO1** Understanding of free electron theory and band theory of electronic conduction.
- **CO2** Understanding of semiconductor physics, mechanism of charge carrier generation, transport and recombination phenomenon
- **CO3** Acquire knowledge of construction, basics of operation and performance analysis of the devices like pn-junction diodes, BJT, MOSFETs.
- **CO4** Understanding of the physics of optical devices and mechanisms like stimulated emission, photo-detection, photo-conduction.

Details of the Syllabus:

S. No.	**Particulars**
1.	**Overview of Free Electron Theory**
2.	**Band Theory of Electronic Conduction:** Kroning Penny model, block wave Brillion zones, effective mass, density of states & energy discontinuity, electron and hole conduction.
3.	**Semiconductor Physics:** Fermi Dirac distribution functions, Fermi energy and contact potential, electronic conductivity and means free time. Intrinsic and Extrinsic semiconductors, free carrier concentration and Fermi level, donor and acceptor states, derivation of fermi level, carrier concentration and mobility, scattering mechanisms, semiconductor materials and their energy band structures.
4.	**Transport and Recombination Phenomenon.**
5.	**Physics of:** Metal semiconductor contact, p-n junction diodes, bipolar junction transistor, thyristor, junction field effect transistor, metal insulator semiconductor structure, MOSFET.
6.	**Optical Devices:** Junction, luminescence and energy band gap, spontaneous emission and carrier life time for band to band transition, stimulated emission, p-n junction laser, photo-detective and photo conductive devices.

Recommended Books:

1.	Electronic Processes & Materials	Azaroff & Brophy
2.	Fundamentals of Solid-State Devices & Circuits	Barlev
3.	Solid State Electronic Devices	Ben G. Streetman
4.	Fundamentals of Semiconductor Theory	S. Wang

Subject: Computer Organization and Architecture (Code: ECT352)	**Year & Semester:** B. Tech Electronics and Communication Engineering 3rd Year & 6th Semester		**Total Course Credits: 4**		
			L	**T**	**P**
			3	**1**	**0**
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: To study the basic structure and organization of computer and its modules, instruction execution, peripheral devices, memories and organization.

Course Outcomes:

CO1 To Discuss the basic concepts and structure of computers.
CO2 To Explain different types of Addressing Modes.
CO3 To Understand the theory and architecture of Central Processing Unit.
CO4 To understand the organization of Memory and Input/output units. Introduce the concepts of Pipelining and parallel processing.

Details of the Syllabus:

S. No.	**Particulars**
1.	Introduction to computer architecture and organization: Basic structure of computers, Operational concepts, performance.
2.	Computer Organization and instruction cycle control: Machine Instructions & Programs, Memory location & Addresses, Instruction & Instruction Sequencing, addressing modes, Stacks & Queues, Subroutines, Additional Instructions and Encoding of Machine Instructions.
3.	CPU organization: Fundamental concepts, Execution of a complete Instruction, Multiple Bus organization, Hardwired control, Microprogrammed control.
4.	I/O devices and Organization: Accessing I/O devices, Interrupts, DMA, Buses, Interface Circuits, Standard I/O Interfaces & Computer peripherals.
5.	Types of memories and memory organization: Basic Concepts, Semiconductor RAM Memories, ROM's Cache Memories, performance Considerations, Virtual Memories, Secondary Storage.
6.	Arithmetic addition & Subtraction of Signed numbers, Design of fast adders, Multiplication of Positive numbers, Signed-Operand Multiplication, Fast Multiplication, Integer Division, Floating Point Numbers & Operations.
7.	Introduction to Pipelining & Embedded Systems.

Recommended Books:

1.	Computer Organization & Architecture	M. Mano
2.	Computer organization	Hamachar

<table>
<tr><td rowspan="3">Subject: Data Comm. & Networking
(Code: ECT353)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering 3rd Year & 6th Semester</td><td colspan="3">Total Course Credits: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: To study the techniques of data communication, encoding and protocols, error detection, correction, multiplexing and understand network topologies, routing and switching techniques of data transmission.

Course Outcomes:

CO1 Understand fundamental principles of computer communication in data networks and the Internet.

CO2 Understand network topologies, multiplexing and various error detection and correction techniques.

CO3 Understand data encoding and recognize the different internetworking devices and their functions.

CO4 Understand the principles and the role of protocols in networking.

Details of the Syllabus:

S.No.	**Particulars**
1.	Data Transmission, data encoding, digital data communication technique
2.	Error detecting and error correcting technique, nature of transmission errors, error detecting codes, error correcting codes, retransmission techniques.
3.	Multiplexing and de-multiplexing techniques viz.., TDM, FDM.
4.	Synchronous and asynchronous communications, carriers, bit and frame synchronization.
5.	OSI reference model.
6.	Introduction to transmission media and network topologies, MAN, LAN, WAN.
7.	Circuit switching, message switching and packet switching, relative advantages and disadvantages.
8.	Routing techniques, flooding static routing, centralized routing, distributed routing**.**
9.	Multiple access scheme viz., TDMA, FDMA, ALOHA, CSMA techniques.
10.	Integrated services, digital network, broadband ISDN.
11.	Link level protocols.

Recommended Books

1.	Data Communications and Computer Networking	W. Stallings
2.	Data Communications and Computer Networking	Behrouz Forouzan

Subject: Power Electronics (Code: EET3_----)	**Year & Semester:** B. Tech Electronics and Communication Engineering 3rd Year & 6th Semester		**Total Course Credits: 4**		
			L	**T**	**P**
			3	**1**	**0**
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Objectives: To understand the fundamentals of power devices like diodes, transistors, Thyristors, phase control circuits, converters etc.

Course Outcomes:

- **CO1** Explain the need for Power Electronics Devices and Circuits and their basic operation.
- **CO2** Analysis of driving and control and triggering circuits for Power Electronic converter.
- **CO3** Analysis of AC to DC converters (Single phase and three phases, controlled and uncontrolled), A.C Voltage controllers, DC to DC converters (choppers), and single-phase D.C to A.C converters (Inverters) in square wave mode.
- **CO4** Fourier analysis and knowledge of Power Quality issues associated with power electronic circuits.

Details of Syllabus

S.No.	Particulars
1.	**An Introduction to Thyristor Engineering.**
2.	**Power Electronic Devices:** Heavy current and high voltage solid state devices, power diodes, power transistors, SCR's. Triacs Diacs and other Thyristors, Basic theory of operation and characteristics of SCR, Ratings, protection, series and parallel operation of SCRs. Driving circuits, GIO"s, IGBT,MOSFET.
3.	**Firing Circuits**: Line commutation of SCRs and forced commutation techniques.
4.	**Line Commutated Converters:** 2 pulse, 3 pulse, 6 pulse and higher pulse configurations.
5.	**AC Phase Control:** Integral cycle control**.**
6.	**Choppers:** Principle and basic chopper circuits.
7.	**Inverters:** Series parallel and bridge inverters and voltage control.
8.	**Application of Thyristor Technology to Electric Drives.**
9.	**Design of transformers, pulse transformer and design of inductors.**

Recommended Books

1.	Power Electronics	Rashid
2.	Power Electronics	Ned Mohan

Subject: Electronic Design & Automation Tools (Code: ECL354)	**Year & Semester:** B. Tech Electronics and Communication Engineering 3rd Year & 6th Semester	**Total Course Credit: 1**		
		L	**T**	**P**
		0	**0**	**2**
Evaluation Policy	**Mid-Term/ Class Assessment**	**End-Term**		
	40 Marks	60 Marks		

Objectives: To study the design of various electronic circuits and systems using automatic simulation tools.

Course Outcomes:

CO1: To develop the working knowledge of Vivado tool and any other electronic simulator available.
CO2: To develop the VHDL code for implementing the digital circuits.
CO3: To implement combinational or sequential circuits.
CO4: To test the hardware (FPGA Boards) using the implemented code.

Details of Syllabus

S.No.	**Particulars**
1.	SPICE
2.	MATLAB
3.	ANSYS
4.	Any other electronic simulator available

<table>
<tr><td rowspan="3">Subject: Industrial Training
(Code: ECI355)</td><td rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering 3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term/ Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td></td><td colspan="3"></td></tr>
</table>

Objectives: Students are required to be a part of industrial organization and understand the implementation of technology there. The practical knowledge gained is to be presented in form of detailed report of work experience. The course will be evaluated on basis of viva and report.

Course Outcomes:

CO1 Acquaint themselves with the essential practical tasks emphasized in their Professional study.

CO2 Ability to identify, formulate & model problems & find engineering solutions based On a systems approach.

CO3 Learn professional ethics & economic aspects of industry.

CO4 Learn industrial settings, gaining hands-on experience in designing & manufacturing.

<table>
<tr><td rowspan="2">Subject: Power Electronics Lab (Code: EEL 3x x)</td><td rowspan="2">Year & Semester: B. Tech Electronics and Communication Engineering 3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L
0</td><td>T
0</td><td>P
2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term/ Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>40 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives:

Course Outcomes:

CO1
CO2
CO3
CO4

Details of Syllabus

S.No.	Particulars
1.	To obtain V-I Characteristics of an SCR. To obtain V-I Characteristics of a Triac.
2.	To obtain the Static Emitter Characteristics of a UJT.
3.	To study the Line-synchronized UJT Relaxation Oscillator as a triggering agent for a thyristor and plot load voltage Vs. firing angle.
4.	To study various firing schemes of an SCR and draw the traces for various waveforms: Resistance Triggering Technique, R-C Triggering Technique, Linear Firing Scheme, Inverse Cosine Firing Scheme.
5.	To study a Single-Phase Half-Wave Converter and plot Source voltage, Load voltage and load current for R and R-L loads.
6.	To study a Single-Phase Semi-Converter and plot Source voltage, Source current, Load voltage and load current for R, R-L and Motor Loads.
7.	To study a Single-Phase Full-Converter and plot Source voltage, Source current, Load voltage and load current for R, R-L and Motor Loads.
8.	To study a Three-Phase Semi-Converter and plot Source voltage, Source current, Load voltage and load current for R, R-L and Motor Loads.
9.	To study a Three-Phase Full-Converter and plot Source voltage, Source current, Load voltage and load current for R, R-L and Motor Loads.
10.	To study a Single-Phase Dual Converter on Motor Load.
11.	To study a DC-DC Buck Converter (Step Down Chopper) for R, R-L and DC Motor Load and plot Load voltage Vs. Duty Ratio.

12.	To study a Single-Phase Voltage Source Inverter on R and R-L Loads.
13.	To study a Three-Phase Voltage Source Inverter on R and R-L Loads.

Elective I

Subject: Multimedia Information Systems (Code: ECT- 356)	**Year & Semester:** B. Tech Electronics & Communication Engineering 3rd Year & 6th Semester		**Total Course Credit: 3**		
			L	**T**	**P**
			2	**1**	**0**
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: The course is aimed to give students exposure to various audio, image and video standards so that the students gain enough skills to understand and handle multimedia systems.
Course Outcomes (COs): Upon successful completion of the course, student should be able to:
CO1: understand various digital audio standards and their utility in the practical systems.
CO2: comprehend various image data formats & their practical applications.
CO3: handle video systems used in practice.
CO4: understand various data compression standards used in practice.
Details of the Syllabus:

S. No.	**Particulars**
1	Introduction: Multimedia systems: Components , Functional Requirements and Applications Multimedia Data Acquisition and formats
2	Digital Audio: Sound digitization, Representation- Time Domain & Transform Domain Representation, Coding for Digital Audio - Pulse code modulation , Differential Coding Techniques
3	Graphics & Image Data: Graphics/ Image Data Types , Image Data Formats Colour Models in Images -- RGB, CMY, CMYK
4	Fundamental of Video Processing: Types of Video Signals- Composite Video , S-video; Analog and Digital Video Standards
5	Multimedia Data Compression: Lossless Compression -- Run Length Coding, Variable Length Coding Lossy Compression -- Discrete Cosine Transform , Wavelet Transform

Recommended Books:

S. No.	**Name of Book**	**Author**	**Publisher**
1	Fundamentals of Multimedia	Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan	Pearson Education
2	Multimedia Systems and Design	Prabat K Andleigh and Kiran Thakrar	Pearson Education

<table>
<tr><td rowspan="3">Subject: Advanced Microprocessors (Code: ECT357)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credits: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid Term</td><td>Class Assessment</td><td colspan="3">End Term</td></tr>
<tr><td>30</td><td>10</td><td colspan="3">60</td></tr>
</table>

Objectives: To make students familiar about different types of Processor/Architectures and induce in them the sense of inquisitive thinking about design and implementation issues related to computer processors/architectures taking MIPS architecture as an example.

Course Outcomes:

CO1: Computer architectures, their significance and difference

CO2: Performance measures of processors and their evaluation

CO3: Design of data path for single cycle MIPS-32 implementation and introduction to multicycle implementation

CO4: Performance enhancement of the computer system using pipelining and memory management

Syllabus Details:

S.No	Particulars
1	Familiarization and importance of CISC and RISC processors, their design issues. Hardware and Software interaction in Computers
2	Performance of Computers. Understanding and evaluation of CPU performance. Factors used for enhancement of performance. Performance bench marks
3	Introduction to MIPS-32 and MIPS-64 processors and their instruction formats/addressing modes. Single Cycle Data Path implementation of MIPS-32 and introduction to multipath implementation.
4	Performance enhancement of MIPS-32 using pipelining. Pipeline Hazards and the resolution of Pipeline Hazards
5	Memory hierarchy and use of memory hierarchy for improvement of computer performance. Virtual memory importance and implementation in the computer system.

<table>
<tr><td rowspan="3">Subject: VLSI Technology
(Code: ECT358)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credits: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid Term</td><td>Class Assessment</td><td colspan="3">End Term</td></tr>
<tr><td>30</td><td>10</td><td colspan="3">60</td></tr>
</table>

Objectives: To introduce students with the basic concepts of VLSI and ULSI theory and technology. Profound understanding of the latest fabrication techniques, with emphasis on the ultra deep submicron technology and their issues and challenges

Course Outcomes:
CO1: Develop the concept of crystal growth and wafer preparation.
CO2: Develop the knowledge of various fabrication processes such as Epitaxy, Oxidation, Lithography and Etching.
CO3: Study the methodology of doping in detail and process of metallization.
CO4: Apply the concept of fabrication processes for process simulation, integration and understanding of different assembly and packing techniques.

Details of Syllabus:

S. No.	Particulars
1	**Crystal Growth, Wafer Preparation, Epitaxy and Oxidation** Electronic Grade Silicon, Czochralski crystal growing, Silicon Shaping, processing consideration, Vapor phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation, Growth Mechanism and kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxide properties, Redistribution of Dopants at interface, Oxidation of Poly Silicon, Oxidation induced Defects.
2	**Lithography and Relative Plasma Etching** Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, Feature Size control and Anisotropic Etch mechanism, Relative Plasma Etching techniques and Equipments
3	**Deposition, Diffusion, Ion Implantation and Metallization** Deposition process, Polysilicon, plasma assisted Deposition, Models of Diffusion in Solids, Flick's one dimensional Diffusion Equation – Atomic Diffusion Mechanism – Measurement techniques – Range theory- Implant equipment. Annealing Shallow junction – High energy implantation – Physical vapour deposition – Patterning.
4	**VLSI Process Integration and Process Simulation** Ion implantation – Diffusion and oxidation – Epitaxy – Lithography – Etching and Deposition- NMOS IC Technology – CMOS IC Technology – MOS Memory IC technology - Bipolar IC Technology – IC Fabrication. Introduction to process simulation
5	**Assembly Techniques and packaging of VLSI Devices** Analytical Beams – Beams Specimen interactions - Chemical methods – Package types – banking design consideration – VLSI assembly technology – Package fabrication technology.

Recommended Books:

1.	VLSI Technology McGraw Hill	Sze
2.	ULSI Technology McGraw Hill	Chang and Sze
3.	Silicon VLSI Technology: Fundamentals, Practice, and Modeling Pearson	Plummer
4	VLSI Fabrication Principles: Silicon and Gallium Arsenide Wiley Student edition	S K Gandhi

Subject: Network Synthesis (Code: ECT359)	**Year & Semester:** B. Tech Electronics and Communication Engineering 3rd Year & 6th Semester		Total Course Credits: 4	
		L	T	P
		2	1	0
Evaluation Policy	Mid Term	Class Assessment	End Term	
	30	10	60	

Objectives: To introduce students with the basic concepts of Electric Circuit design theory and familiarize them how to synthesis the circuits to get transits as well as steady state response of the proposed system with emphasis on synthesis in frequency domain using different techniques.

Course Outcomes:

CO1	Comprehensive understanding of synthesizing techniques for circuits and systems
CO2	Understanding of causality, stability, and realizability theory; Hurwitz polynomial; Positive real functions
CO3	Synthesis procedure for driving point and transfer immittance functions for RLC circuits
CO4	Synthesis and filter design, transient response, magnitude and frequency normalization, frequency transformation

Details of the syllabus:

S. No	Particulars
1	Introduction: Frequency domain representation of networks, Laplace transforms of shifted functions, transient & steady response. Time domain behaviors from poles and zeros, Convolution Theorem.
2	***Network Synthesis:*** *Network functions, Impedance & Admittance function, Transfer functions, Relationship between transfer and impulse response, poles and zeros and restrictions, Network function for two terminal pair network.*
3	***Poles and Zeros:*** *Sinusoidal network in terms of poles & zeros. Real liability condition for impedance synthesis of RL & RC circuits, Network synthesis techniques for 2-terminal network, Foster and Cauer forms.*
4	***Filters Synthesis:*** *Classification of filters, characteristics impedance and propagation constant of pure reactive network, Ladder network, T section, IT section, terminating half section, Pass bands and stop bands. Design of constant-K, m-derived filters, Composite filters.*

Suggested Books:

1.	Network Synthesis	Van Valkenberg
2.	Network Synthesis	IVS Iyer
3.	Network Analysis & Synthesis	Franklin F Kou

Subject: Python Programming (Code: CST 310)	**Year & Semester:** B. Tech Electronics & Communication Engineering 3rd Year & 5th Semester		**Total Course Credit: 4**		
			L	T	P
			2	1	-
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Objectives: (Maximum 25 Words): The course is designed to provide Basic knowledge of Python. Python programming is intended for software engineers, system analysts, program managers and user support personnel who wish to learn the Python programming language.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Understand Python syntax and semantics and self-assured in the use of Python flow control and functions.

CO2: Implement Python Programs using core data structures like Lists, Dictionaries and use Regular Expressions.

CO3: Learn to approach real world problems as a programmer, including skills necessary to contribute to a production development team.

CO4: Gain functional knowledge of Python, SQL databases and the Django framework.

Details of the syllabus:

S.No.	Particulars
1.	**Introduction to Python:** What is Python and history of Python? Unique features of Python, Python-2 and Python-3 differences, Install Python and Environment Setup, First Python Program. Python Identifiers, Keywords and Indentation, Comments and document interlude in Python, Command line arguments, Getting User Input, Python Data Types, What are variables?
2.	**Control Statements:** Python Core objects and Functions, Number and Maths , if-else, if-elif-else, while loop, for loop, break, continue, assert, pass, return.
3.	**List, Ranges & Tuples in Python:** Introduction to Lists in Python, More about Lists, Understanding Iterators ; Generators, Comprehensions and Lambda Expressions, Understanding and using Ranges, More About Ranges, Ordered Sets with tuples
4.	**Input and Output in Python:** Reading and writing text files, writing Text Files, Appending to Files and Challenge, Writing Binary Files Manually, Using Pickle to Write Binary Files
5.	**Python built in function and Data Science Using Python:** Python user defined functions, Python packages functions, Defining and calling Function, The anonymous Functions, Loops and statement in Python, Python Modules & Packages. Introduction to numpy, Creating arrays, Indexing Arrays, Array Transposition, Universal Array Function, Array Processing, Array Input and Output

6.	**Exceptions & Python Regular Expressions:** Errors in Python, Compile-Time Errors, Runtime Errors, Logical Errors, What is Exception? Handling an exception, try….except…else. What are regular expressions? The match Function, The search Function, Matching vs searching, Search and Replace, Extended Regular Expressions

Recommended Books:

S. No	Name of Book	Author
1.	"Python for Everybody: Exploring Data Using Python 3", 1st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf) (Chapters 1 – 13, 15)	Charles R. Severance
2	"Think Python: How to Think Like a Computer Scientist", 2ndEdition, Green Tea Press, 2015. (http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Chapters 15, 16, 17)	Allen B. Downey
3	"Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014	Charles Dierbach,
4	"Data Structures and Algorithms in Python",1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176	Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich,

<table>
<tr><td rowspan="3">Subject: Numerical Analysis & Techniques (Code: MAT 603)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering
3rd year & 6th Semester</td><td colspan="3">Total Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>-</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: The objective of this subject is to make the students aware of the numerical methods for the solution of scientific problems which cannot be solved analytically.

Course Outcomes (COs):
Upon successful completion of the course, student should be able to:
CO1: Error estimate and Solve algebraic and transcendental equations using numerical techniques
CO2: Solution of Simultaneous Linear Algebraic Equations
CO3: Construction of Interpolating polynomial and finding intermediate value
CO4: Solve ordinary differential equations by numerical techniques
CO5: Apply Numerical techniques in Electronics & Communication Engineering problems
Details of the syllabus:

S. No.	Particulars
1.	**Errors in Numerical Calculations:(3 lectures)** Floating- point form of numbers, Round-off, Algorithm, Stability, Programming errors, Errors of Numerical Results, Error propagation, Basic error principle, Loss of significant digits.
2.	**Interpolation:(11 lectures)** Difference Table and its usage. The difference operators Δ, ∇ and the operator E. Interpolation Forward, Backward and Shift operators, Central differences , over-raging operator μ. Relations between the operators, their relations , Existence, Uniqueness of interpolating polynomial, Interpolation with equal intervals: Newton's advancing difference formula. Newton's backward difference formula. Interpolation with unequal intervals. Newton's divided difference formula. Lagrange's interpolation formula. Gauss forward and backward interpolation formula
3.	**Numerical solution of algebraic and Transcendental Equations: (4 lectures)** Graphic Method, Regula-Fast method, Bolzano's Process of bisection of intervals, Newton-Raphson Method and its geometrical significance
4.	**Numerical Integration: (4 lectures)** Numerical Integration, General Quadrature Formula, Simpson's 1/3rd and 3/8th rules, Weddle's' rule, Trapezoidal rule.
5.	**Numerical Solution of ordinary differential equations:(4 lectures)** Numerical solution of ordinary differential equations, Picard's method. Taylor's series method, Euler's method, Runge Kutta Method

Recommended Books:

S. No	Name of Book	Author
1.	Numerical Methods for Scientists and Engineering, Wiley Eastern Ltd New age international publishers, 7th Edition, 2019, ISBN: 9789387477254, 9387477258..	M.K. Jain, S. R. Iyengar & R.K. Jain
2	Introductory methods in Numerical Analysis, 5th Edition, Prentice Hall India learning Pvt Ltd, ISBN: 9788120345928, 9788120345928	S.S. Sastry,
3.	Elementary Numerical Analysis, , 3rd Edition, 2006, Wiley India Pvt Ltd, ISBN-13: 978-9754142747	Kendall E. Atkinson, Han
4	Elementary Numerical Analysis An algorithmic approach, McGraw-Hill, 1980, **ISBN-13:** 978-0070124479	S. D. Conte and C. de Boor
5	Mathematical Numerical Analysis, Oxford and IBH Publishers, 6th Edition, 2020, ISBN: 9788120417595, 9788120417595	J.B. Scarborough

7th Semester B Tech ECE Syllabus

<table>
<tr><td rowspan="3">Subject: Embedded Systems (Code: ECT401)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering 4th year 7th semester</td><td colspan="3">Total Course Credits: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-term</td><td>Class assessment</td><td colspan="3">End-term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: Develop an understanding of the technologies behind the embedded computing systems. To introduce students to the design issues of embedded systems. Enable students to analyze and develop software programs for embedded systems.

Course Outcomes:

CO1	Knowledge about Embedded systems and its architecture with basic of memory System and I/o Sub-system
CO2	To analyze various memory devices and their characteristics with component (Memory and I/O device) interfacing
CO3	To understand programming languages and basic compilation techniques
CO4	To understand features of operating system along with real-time memory management and network fundamentals

Details of Syllabus:

S.No	Particulars
1.	**Introduction:** Characteristics of Embedding Computing Applications, Concept of Real time Systems, Challenges in Embedded System Design. Design Process.
2.	**Embedded System Architecture:** Instruction Set Architecture - CISC and RISC instruction set architecture, Basic Embedded Processor/Microcontroller Architecture, Memory System Architecture, I/o Sub-system, Co-processors and Hardware Accelerators, Processor Performance Enhancement, CPU Power Consumption.
3.	**Designing Embedded Computing Platform:** Using CPU Bus, Memory Devices and their Characteristics – RAM, ROM, UVROM, EEPROM, Flash Memory, DRAM. I/O Devices. Component Interfacing - Memory Interfacing, I/O Device Interfacing, Interfacing Protocols. Designing with Processors.
4.	**Programming Embedded Systems:** Program Design, Programming Languages - Desired Language Characteristics, Use of High Level Languages, Programming and Run-time Environment, Basic Compilation Techniques, Analysis and Optimization of - Execution Time, Energy and Power, Program Size.
5.	**Operating System:** Basic Features of an Operating System, Kernel Features, Processes and Threads, Context Switching, Scheduling, Inter-process Communication, Real-time Memory Management, I/O, Evaluating and Optimizing Operating system performance, Power Optimization Strategies for Processes.
6.	**Network Fundamentals:** Layers and Protocols, Distributed Embedded Architectures, Elements of Protocol Design, High Level Protocol Design Languages, Network Based Design, Internet-Enabled Systems, Wireless Applications – Bluetooth.

Recommended Books:

S. No.	Book Name	Author Name
1	Embedded Systems: Architecture, Programming and Design	Raj Kumar
2	Embedded System Design- A unified Hardware/software Introduction	Frank Vahid, Tony Givargis
3	Programming Embedded Systems in C and C ++	Michael Barr, O'Reilly
4	Real-Time Concepts for Embedded Systems	Q. Li and C. Yao

<table>
<tr><td rowspan="3">Subject: Digital Signal Processing
(Code: ECT402)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering 4th year 7th semester</td><td colspan="3">Total Course Credits: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-term</td><td>Class assessment</td><td colspan="3">End-term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: To acquire knowledge and become familiar with various types of signals, 2D signals, different types of systems, filter design & to develop the concept of various mathematical tools like Fourier transform, z transform, finite modeling, etc.

Course Outcomes:

CO1	Thorough understanding of the discrete time signals and systems and the system properties based on Fourier analysis, Z transform, FFT
CO2	To understand various algorithms and their computational complexities.
CO3	Design, implementation and analysis of IIR and FIR filters and their modeling effects in signal processing.
CO4	Understand the architecture of Digital Signal Processing

Details of Syllabus:

S.No.	Particulars
1.	**Introduction**:-Discrete time signals and systems frequency domain representation
2.	**Transforms**:-Z- transform, Discrete Fourier transform. Discrete correlation and correlator, Two dimensional signals and systems and their frequency domain representations. Discrete Hilbert transform. Fast Fourier transform
3.	**Algorithms**: - Computational consideration. Bluestein chirp – z transform Algorithm.
4.	**Filters: -** Digital filters. Representation, form realization. Design of digital filters, specification and design techniques. IIR and FIR digital filters.
5.	Finite modeling effect in digital signal processing applications.
6.	Introduction to DSP processors.

Recommended Books:

1.	Digital Signal processing	Proakis
2.	Digital Signal Processing	Chittod

		Total Course Credits: 3

<table>
<tr><td rowspan="2">Subject: Wireless Communication (Code: ECT403)</td><td colspan="2" rowspan="2">Year & Semester: B. Tech Electronics & Communication Engineering 4th year 7th semester</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-term</td><td>Class assessment</td><td colspan="3">End-term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: To introduce basic cellular concepts & to develop the understanding of frequency reuse, cell splitting, shadowing, fading, GSM standards, mobility management,IS-95, GPRS, etc.

Course Outcomes:

CO1	To understand basic concepts of wireless communication, performance parameters, noise, spectrum and interference limitations.
CO2	To understand cellular communication principles and perform the analysis using the concepts of frequency reuse, handover and interference management.
CO3	To understand large scale and small scale channel propagation models and obtain quantitative results for link budget, BER analysis and different diversity techniques.
CO4	To learn various multiple access techniques, performance analysis issues and get exposure of recent trends in wireless communication.

Details of Syllabus:

S.No.	Particulars
1.	**Introduction:** Classification of wireless systems Types of Services, Requirements for the services, Performance parameters in wireless communications, Multipath propagation, Spectrum Limitations, Noise and Interference limited systems, Economic considerations, Standards
2.	**Propagation Channels:** Radio Propagation Mechanisms (Qualitative treatment), Propagation effects with mobile radio, Channel Classification, Link calculations, Narrowband and Wideband models.
3.	**Diversity**: Diversity modeling, BER performance Improvement with Diversity, Types of Diversity – Frequency, Time, Space
4.	**Cellular Communication:** Introduction to Cellular Communications, Frequency reuse, Basic theory of cell layout, Cellular Processes - Call Setup, Handover etc,
5.	**Multiple Access Schemes:** FDMA, TDMA, CDMA, and Random multiple accesses, Comparison, Performance Analysis issues, and Design.
6.	**Recent Trends:** UWB, MIMO, 4G & 5G, Cognitive Radio, Network on a chip.

Recommended Books:

1.	Wireless Communications	Andreas F. Molisch.
2.	Wireless Communications Principles and Practice	Rappaport.
3.	Wireless Communications and Networks	Stallings.

Subject: Electronic Measurements & Instrumentation (Code: ECT404)	**Year & Semester:** B. Tech Electronics & Communication Engineering 4th year 7th semester		**Total Course Credits: 4**		
			L	T	P
			3	1	0
Evaluation Policy	Mid-term	Class assessment	End-term		
	30 Marks	10 Marks	60 Marks		

Objectives: To introduce the instrumentation system, to teach the construction, operation of various transducers, sensors, etc, to develop the concept of function generators, frequency counters, data acquisition systems, interfacing of micro controllers and basic GPIB techniques.

Course Outcomes:

CO1: To familiarize with measurement standards and systems with their responses

CO2: To get a detailed understanding of various analog meters

CO3: To introduce transducers, sensors and actuators used in measurements

CO4: To understand the working of wave generators, analyzers and digital meters and to get knowledge about data acquisition system and interfacing with microcontrollers

Details of Syllabus:

S.No.	Particulars
1.	**Measurement System and Standards:** Instrumentation System and its classification, Primary and secondary standards, Standards of various electrical quantities, IEEE standards, Static and Dynamic response, Errors, and accuracy of an instrumentation system.
2.	**Measurement of Basic Parameters:** Galvanometer and its principle, Moving Coil, Moving iron meters, true rms meter, Bridge measurements, Q meters, Measurement of Voltage, Current, Power, Energy. Measurement of Resistance, Capacitance, Inductance.
3.	**Transducers, Sensors, and Actuators:** Active and Passive, Transducers types: Resistive, Inductive, capacitive, Piezoelectric, Optical, Photo diodes; Measurement of Physical, Physiological, And chemical quantities: (Temperature, pH, Luminescence, Flow, Pressure, Torque, Speed, acceleration, Rotation, Stress, Strain, etc,), Sensors for hostile environments, Actuators: Relays, Solenoids, Stepper motors.
4.	**Signal Generators and Analyzers:** Function generators, RF Signal Generator, Sweep Generator, Frequency synthesizer, Wave Analyzers for Audio and radio frequency waves. Measurement of harmonic distortion. Spectrum analysis, RF Power measurement.
5.	**Digital Instrumentation:** Comparison of analog and digital techniques, Digital voltmeter, Digital multimeter, Frequency counter, Measurement of frequency and time interval, extension of frequency range, Measurement errors.
6.	**Data Acquisition System:** Components of data acquisition system, Interfacing of transducers, Single Channel and Multi-channel system, Multiplexing, interfacing with micro controllers, IEEE 488 Bus, Automated data acquisition,

7.	**Advanced topics:** Virtual Instrumentation, Low level measurements and Noise rejection, GPIB based measurement techniques. Measurements using MEMS
8.	**Measurement System and Standards:** Instrumentation System and its classification, Primary and secondary standards, Standards of various electrical quantities, IEEE standards, Static and Dynamic response, Errors, and accuracy of an instrumentation system.

Recommended Books:

1.	**Electronic Measurements**	**W Cooper**
2.	**Electrical & Electronic Measurements**	**A K Sawhney**

<table>
<tr><td rowspan="3">Subject: Microwave Engineering
(Code: ECT405)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering 4th year 7th semester</td><td colspan="3">Total Course Credits: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-term</td><td>Class assessment</td><td colspan="3">End-term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: To understand basics of microwave communication, various active and passive devices, microwave amplifiers and oscillators.

Course Outcomes:

CO1	To have good idea about microwaves, microwave communication and wave propagation through waveguides.
CO2	To understand microwave cavities, scattering parameters and microwave passive devices
CO3	To be able to understand the working and construction of various Active microwave devices
CO4	To have in-depth understanding about high frequency semiconductor active devices and to be able to design microwave amplifiers and oscillator circuits

Details of Syllabus:

S.No.	Particulars
1.	**Introduction to Microwave Communication:** Need, Advantages and application of microwave signals.
2.	**Waveguides and Cavity Resonators**: Transverse Electric and Transverse magnetic Waves, Wave propagation through rectangular and circular waveguides, Power transmission and attenuation in waveguides, Electromagnetic Resonators, Rectangular & Circular cavities.
3.	**Microwave Passive Devices:** Scattering Matrix (S Parameter) representation of multi-port networks, Tees, Directional Coupler, Circulator and Isolator.
4.	**Microwave Active Devices:** Limitations of conventional vacuum tubes at microwave frequencies, Klystrons, Traveling wave tube, Magnetron, Microwave Detectors, Mixers-Single ended and Balanced.
5.	**High Frequency Devices:** PIN diode, Varactor diode, Tunnel diode, Read diode , IMPATT, TRAPATT and Gunn diode, Microwave Switches
6.	**Microwave Amplifiers and Oscillators:** Microwave Transistors-Bipolar and Field Effect Transistor Characteristics, Gain and Stability, Microwave Amplifier design, Gunn and transistor oscillators.

Recommended Books:

1.	**Microwave Devices & Circuits, PHI**	**Liao, S. Y**
2.	**Microwave Engineering, John Wiley**	**David Pozar**
3.	**Foundations for Microwave Engineering**	**R E Collin**

<table>
<tr><td rowspan="3">Subject: Pre-Project & Seminar
(Code: ECP406)</td><td rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering 4th year 7th semester</td><td colspan="3">Total Course Credits: 2</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-term/Class assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>40</td><td colspan="3">60</td></tr>
</table>

Objectives: The main objective of this course is to attain skills for literature survey, writing report, preparing presentations and aural presentation of Technical subjects.

Course Outcomes:

CO1	Review literature on a given advance topic related to the specific stream.
CO2	Summarize the concept of the chosen topic systematically after considerable study of the content from primary as well as secondary sources
CO3	Learn and present the structure and format of technical reports as per specified norms
CO4	Interpret graphs/results of various kinds and discuss the concept and conclusion in an open seminar

<table>
<tr><td rowspan="3">Subject: Embedded Systems LAB
(Code: ECL 407)</td><td rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering 4th year 7th semester</td><td colspan="3">Total Course Credits: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid Term</td><td colspan="3">End Term</td></tr>
<tr><td>40</td><td colspan="3">60</td></tr>
</table>

Objectives: To introduce the basics programming of Microcontroller along with interfacing with different real time modules.

Course Outcomes:

CO1	Knowledge about programming of Microcontroller.
CO2	Interfacing of the Microcontroller with various modules like LED, Seven Segment Display, LCD, Keypad and ADC.
CO3	Use of on chip modules like timers and interrupts.
CO4	Implementation of serial communication using Microcontroller.

List of Experiments (8051 Programming):

1. Write a program for performing simple arithmetic operations.
2. Write a program for square waveform generation, with different frequencies and duty cycles.
3. Write a simple program for flashing LEDs using software delays.
4. Write a program for flashing LEDs using timers and interrupts.
5. Write a program for interfacing Seven Segment Display with 8051.
6. Write a program for interfacing LCD with 8051 and display message on LCD.
7. Write a program for interfacing Keypad with 8051 and display keypad input on LCD.
8. Write a program for serial communication through UART using polling and interrupt methods.
9. Write a program for interfacing ADC 0804 with 8051.
10. Write a program to interface sensor to I/O ports.

<table>
<tr><td rowspan="3">Subject: EDA Tools II Lab (Code: ECL 408)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering
3rd Year & 7th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td></td><td>10 Marks</td><td colspan="3">90 Marks</td></tr>
</table>

Objectives: To understand the use of MATLAB and Verilog-A as languages for implementation of models for device and circuit simulation

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Use MATLAB as a language for simulating device models

CO2: Use Verilog-A for device simulation

CO3: Implement a SPICE netlist using Verilog-A models

CO4: Get familiarity with Industry Standard Compact Models for Electronic Design Automation

List of Experiments:

S. No.	Particulars
1.	Installation of MATLAB with the basic information of MATLAB workspace and working directory.
2.	Creating matrices and some simple matrix operations.
3.	Statistics and working with basic programs.
4.	MATLAB Programming language-looping and branching.
5.	Writing MATLAB functions.
6.	Graphics and Plotting- 2D graphs.
7.	Introduction to Verilog HDL Basics.
8.	Working with Verilog MODELING for SPICE
9.	Verilog Syntax, Data type, Fundamentals.
10.	Working with Verilog Structure.

<table>
<tr><td rowspan="3">Subject: Microwave Engineering Lab (Code: ECL409)</td><td rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering 4th year 7th semester</td><td colspan="3">Total Course Credits: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-term/Class assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>40 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: The experimental setups are introduced to and performed by the students to enable them to give optimal performance in professional life.

Course Outcomes:
CO1: Explain and Perform the Reflex klystron Characteristics using Microwave bench set
CO2: Explain and Perform the Gunn diode Characteristics using Microwave bench setup
CO3: Measure the Frequency, attenuation, VSWR, Impedance using Klystron Bench Setup
CO4: Analyze various characteristics of microwave junctions and design of microwave communication links

Details of Syllabus:

S.No.	Particulars
1.	To determine the characteristic impedance of lumped constant delay line.
2.	To study the voltage distribution along a lumped constant delay line in the cases when it is: (i) Open Circuited ii. Short Circuited (ii) iii. Terminated in Zo and hence determine attenuation constant, phase constant, propagation constant and wavelength.
3.	To study the method of measuring VSWR at the input of the component under test or unknown load when (i) VSWR<10 and (ii) VSWR>10
4.	To set up an LOS link using microwave horn antennas and study the link performance under different obstructions.
5.	To study the method of evaluation of an unknown load impedance by measuring VSWR and the position of voltage minimum
6.	i. To study the characteristic of wave propagation in a waveguide by studying standing wave pattern and hence to plot W.B. diagram. ii. To verify relationship between guide wavelength and free space wavelength
7.	To study the method of measurement of VSWR at the input of the component under test (say pyramidal horn) and hence to determine its input impedance.
8.	To measure the frequency of a microwave source.
9.	To study Gunn oscillator as a source of microwave power and hence to study. i. I-V Characteristics ii. Power frequency characteristics
10.	To measure main line and auxiliary line VSWR of a directional coupler
11.	To study the properties of E and H-plane waveguide tee junctions and to determine isolations, coupling coefficients and input VSWR.

Elective II

Subject: Radar Systems (Code: ECT- 410)	**Year & Semester:** B. Tech Electronics & Communication Engineering 4^{th} Year & 7^{th} Semester		**Total Course Credit: 3**		
			L	**T**	**P**
			2	**1**	**0**
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: The course is aimed to expose students to radar techniques for target detection in presence of noise and clutter. The course will enable students to gain insight into the emerging applications of radar technology.

Course Outcomes : Upon successful completion of the course, student should be able to:
CO1: understand the radar operation and its applications in practice.
CO2 : design a radar signal for a given problem.
CO3: choose a suitable detection method for detecting a target in presence of noise and clutter.
CO4: understand the tracking methods in a radar system.

Details of the Syllabus:

S. No.	**Particulars**
6.	Introduction to Radar Systems: Radar Equation, Radar Cross section, Area and volume Targets
7.	Radar Signals: Radar Signal Types and their LTI response, Matched Filter Response for stationary and moving targets, Ambiguity function Pulse compression of Radar Signals. Basic Concept and compression techniques.
8.	Radar Detection: Basic Detection principles, Optimum decision rule, Detection criteria for different target models.
9.	Radar measurements: Range, Doppler frequency and angle measurement. Optimum Receiver Design, Radar Tracking
10.	Emerging Trends in Radar technology: 3D Radar, Active Scanned Arrays for RADARs, Broadband Multifunction Radar, Distributed Aperture Radar Systems, Use of Light Detection and Ranging(LIDAR) sensors in Radar systems.

Recommended Books:

S. No.	**Name of Book**	**Author**	**Publisher**
3.	Radar Principles	P.Z.Peebles	Wiley
4.	Introduction to Radar Systems, (3/e)	Merrill I. Skolink	Tata MG Graw Hill

Subject: System Design (Code: ECT 411)	**Year & Semester:** B. Tech Electronics & Communication Engineering 3rd Year & 7th Semester		**Total Course Credit:** 4		
			L	T	P
			2	1	0
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: To learn basic techniques for the interfacing between system components, meta-stability, and techniques for handling them; to study Layout strategies at IC and board level for local and global signals

Course Outcomes: Upon successful completion of the course, student should be able to:

CO1: Understand the System partitioning techniques in different forms and Interfacing in linear and digital systems.
CO2: Design finite state machines, and implement state assignment strategies.
CO3: Carry out implementation of DSP algorithms, and comprehend signal integrity and high speed behavior of interconnects.
CO4: Get familiar with the Layout strategies at IC level.

Details of the syllabus:

S.No.	**Particulars**
1.	**Module I:** Basics of system hardware design. Hierarchical design using top-down and bottom-up methodology.
2.	**Module II:** System partitioning techniques, interfacing between system components. Handling multiple clock domains, Synchronous and asynchronous design styles. Interface between synchronous and asynchronous blocks. Meta-stability and techniques for handling it. Interfacing linear and digital systems, data conversion circuits.
3.	**Module III:** Design of finite state machines, state assignment strategies. Design and optimization of pipelined stages. Use of data flow graphs, Critical path analysis, retiming and scheduling strategies for performance enhancement. Implementation of DSP algorithms. Signal integrity and high speed behavior of interconnects: ringing, cross talk and ground bounce.
4.	**Module IV:** Layout strategies at IC and board level for local and global signals. Power supply decoupling.

Recommended Books:

S. No	**Name of Book**	**Author**
1.	System Analysis & Design	V K Jain
2.	Modern Systems Analysis and Design	Jeffrey A. Hoffer
3.	System Analysis & Design	Silver and Silver Addison Wesley, last edition.

4.	System Analysis & Design	Kenneth E. Kendall

Subject: Analog CMOS Design (Code: ECT 412)	**Year & Semester:** B. Tech Electronics & Communication Engineering 3rd Year & 7th Semester		**Total Course Credit: 4**		
			L	T	P
			2	1	0
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: As the course title suggests, the course will be specific to Analog CMOS circuit implementations. In particular, the course will focus on different configurations of CMOS analog amplifier and different differential amplifier topologies and their analysis. The course will also cover voltage references and current mirrors.

Course Outcomes:

CO1	To design and analyze Basic CMOS Amplifier configurations Analysis using small signal model; and Large signal Analysis of Amplifiers
CO2	Able to analyze and design analog circuits such as Differential Amplifier, OP-AMP, Current mirrors, Biasing, Voltage references, Frequency Synthesizers
CO3	Ability to analyze high-frequency response of amplifiers and stability compensation for amplifiers
CO4	Performance Analysis and Design of Multistage amplifiers

1 Details of Syllabus:

S. No.	**Particulars**
1	Introduction to analog VLSI and mixed signal issues in CMOS technologies. Basic MOS models, SPICE Models and frequency dependent parameters.
2	Basic NMOS/CMOS gain stage, CS, CG, CD configurations, cascade and cascode circuits. Frequency response, stability
3	Differential amplifier and OP-AMP design, Frequency response, stability
4	Current Sources and Voltage references, Frequency Synthesizers, Voltage Controlled Oscillators and Phased lock-loop
5	Multi stage Amplifiers
6	Noise issues in Amplifiers.

2 Suggested Book :

1.	Design of Analog CMOS Integrated Circuits McGraw Hill	Behzad Razavi
2.	CMOS Analog Circuit Design, Oxford University Press	Allen and Holberg,
3	CMOS Circuit Design, Layout, and Simulation, PHI	Baker, Li, and Boyce

<table>
<tr><td rowspan="3">Subject: Advanced Power Electronics
(Code: EET 4xx)</td><td rowspan="3" colspan="2">Year & Semester: B. Tech Electronics and communication Engineering
4th Year VII Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Understand three phase voltage source and current source inverters and their modulation strategies.

CO2: Understand the operation of non-isolated DC-DC Converters

CO3: Understand the operation of isolated DC-DC converter.

CO4: Perform comparative assessment of different modulation techniques

CO5: Understand the applications of power electronics in appliances such as Power conditioners and UPS.

Details of syllabus

S.No.	Particulars
1	**Unit 1:** Three phase Voltage source inverters in square wave mode. 120 and 180degree modes of conduction. Three phase Current Source Converter
2	**Unit 2**:Different modulation strategies- Sine PWM, Hysteresis Current Control Technique, Selective Harmonic Elimination, Space Vector Modulation.
3	**Unit 3:** Non Isolated D.C to D.C converters in CCM and DCM, Boundary conditions, Non-Ideal Behavior, Design of Passives for: Buck, Boost, Buck-Boost and Cukconverter circuits.
4	**Unit 4:** Isolated DC-DC converters: Flyback converter, Forward converter, Push-Pull converter, Half-Bridge converter and Full-Bridge converter
5	**Unit 5:** Power line disturbances and their effect on equipment, Power conditioners, offline and online UPS

Text Books

4. Power Electronics by Daniel W Hart, Tata Mc Graw Hill
5. Power Electronics: Converter, Applications & Design, by N. Mohan, T.M. Undeland & W.P. Robbins, John Wiley & Sons, 1989
6. Fundamentals of Power Electronics, Erickson and Macsimovic

References

7. Power Electronics: Devices, Drivers, Applications, and Passive Components by Barry Williams
8. Modern Power Electronics and AC motor Drives By Bimal K Bose- Pearson Publishers.
9. Referred Journal/Conference publications.

<table>
<tr><td rowspan="3">Subject: Design & Analysis of Algorithms
(Code: CST 306)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>-</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: (Maximum 25 Words) This course covers, principles of algorithm design, elementary analysis of algorithms, and fundamental data structures. The emphasis is on choosing appropriate data structures and designing correct and efficient algorithms to operate on these data structures.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:
CO1: Learn how to analyze algorithms and estimate their worst-case and average-case behavior (in easy cases);
CO2: Analyze the asymptotic performance of algorithms. Write rigorous correctness proofs for algorithms
CO3: Accustomed to the description of algorithms in both functional and procedural styles;
CO4: Learn how to apply their theoretical knowledge in practice (via the practical component of the course).

Details of the syllabus:

S.No.	Particulars
1.	**Analysis of Algorithms:** Algorithm Design paradigms, motivation. Review of algorithmic strategies, asymptotic analysis: upper and lower complexity bounds. Identifying differences among best, average and worst Case Behaviors. Big O, little O, omega and theta notations, Standard complexity classes. Empirical measurements of performance. Time and space trade-offs in algorithms. Analyzing recursive algorithms using recurrence relations.
2.	**Divide & Conquer:** Structure of divide and conquer algorithms: examples, Binary search, Quick sort, analysis of divide and conquer run time recurrence relations. **Greedy Algorithms:** Overview of the greedy paradigm, examples of exact optimization solution (minimum cost spanning tree), approximate solution (Knapsack problem), single sourceshortest paths.
3.	**Dynamic Programming**: Overview, difference between dynamic programming and divide and conquer, applications: shortest path in graph, matrix multiplication, travelling salesperson problem, longest common sequence.
4.	**Graph Algorithms:** Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Minimum Spanning Trees (MST), Prim's and Kruskal's algorithms for MST, Connected Components, Dijkstra's Algorithm for Single Source Shortest Paths, Warshall's Algorithm for finding Transitive Closure of a Graph, Floydd's Algorithm for All-Pairs Shortest Paths Problem.
5.	**Back Tracking:** Overview, 8-Queens problem and Knapsack problem. **Branch & Bound:** LC searching, bounding, FIFO branch and bound, Applications: 0/1 Knapsack problem, Travelling salesperson problem.

6.	**Computational complexity:** Complexity measures, Polynomial vs non-polynomial time complexity; NP hard and NP complete classes, Examples.

Recommended Books:

S. No	Name of Book	Author
1.	"Introduction to Algorithms", PHI.	**Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein**
2	"Data Structures and Algorithm Analysis in C++",	**Mark Allen Weiss Third Edition, Pearson Education, 2006**
3	"Fundamentals of Computer Algorithms", Second Edition, Universities Press, 2011	**Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran,**

<table>
<tr><td rowspan="3">Subject: Fuzzy Logic and Neural Networks (Code: MAT xxx)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering
4th Year & -8th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>-</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objective: The principle objective of this course is to have a knowledge of Fuzzy logic and natural neural networks and thereby develop the artificial neural networks for solving real life problem

Pre –requisites :

Fundamental of Computing Assumed knowledge: fuzzy control system is a control system based on fuzzy logic—a mathematical system that analyzes analog input values in terms of logical variables that take on continuous values between 0 and 1, in contrast to classical or digital logic.

MICROCONTROLLED BASED SYSTEM DESIGN,
AUTOMOTIVE ELECTRONICS,
VIRTUAL INSTRUMENTATION

Course Outcomes

CO1: To understand the Fuzzy logic systems
CO2: To study the basic architecture of neural networks and applications
CO3: To understand the basic neural network operations
CO4: To have knowledge of various types of neural networks, their operations and applications in real life problems.

Details of the syllabus:

S.No.	Particulars
1.	**FUNDAMENTALS OF FUZZY LOGIC:** Basic concepts: fuzzy set theory- basic concept of crisp sets and fuzzy sets- complements- unionintersection- combination of operation- general aggregation operations- fuzzy relations-compatibility relations-orderings- morphisms- fuzzy relational equations-fuzzy set and systems
2.	ARCHITECTURE OF NEURAL NETWORKS: Architectures: motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications-typical Architecture-setting weights-common activations functionsBasic learning rules- Mcculloch-Pitts neuron- Architecture, algorithm, applications-single layer net for Page 1 of 7 pattern classification- Biases and thresholds, linear separability - Hebb'srule- algorithm -perceptron - Convergence theorem-Delta rule

3.	BASIC NEURAL NETWORK TECHNIQUES: Back propagation neural net:standard back propagation-architecture algorithm- derivation of learning rulesnumber of hidden layers--associative and other neural networks- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine
4.	COMPETITIVE NEURAL NETWORKS: Neural network based on competition: fixed weight competitive nets- Kohonenself organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART2
5.	SPECIAL NEURAL NETWORKS : Cognitron and Neocognitron - Architecture, training algorithm and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems.

Recommended Books:

S. No	**Name of Book**	**Author**
1.	Fuzzy System & Fuzzy logic	T1. Kliryvan- Prentice Hall of India, First Edition.
2	Fundamental of Neural network	Lawrence Fussett- Prentice Hall , First Edition.
3.	Neural network and Fuzzy System‖	Bart Kosko, Prentice Hall-1994.
4	Introduction to artificial neural systems‖-	J.M.Zurada, Jaico Publication house,Delhi 1994.

8th Semester B Tech ECE Syllabus

<table>
<tr><td rowspan="3">Subject: Project Major (Code: ECP450)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering 4th Year & 8th Semester</td><td colspan="3">Total Course Credits: 8</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>16</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>---</td><td>---</td><td colspan="3">----</td></tr>
</table>

Objectives: Students need to select a standard project related to electronics and communication. The project has to be workable to be demonstrated practically. Extensive literature review is to be carried out related to the project and same is to be submitted in form of a thesis. Related project will be completed with a power point presentation and viva.

Course Outcomes:

CO1 Identify methods & materials to carry experiments / develop code.
CO2 Reorganize the procedure with a concern for society, environment and ethics.
CO3 Analyze and discuss the results to draw valid conclusions.
CO4 Prepare a report as per recommended format and defend the work
CO5 Explore the possibility of publishing paper in peer reviewed journal/conference proceedings.

<table>
<tr><td rowspan="3">Subject: Optical Fiber Communication
(Code: ECT451)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credits: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: To make the students aware about the basic theory and working of various subsystems of optical fibre communication systems, their design and integration into a communication setup.

Course Outcomes:

CO1 Basic concepts about Optical Fibers, Ray optics and overview of modes.

CO2 Basic knowledge about various degradation phenomenon including attenuation, scattering dispersion and bending in optical fibers.

CO3 To understand concepts related to various optical fiber sources including LED and LASERS and their coupling with optical fibers. To understand operation of various Fiber Optical Receivers including PIN and APD diodes.

CO4 To understand point to point link considerations including link power budgets and rise time budgets. To understand operational principles of WDM, Soliton and analyze Noise effects on system performance including EDFA, Sonnet/ SDH networks.

Details of the Syllabus:

S.No.	Particulars
1.	**INTRODUCTION TO OPTICAL FIBERS:** Evolution of fiber optic system- Element of an Optical Fiber Transmission link- Ray Optics-Optical Fiber Modes and Configurations -Mode theory of Circular Wave guides- Overview of Modes-Key Modal concepts- Linearly Polarized Modes - Single Mode Fibers-Graded Index fiber structure.
2.	**SIGNAL DEGRADATION OPTICAL FIBERS**: Attenuation - Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Wave guides-Information Capacity determination - Group Delay-Material Dispersion, Wave guide Dispersion, Signal distortion in SM fibers-Polarization Mode dispersion, Intermodal dispersion, Pulse Broadening in GI fibers-Mode Coupling -Design Optimization of SM fibers-RI profile and cut-off wavelength.
3.	**FIBER OPTICAL SOURCES AND COUPLING:** Direct and indirect Band gap materials-LED structures -Light source materials - Quantum efficiency and LED power, Modulation of a LED, lasers Diodes-Modes and Threshold condition -Rate equations -External Quantum efficiency -Resonant frequencies -Laser Diodes, Temperature effects, Introduction to Quantum laser, Fiber amplifiers- Power Launching and coupling, Lencing schemes, Fibre – to - Fibre joints, Fibre splicing.
4.	**FIBER OPTICAL RECEIVERS**: PIN and APD diodes -Photo detector noise, SNR, Detector Response time, Avalanche Multiplication Noise -Comparison of Photo detectors -Fundamental Receiver Operation -preamplifiers, Error Sources -Receiver Configuration -Probability of Error - Quantum Limit.
5.	**DIGITAL TRANSMISSION SYSTEM:** Point-to-Point links System considerations -Link Power budget -Rise- time budget -Noise Effects on System Performance-Operational Principles of WDM, Solitons-Erbium-doped Amplifiers. Basic on concepts of SONET/SDH Network.

Recommended Books

1.	Optical Fiber Communication	By Gerd Keiser
2.	Optical Communication, Principles and Practice	By J.Senior

<table>
<tr><td rowspan="3">Subject: Computer &Network Security (Code: ECT452)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credits: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: To develop an understanding of security on computer networks, various cipher techniques, public key cryptography, authentication, virtual private networks, firewalls.

Course Outcomes:

CO1 Develop concept of security needed in communication of data through computers and networks along with various possible attacks

CO2 Understand various encryption mechanisms for secure transmission of data and management of key required for encryption

CO3 Understand authentication requirements and study various authentication mechanisms

CO4 Understand network security concepts and study different web security mechanisms

Details of the syllabus:

S.No.	Particulars
1.	**Introduction:** Need of security, Security attacks, services and mechanisms, Network security, Model.
2.	**Symmetric Ciphers:** Substitution and transposition techniques, Block cipher Principles and Modes of operation DES, Triple DES, Stream Ciphers and RC4.
3.	**Public Key Cryptography:** Need and principles of Public key cryptosystems, RSA Algorithm, Key, Distribution and management, Diffie-Hellman Key Exchange, Digital
4.	**Authentication:** Authentication Requirements, Message Authentication Codes, Hashes, MD5and SHA, User Authentication: Password, Certificate based and biometric
5.	**Network Security:** Firewalls, IP Security, Virtual Private Networks and Intrusion Detection, Web Security-SSL and TLS.

Suggested Books:

1.	**Cryptography and Network Security, PHI**	**William Stalling**
2.	**Cryptography and Network Security, Mc Graw Hill**	**Atul Kahate**
3.	**Cryptography and Network Security, PHI 4.**	**Forouzan**

<table>
<tr><td rowspan="3">Subject: Industrial Organization & Management (Code: HSL4)</td><td rowspan="3" colspan="2">Year & Semester: B. Tech Electronics and Communication Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credits: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: The experimental setups are introduced to and performed by the students to enable them to give optimal performance in professional life.

Course Outcomes:

CO1 Develop the ability to explain economic terms and concepts, Understand and explain the function of market, its types and determination of price under various competencies.

CO2 Demonstrate the ability to employ the economic way of thinking like application of marginal analysis, use of benefit/cost analysis, utility and demand forecasting techniques.

CO3 Practice the process of management's four functions: planning, organizing, directing and controlling to make an appropriate staffing decision which includes recruitment and selection design, implement and evaluate training programmes.

CO4 Understand an organization's characteristics and how they might impact on management practices and analyze both qualitative and quantitative information to isolate issues and formulate best control methods.

Details of the syllabus:

S.No.	Particulars
1.	Industry, meaning of Industrialization, Industrial revolution, Need problems and prospects of Industrial change in the developing countries.
2.	Industrial Evolution in India. Downfall of early industries, evolution of modern industry, effects of partition, industrial policy and progress after independence.
3.	Forms of Industrial Organization: a) Single Proprietorship b) Partnership c) Joint Stock companies
4.	Growth of Industry and Management Meaning of industrial management, functions and tools of management, growth of management concepts.
5.	Objectives of Industrial Management: Defining management objectives, managerial activity and objectives, tests of management of objectives, primary, secondary personal and social objectives of management.
6.	Management Organization: Various forms of organization of departmentalization line staff, functional and committee organization, formal and non formal organization.
7.	Management and Authority, Decision Making in Management
8.	Leadership, Definition, Traits, inborn traits, acquired traits, analytical etc.
9.	Marketing of Industrial Products and the Sales Manager.
10.	Personal Management: Recent changes in personal management function of personal departments, sections, training and placement other functions of personal department.

Suggested Books:

1.	Principles of Management	G. R. Terry
2.	Industrial Organization & Management	Tara Chand
3.	Business Organization & Management	M. C. Suckla

<table>
<tr><td rowspan="3">Subject: Optical Fiber Communication Lab (Code: ECL454)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering 4th Year & 8th Semester</td><td colspan="3">Total Course Credits: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>Marks</td><td>Marks</td><td colspan="3">Marks</td></tr>
</table>

Objectives: To understand basic concepts about Optical Fibers and ray optics. To understand concepts related to various optical fiber sources including LED and LASERS and their coupling with optical fibers.

Course Outcomes:

CO1 Basic concepts about Optical Fibers, Ray optics and overview of modes.

CO2 Basic knowledge about various degradation phenomenon including attenuation, scattering dispersion and bending in optical fibers.

CO3 To understand concepts related to various optical fiber sources including LED and LASERS and their coupling with optical fibers. To understand operation of various Fiber Optical Receivers including PIN and APD diodes.

CO4 To understand point to point link considerations including link power budgets and rise time budgets. To understand operational principles of WDM, Soliton and analyze noise effects on system performance including EDFA, Sonnet/ SDH networks.

Details of the syllabus:

S. No	Particulars
1	Voice transmission through optical link.
2	AM system using Analog & Digital Input Signals.
3	Frequency Modulation System
4	Pulse Width Modulation system.
5	Study of Propagation Loss in optical fiber System.
6	Study of Bending Loss
7	Measurement of Numerical Aperture
8	Characteristics of E-O Converter (LED)
9	Fiber optic digital link
10	PC to PC communication Link using optical fiber.

Elective III

Subject: Millimetre Wave Communication (Code:ECT454)	**Year & Semester:** B. Tech Electronics & Communication Engineering ear & -8th Semester	l Course credit:4		
		L	T	P
		2	1	-

Evaluation Policy	**Mid-Term**	**Class assessment**	**End-Term**
	30 Marks	10 Marks	60 Marks

Objectives: To familiarise students with Millimetre wave communication technology which is a major part of future WLAN as well as cellular systems.

Course Outcomes Upon successful completion of the course, student should be able to:
CO1: Understand significance of Millimetre Wave(mmWave) Communication for future mobile applications
CO2: To know fundamentals of mmWave Propagation, devices and circuits
CO3: Understand various components of mmWave Communications system
CO4: To know antenna design at mmWave frequencies and mmWave MIMO and mmWave Standards

Details of the syllabus:

.	**Particulars**
	INTRODUCTION : Millimeter Wave (mmWave) Wireless, mmWave Implementation Challenges, Emerging Applications of mmWave Communications, propagation characteristics of mm waves: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Coverage and capacity in mmWave.
	MM WAVE DEVICES AND CIRCUITS: Millimeter wave generation and amplification: Peniotrons, Ubitrons, Gyrotrons and Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mmWave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm Wave devices, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's.
	MM WAVE COMMUNICATION SYSTEMS: Modulations for mmWave communications, mmWave link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, mmWave calibration, production and manufacture, Future considerations.
	ANTENNAS FOR MM WAVE SYSTEMS: Antenna beamwidth, polarization, mmWave antenna design considerations, mmWave antennas for 5G, On-chip and In package mm wave antennas, Techniques to improve gain of mmwave antennas, mm wave adaptive antenna arrays, Advanced beam steering and beam forming for mmWave applications.
	MM WAVE MIMO : mmWave MIMO, Massive MIMO, Noise coupling in MIMO system, Multiple Antennas, Multiple Transceivers, Spatial, Temporal and Frequency diversity, Potential benefits of advanced diversity for mmWave communication, mmWave MIMO for 5G applications

	MM WAVE STANDARDIZATION: Introduction, mmWave Spectrum Regulations, International Recommendations, IEEE 802.15.3c, IEEE 802.15.3 MAC, IEEE 802.15.3c mmWave PHY, Wireless HD, ECMA-387, IEEE 802.11ad, WiGig.

Recommended Books:

S. No	Name of Book	Author
1.	Millimeter Wave Communication Systems", Wiley-IEEE Press	K.C. Huang, Z. Wang
2	Millimeter Wave Wireless Communication", Prentice Hall, 2014	Robert W. Heath, S. Rappaport,
3.	Millimeter - Wave Wireless Communication Systems: Theory and Applications, Hindawi Publishing Corporation	Chia-Chin Chong et al.
4	Millimeter-Wave Integrated Circuits, Springer	Eoin **Carey**

Subject: Biomedical & Image Processing (Code:ECT455)	**Year & Semester:** B. Tech Electronics & Communication Engineering **4th** Year & **8th** Semester		**Total Course Credit: 3**		
			L	T	P
			2	1	0
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: This course presents the applications of digital signal processing to biomedical signals and images. This course provides practical experience in processing physiological data, with examples from cardiology.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Understanding of Fundamental concepts in signal processing and design of digital FIR/IIR filters.

CO2: Understanding of Wavelet theory with applications to medical signals and images

CO3: Understanding of various data acquisition techniques for biomedical signals; methods for removal of artifacts in biomedical signals and biomedical signal analysis.

CO4: Understanding of Image enhancement and feature extraction methodologies.

Details of the syllabus:

S. No.	Particulars
1.	**Background and review of DSP**: Digital filter design and structures: Basic FIR/IIR filter design & structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation
2.	**Wavelets in Biomedical Signal Processing**: Introduction to wavelets, Scaling and wavelet functions, Multiresolution analysis, Filter Banks and Discrete wavelet transform, wavelets based signal processing and applications- Denoising, compression.
3.	**Biomedical Signal analysis:** Introduction to biomedical signals (ECG,EEG,PCG and EMG), Objectives of biomedical signal analysis, Filtering for removal of artifacts, Adaptive noise canceller; Cancellation of 60 Hz interference in electrocardiography, Time Domain filters, frequency domain filters, wiener filtering, adaptive filters , Illustration of the Problem with Case-studies, canceling method to enhance fetal ECG monitoring, Event detection. Heart rate variability-analysis;
4.	**Digital Image Processing**: Digital Image fundamentals, Image enhancement in spatial domain, Image enhancement in frequency domain, Image restoration, Image segmentation, wavelets based image processing

Recommended Books:

S. No	Name of Book	Author
1	Digital Signal Processing, Principles Algorithms and Applications	John G, Proakis and Dimitris G Manolakis

2	Introduction to Wavelets and Wavelet Transforms- A Primer	C. Sidney Burrus, Ramesh A. Gopinath and Haitao Guo
3.	Biomedical signal analysis-A Case-Study Approach	Rangaraj M Rangayan
4	Biomedical Digital Signal Processing	Willis J. Tompkins
5.	Digital Image Processing	Rafael C. Gonzalez, Richard E. Woods

Subject: Molecular Electronics (Code: ECT 456)	Year & Semester: B. Tech Electronics & Communication Engineering **4th Year & 8th Semester**		Total Course Credit: 3		
			L	**T**	**P**
			2	**1**	**-**
Evaluation Policy	Mid-Term	Internal Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Objectives: The course treats the emerging field of molecular electronics from basics. Organic semiconductors will be an important introductory part of this course. The theory and practice of fabricating discrete and integrated molecular electronic devices and their applications in diverse fields will be covered. Lessons from biological molecular behaviour for molecular electronics will be addressed.

Course Outcomes:

CO1	Understand the physics behind organic semiconductors
CO2	Transport properties in the molecular systems, Identify the molecules that can be used for different functions in molecular electronics
CO3	Choose a proper method or combined several methods for fabricating and characterizing organic systems.
CO4	Exploit the behaviour of the biomolecules for molecular electronic

Details of Syllabus:

S. No.	**Particulars**
1	Introduction to organic electronic materials and their basic properties; Electronic Structure of Molecules and energy structure of organic electronics
2	Electronic Properties; Optical properties: Energy levels, color changes, light emission and absorption; Charge transport Mobility, Doping and its Determination
3	Techniques to grow / Fabricate Organic films / Materials
4	Organic electronic circuit components: conductors, resistors, capacitors, diodes, transistors.
5	Organic electronics photovoltaics
6	Organic Memory
7	Characterization Techniques for organic Electronic materials
8	Organic bioelectronics : Applications in neuroscience and plant biology
9	An overview of current applications and commercialization: cost, implementation, environmental consideration, printed and flexible electronics

3 Suggested Book :

1.	Electronics Processes in Organic Crystals and Polymers	Martin Pope & Charles L. Swenberg
2.	Polymer Electronics	Hsin – Fei Meng
3	Organic Electronic Materials and Devices	Shuichiro Ogawa

<table>
<tr><td rowspan="3">Subject: Electrical Power Systems (Code: EET4xx)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics & Communication Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>-</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Internal Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objective: To introduce the concept of power systems, AC & DC distributors, transmission lines and to develop the concept of mechanical design of transmission lines.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Explain the knowledge of power systems generation, transmission & distribution.
CO2: Explain the knowledge of overhead line insulators and string efficiency.
CO3: Explain the modelling, design, capacity and various parameters of transmission lines.
CO4: Acquire knowledge of sag and tension calculations of overhead Transmission lines.
CO5: Explain concept of corona and its effect on line design.

Details of the syllabus:

S. No	Particulars
1	**DC and AC Distribution System:-** Introduction to a power system, definition and classification of distribution systems, connection schemes, various types of DC and AC distributors, voltage drop calculations.
2	**Overhead AC Transmission lines: -** Line Parameters and their calculations, types of conductors, skin effect and proximity effect, classification of overhead AC transmission lines, performance of transmission lines.
3.	**Insulators for overhead lines:-** Overview of insulators and materials used, types of insulators and their uses, potential distribution over a string of suspension insulators, string efficiency, methods for equalizing the potential.
4.	**Interference of power lines with communication circuits**:- Electrostatic and electromagnetic effect, definition and theory of Corona formation, factors affecting corona, critical disruptive and visual critical voltage, power loss due to corona, methods of reducing corona effect.
5.	**Mechanical design of transmission lines**. Sag and tension calculations, effect of wind and ice loading, stringing charts.

Recommended Books:

S. No.	Name of Book	Author (s)
1.	Elements of Power System Analysis	W. D. Stevenson
2.	Transmission & Distribution of Electrical Energy	H. Cotton & Barber
3.	Power System Engineering	Nagrath & Kothari
4.	Electrical Power Systems	C. L. Wadhwa

<table>
<tr><td rowspan="3">Subject: Artificial Intelligence & Machine Learning
(Code: CST 352)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech, Electronics & Communication Engineering 4th Year & 8th Semester</td><td colspan="2">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td></tr>
<tr><td>3</td><td>1</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="2">End Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="2">60 Marks</td></tr>
</table>

Objectives: (Maximum 25 Words) The objective of the course is to understand the fundamentals of computational intelligence, to know about the various knowledge representation methods, to understand the features of neural network and its implementation, to study about various data clustering methods. To gain knowledge in evolutionary computation and neuro – fuzzy systems.

Course Outcomes (COs):

Upon successful completion of the course, student should be able to:

CO1: Implement computational intelligence through applications

CO2: Understand knowledge representation methods and apply approximate reasoning

CO3: Apply evolutionary algorithm to solve the optimization problem

CO4: Gain research Knowledge to develop applications using hybrid systems

CO5: Able to Model Flexible Fuzzy Inference systems for dynamic nonlinear data sets.

Details of the syllabus:

S.No.	Particulars
1.	**Introduction to AI:** Philosophy of artificial intelligence, Course structure and policies. History of AI. Proposing and evaluating AI applications.
2.	**Search and Planning:**Fundamental and advanced search techniques Problem spaces and search, Heuristic search strategies, Search and optimization (gradient descent), Adversarial search, Planning, and scheduling (A*, local search, suboptimal heuristic search, search in AND/OR graphs), Constraint optimization
3.	**Knowledge Representation and Reasoning:**Logic and inference, Temporal reasoning, Knowledge representation and reasoning through propositional and first-order logic, modern game playing. Ontologies, Bayesian reasoning,
4.	**Fuzzy Logic** Crisp set and Fuzzy set, Basic concepts of fuzzy sets, membership functions. Basic operations on fuzzy sets, Properties of fuzzy sets, Fuzzy relations. Propositional logic and Predicate logic, fuzzy If-Then rules, fuzzy mapping rules, and fuzzy implication functions,
5.	**Applications in Machine learning: Supervised and Unsupervised methods** What is machine learning? Supervised vs. unsupervised learning, Regression -- linear, logistic, ridge , Classification – decision trees, SVM, random forests Reinforcement learning, Introduction to probabilistic graphical models (Bayesian networks, Hidden Markov models, Conditional random fields), Introduction to information systems (information retrieval, information extraction).

Recommended Books:

S. No	Name of Book	Author
1	A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013	Deepak Khemani.
2	Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall, 2009.	Stuart Russell and Peter Norvig.
3	Heuristics: Intelligent Search Strategies for Computer Problem Solving, Addison-Wesley, 1984.	Judea Pearl.

Subject: Optimization Techniques (Code: MTH 802)	**Year and Semester:** B. Tech Electronics & Communication Engineering. 4th Year & 8th Semester	**Total Course Credit: 3**		
		L	**T**	**P**
		2	**1**	**0**
luation Policy	**d-Term**	**Class Assessment**		**End -Term**
	Marks	10 Marks		60 Marks

Course Outcomes (COS): Upon successful completion of the course, students should be able to:
CO1: Identify, formulate, and solve the practical Engineering design problems by applying the optimization techniques.
CO2: Figure out the optimal value of the objective function besides presenting an organized strategy for evaluating a feasible region's vertices.
CO3: Determine the schedule for transporting goods from source to destination in a way that minimizes the shipping cost.
CO4:

- Solve multitude of operations research situations through conveniently modeling as networks (nodes connected by branches).
- Find sequence of processing jobs to minimize total elapsed time.
- Determine performance of queuing situation for deciding an appropriate level of service for the facility.

Details of the syllabus:

o	**Particulars**
	Unit-I: Introduction &Concepts of Optimization Formulation of Linear Programming Problems, General Statement of LPP, Assumptions Underlying LP, Solution of Linear Programming Problems: Graphic Method. Some Special Cases of Graphic Method, Convex Set: Extreme points of Convex Set, Convex hull.
	Unit-II: Simplex Techniques LP Model in Equation Form, Transition From Graphical To Algebraic Solution, Simplex Algorithm, Artificial starting solution: Big M-Method, Two-phase Method, Special cases in Simplex Method: Degeneracy, Alternative Optima, Unbounded solution, infeasible solution.
	Unit-III: Transportation Models Mathematical Model of Transportation Problem, Methods of finding Initial basic feasible solution by NWC Rule, LCM,VAM, Test for optimality by Stepping Stone and MODI method, Balanced and Unbalanced Transportation Problems, Degeneracy. Assignment Model: Mathematical Model of Assignment Problem, The Hungarian Method, Simplex Explanation of the Hungarian Method.
4.	**Unit-V: Engineering Applications** Network Models: Shortest route Algorithm, network Construction, Rules for network diagram, Techniques in project planning and Construction, CPM, Project Crashing. Sequencing Model: Advantages of Sequencing, Johnsons Algorithm of Sequencing problems, Type I: n jobs two machines, Type II: n jobs three machines, Type III: two jobs m machines.

	General Structure of Queuing System, Operating Characteristics of Queuing System, Queuing Models, Role of Poisson and Exponential Distributions, Pure Birth and Death Models, Generalized Poisson Queuing Model, Specialized Poisson Queues: Single, Multiple and Machine Serving Models.

Recommended Books:

1. Linear Programming by G. Hadlay, Addison Wasley.
2. Operations Research – An Introductory by Hamidi A. Taha, Macmillan.
3. Operations Research – Methods and problems by M. Sasieni, A. Yaspam and L. Friedman, John Wily and Sons Inc. London.

References:

1 Linear Programming by S.I. Gass, Mc-Graw Hill.
2 Introduction to Operations Research. John Wiley and Sons, New York.
3 Operations Research: An Introduction. Prentice Hall of India Private Limited, New Delhi Wagner.

Elective IV

Subject: TV Engineering le: ECE458)	**Year & Semester:** B. Tech Electronics & Communication Engineering 4th Year & 8th Semester		**otal Course Credit: 4**		
			L	T	P
			3	1	-
Evaluation Policy	**Mid-Term**	**lass Assessment**	**End-Term**		
	40 Marks	10 Marks	50 Marks		

Objectives: This course will develop the subject of TV Engineering from the basics. Starting from the analysis and theory of TV Pictures, Composite Video Signal, Receiver Picture Tube, we move on to the study of Monochrome Television Transmitter and Receiver systems. Aspects of Color TV systems theory will also be covered in detail.

Course Outcomes Upon successful completion of the course, student should be able to:
CO1: To study the analysis and synthesis of TV Pictures, Composite Video Signal, Receiver Picture Tubes and Television Camera Tubes
CO2: To study the principles of Monochrome Television Transmitter and Receiver systems.
CO3: To study the various Color Television systems with a greater emphasis on PAL system.
CO4: To study the advanced topics in Television systems and Video Engineering.

Details of the syllabus:

o	**Particulars**
	FUNDAMENTALS OF TELEVISION: Geometry form and Aspect Ratio - Image Continuity - Number of scanning lines - Interlaced scanning - Picture resolution - Camera tubes- Image orthicon - vidicon-plumbicon-silicon diode array vidicon-solid state image scanners- monochrome picture tubes- composite video signal-video signal dimension- horizontal sync. Composition- vertical sync. Details – functions of vertical pulse train – scanning sequence details. Picture signal transmission – positive and negative modulation – VSB transmission sound signal transmission – standard channel bandwidth.
	MONOCHROME TELEVISION TRANSMITTER AND RECEIVER: TV transmitter – TV signal propagation – Interference – TV transmission Antennas – Monochrome TV receiver – RF tuner – UHF, VHF tuner- Digital tuning techniques- AFT-IF subsystems - AGC – Noise cancellation- Video and sound inter carrier detection- vision IF subsystem- video amplifiers requirements and configurations - DC re- insertion - Video amplifier circuits- Sync separation – typical sync processing circuits- Deflection current waveform – Deflection Oscillators – Frame deflection circuits – requirements- Line Deflection circuits – EHT generation – Receiver Antennas.
	ESSENTIALS OF COLOUR TELEVISION: Compatibility – colour perception- Three colour theory- luminance, hue and saturation-colour television cameras- values of luminance and colour difference signals- colour television display tubes- delta –

	gun-precision – in-line and Trinitron colour picture tubes- purity and convergence- purity and static and dynamic convergence adjustments- pincushion correction techniques- automatic degaussing circuit- grey scale tracking – colour signal transmission- bandwidth- modulation of colour difference signals – weighting factors- Formation of chrominance signal.
	COLOUR TELEVISION SYSTEMS: NTSC colour TV system- NTSC colour receiver- limitations of NTSC system – PAL colour TV system – cancellation of phase errors- PAL –D colour system- PAL coder – Pal-Decolour receiver- chromo signal amplifier- separation of U and V signals- colour burst separation – Burst phase Discriminator – ACC amplifier- Reference Oscillator- Ident and colour killer circuits- U and V demodulators- Colour signal matrixing – merits and demerits of the PAL system – SECAM system – merits and demerits of SECAM system.
	ADVANCED TELEVISION SYSTEMS: Satellite TV technology- Cable TV – VCR- Video Disc recording and playback- Tele Text broadcast receiver – digital television – Transmission and reception- projection Television – Flat panel display TV receiver – Sterio sound in TV – 3D TV – EDTV – Digital equipments for TV studios.

Recommended Books:

. No	Name of Book	Author
1.	Monochrome Television Practice, Principles, Technology and servicing	By R.R.Gulati
2	Monochrome and colour Television	By R.R.Gulati
3.	Colour Television, Theory and Practice	By S.P.Bali

Subject: Telemedicine (Code:ECT460)	**Year & Semester:** B. Tech Electronics & Communication Engineering 4th Year & 8th Semester		**Total Course Credit: 3**		
			L	T	P
			2	1	0
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: This course presents how telecommunications technology is used by health care professionals to evaluate, diagnose and treat patients at a distance.

Course Outcomes : Upon successful completion of the course, student should be able to:

CO1: Understanding the Scope, Benefits and clinical applications of Telemedicine.
CO2: Understanding of data security & standards
CO3: Understanding of a tele-radiology system
CO4: Understanding various applications of telemedicine in medical fields.

Details of the syllabus:

S. No.	Particulars
1.	**History of Telemedicine:** Telemedicine: Definition and history, Block diagram, Scope, Benefits, Limitations and Clinical applications - Real-time and store-forward, Types of information: Audio, Video, Still Images, Text and data, and Fax - Types of Communication and Network: PSTN, POTS, ATN, and ISDN - Basic concepts of Communication and Network: Internet, and Wireless communications (GSM, Satellite and Micro- wave), Types of antennas depending on requirements.
2.	**Medical Data Security and Legal Issues:** Data Exchanges: Network configuration, Video conferencing- Data security and Standards: Encryption, Cryptography, Mechanisms and phases of encryption- Protocols and Standards -encryption, Ethical and legal aspects of Telemedicine, patient rights and consent form, aces to medical records, Intelectual property rights.
3.	Tele-Radiology and Tele-Pathology: Tele-radiology and its basic system components, Image acquisition system, Display system, Communication networks, Interpretation, Tele-pathology, Multimedia databases, color images of sufficient resolution, image compression methods, Interactive control of color and controlled sampling.
4.	**Other Medical Applications:** Tele-dermatology, Tele-psychiatry, Tele-cardiology, Tele-trauma, role of tele-education, evaluation in telemedicine, Tele-oncology, Tele-surgery, security and confidentiality tools.

Recommended Books:

S. No	Name of Book	Author
1.	Handbook of Telemedicine	Olga Ferrer-Roca, M.Sosa Ludicissa
2	Essentials of Telemedicine and Telecare	Norris A.C

		Total Course Credits: 3

Subject: RF Design (Code: ECT461)	**Year & Semester:** B. Tech Electronics and Communication Engineering 4th Year & 8th Semester		L	T	P
			2	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Objectives: This course will develop electronic circuits for radio frequency applications, specific to CMOS integrated circuits. As the course title suggests, the course will be specific to CMOS integrated circuits, and specific to radio frequencies. In particular, the course will focus on circuits for radio front-ends for mobile phone handsets. The course will cover low noise amplifiers, mixers, power amplifiers, frequency synthesizers (and phase locked loops). The course will also cover several modern radio architectures.

Course Outcomes

CO1 To design and analyze basic RF systems, architectures and passive RLC networks. To analyze the behavior of passive components at high frequencies.

CO2 Understanding the performance parameters and characteristics of noise parameters at high frequencies

CO3 Design and Analysis of RF amplifiers, Mixers, VCO and PLLs. Understanding the Frequency analysis of Oscillators and Mixers.

CO4 Design and Analysis of GSM, 3G and other communication technologies.

Details of Syllabus:

S. No	Particulars
1	RFIC System Overview: Complexity comparison, Design bottle necks, Applications, Analog and digital systems, Choice of Technology, Overview of RF Filter design and Transmission Lines, Smith Chart
2	Receiver Architecture: Different types of Receiver architectures; Performance parameters
3	Noise: Classification of Noise; Noise performance and limitations of devices, integrated parasitic elements at high frequencies
4	Low Noise Amplifiers: Low noise Amplifier design in different technologies and their performance
5	Mixers: Design of Mixers at GHz frequency range, Various mixers- working and implementation, Spur Chart
6	Voltage-Controlled Oscillators and Phase-Locked-Loop: Basic topologies VCO and definition of phase noise, Noise power and trade off, Radio frequency Synthesizers-PLLS, Various RF synthesizer architectures and frequency dividers
7	Power Amplifiers: General considerations, linear and nonlinear PAs, classification, High Frequency power amplifier, large signal impedance matching, linearization techniques

Recommended Book :

1.	RF Microelectronics Prentice Hall of India	Behzad Razavi
2.	The Design of CMOS Radio Integrated Circuits, Cambridge University Press	Thomas H. Lee
3	VLSI for Wireless Communication Prentice Hall of India	Leung Bosco

<table>
<tr><td rowspan="3">Subject: Smart Grid Communications (Code: ECT453)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Electronics and Communication Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credits: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Objectives: The objective of this course is provide electronics & communications engineering students with a basic understanding of communication systems concepts and principles as applied to electric utility applications. One of the key enabling technologies for the emerging “smart power grid” is the advanced communication technology. Hence, it is becoming imperative for ECE students to have an understanding of the communication technologies and their use for the smart grid. This course serves as an interdisciplinary course to prepare students to be knowledgeable in these critical and relevant areas of communications, cyber security and their use for the smart grid. In this course, students are also prepared to get exposure of recent trends in smart grid technology including IoT, Artificial Intelligence/Machine Learning based solutions for smart grid communication.

Course Outcomes:

CO1 To understand the overall objective of smart grid and its relevance to power distribution system.

CO2 To understand the smart grid communication network, data acquisition and control system

CO3 To understand the smart grid network architecture and its design and security issues.

CO4 To get exposure of recent trends in smart grid communication including IoT, Machine Learning and AI Based solutions.

Details of the syllabus:

S.No.	Particulars
1.	**Introduction to Smart Grid:** Definition, Objectives and Domain of Smart Grid; Revision of Voltage, Current, Alternating Current Phasor representation, Power Generation, Transmission System, Distribution System and Faults in Power System
2.	**Communication Networking for Smart Grid:** Elements of Data Communication Networks; Protocols and Protocol Layers; Data Networking Technologies; Supervisory Control and Data Acquisition systems (SCADA); Networking with SCADA; Teleprotection

3.	**Smart Grid Network Architect and Design:** Architecture Framework, Wide Area Network, Field Area Network (FAN), Network Design Process, Network Traffic, Routing architecture, QoS in Smart grid network, Security in Smart Grid Network
4.	**Recent Trends in Smart Grid:** IoT based Smart Grid Communication, Machine Learning and Artificial Intelligence Based Solutions for Smart Grid, Other recent trends based on recent Journal papers.

Recommended Books:

1.	Communication networks for smart grids. Springer London Limited, 2016.	Budka, Kenneth C., Jayant G. Deshpande, and Marina
2.	Smart grid: Communication-enabled intelligence for the electric power grid. John wiley & sons, 2014.	Bush, Stephen F.
3.	Smart grid communications and networking. Cambridge University Press, 2012.	Hossain, Ekram, Zhu Han, and H. Vincent Poor, eds.

Subject: Computer Networks **(Code: CST 54)**	**Year & Semester:** B. Tech, Electronics & Communication 4^{th} Year & 8^{th} Semester		**Total Course Credit: 4**		
			L	T	P
			3	1	-
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Objectives: (Maximum 25 Words) Concepts and implementation of computer networks; architecture, protocol layers, inter-networking and addressing; network application development.

Course Outcomes: Upon successful completion of the course, student should be able to:
CO1: Describe and analyze the hardware, software, components of a network and the interrelations.
CO2: Explain networking protocols and their hierarchical relationship
CO3: Compare protocol models and select appropriate protocols for a particular design.
CO4: Explain concepts and theories of networking and apply them to various situations, classifying networks

Details of the syllabus:

S.No.	Particulars
1.	**Basic concept of network:** Advantages and applications, Types of networks (LAN, MAN and WAN), Different network topologies like star, ring, hybrid, tree.
2.	**Network Protocol Architecture**: OSI Reference model, Layers of the OSI model. Physical, Data-link, Network, Transport, Session, Presentation and Application layer.
3.	**Network Switching Techniques:** Circuit switched, message switching and packet switched networks, Datagram and virtual circuit services, Frame relay, ATM
4.	**Flow and Error Control:** Stop and wait flow control, Sliding window flow control, error control protocols, ARQ techniques, Stop-&-wait ARQ, Go back by N ARQ, Selective repeat ARQ.
5.	**Routing algorithms:** Routing tables, features of a routing algorithm, classification, optimality principle, sink tree, shortest path algorithm, Dijkstra algorithm, flooding, fixed routing, random routing, adaptive routing, distance vector and link state algorithm. **Congestion Control:** Congestion in networks and quality of service.
6.	**Medium Access Control Protocols**: TDMA, FDMA, CDMA, ALOHA, Slotted ALOHA, CSMA, CSMA/CD, Ethernet, Token Ring network
7.	**Network security:** Need for network data security, plaintext, cifertext, encryption techniques, substitution, transposition, DES encryption standard, Private key, public key, Authentication.

Recommended Books:

S. No	Name of Book	Author
1	Data & Computer Communications, 7th Ed, PHI	William Stallings
2	Computer Networks, PHI	Andrew Tanenbaum,
3	Computer Networks, A Systems Approach", 5th ed., Elsevier, 2011	Peterson and Davie
4	"Computer Networks: An Open Source Approach", McGraw-Hill, 2011.	Ying-Dar Liu, Ren-Hung Hwang, Fred Baker,

Subject: Discrete Mathematics (Code: MAT 801)	**Year & Semester:** B. Tech Electronics & Communication Engineering 4th Year & 8th Semester		**Total Course Credit: 3**		
			L	**T**	**P**
			2	1	-
Evaluation Policy	**Mid-Term**	**Class Assessment**	**End-Term**		
	30 Marks	10 Marks	60 Marks		

Prerequisites: Elementary knowledge of set theory is needed.

Course Outcomes: This course covers discrete mathematics for Electronics and Communication Engineering. So, at the end the student should be able:

CO 1	to use different counting techniques
CO 2	to understand and identify structures on many levels
CO 3	to apply the concepts needed to test the logic of a programme
4	to familiarize the applications of some elementary algorithims and classical theorems on graphs, apply graphs in concrete situations
5	to apply the concepts and properties of algebraic structures like groups, rings and fields
6	to familiarize the properties of modular arithmetic

Details of the syllabus:

S.No	**Particulars**
1.	**Combinatorics (08 hrs)** Introduction, basic counting principles, pigeon hole priniciple with applications, inclusion-exclusion principle, recurrence relations and generating functions, introduction to special numbers.
2.	**Ordered sets and Lattices (08 hrs)** Ordered sets, Partially ordered sets, Supremum and Infimum, well ordered sets, Lattices, basic properties of algebraic systems defined by lattices, complemented lattices and distributive lattices. Coding Theory: coding of binary information and error detection, decoding and error correction
3.	**Graph Theory-I (08 hrs)** Introduction to graphs, graph terminology, Euler and Hamiltonian paths, graph connectivity, graph homomorphism, graph isomorphism, planar graphs, graph coloring, matrix representation of graphs, introduction to directed graphs, strong directed graphs
4.	**Graph Theory-II (06 hrs)** Introduction to trees, properties of trees, spanning trees, minimal spanning trees, Prim's Algorithm and Kruskal's Algorithm, matrix tree theorem, Degree sequences in trees, Necessary and sufficient conditions for a sequence to be a degree sequence of a tree.
5.	**Algebraic Structures (08 hrs)** Groups, subgroups, generators and relations, cyclic groups, groups of rotations and reflections, cosets and Langrange's Theorem, homomorphisms and normal subgroups, isomorphisms, automorphisms, semi-groups, rings, ring homomorphism and isomorphism,

	ideals, finite fields.
6.	**Number Theory & Cryptography (08 hrs)** Modular arithmetic, the distribution of primes, prime number theorem, Fermat's theorem and its consequences, symmetric ciphers, public key cryptography.

Text Books:
1. G. Chartand and P. Zhang, *A first course in graph theory,* 2nd Edition, Dover publications, New York, (2012).
2. M. R. Spiegel: *Discrete Mathematics (Schaum's Outline series)*, Tata Mc-Graw Hill, (2009).
3. K. H. Rosen, *Discrete Mathematics and its* applications, 5th Edition, Tata Mc-Graw Hill, (2003).
4. I. Niven, H. Zuckerman, An Introduction to Theory of Numbers, 5th Edition, Wiley Publications, (1991).

Reference Books:
1. C. L. Liu, *Elements of Discrete Mathematics*, 2nd Edition, Tata Mc-Graw Hill, (2000).
2. B. Kolman, R. Busby and S. Ross, *Discrete Mathematical Structures*, 6th Edition, Prentice Hall, (2009).
3. D. B. West, *Introduction to Graph Theory*, 2nd Edition, Pearson publications, (2002).
4. T. Koshy, *Discrete Mathematics with Applications*, 1st Edition, Elesvier Academic press, (2004).

DEPARTMENT OF INFORMATION TECHNOLOGY

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

SCHEME OF COURSES

FOR

B. TECH. INFORMATION TECHNOLOGY

2019 BATCH
3rd and 4th year

Semester - V

S.No.	Course	Code	L T P	Credits
1	Design & Analysis of Algorithms	ITT301	3 1 0	4
2	Microprocessor	ITT302	3 1 0	4
3	Computer Organization & Architecture	ITT303	3 1 0	4
4	Theory of Computation	ITT304	3 1 0	4
5	Data Communication	ITT305	3 1 0	4
6	Introduction to Probability and Statistics	MAT301	3 0 0	3
7	Design & Analysis of Algorithms Lab	ITL306	0 0 2	1
8	Microprocessor Lab	ITL307	0 0 2	1
	Total credits			**25**

Semester - VI

S.No.	Course	Code	L T P	Credits
1	Computer Networks	ITT350	3 1 0	4
2	Artificial Intelligence	ITT351	3 0 0	3
3	Computer Graphics	ITT352	3 0 0	3
4	Big Data	ITT353	3 0 2	4
5	Object-Oriented Programming II with Java	ITT354	3 0 0	3
6	Computer Networks Lab	ITL355	0 0 2	1
7	Artificial Intelligence Lab	ITL356	0 0 2	1
8	Computer Graphics Lab	ITL357	0 0 2	1
9	Object-Oriented Programming II with Java Lab	ITL358	0 0 2	1
10	Elective I	ITx0xx	Refer to Elective List	3
11	Tour & Training	ITI359	0 0 2	1
	Total credits			**25**

Semester - VII

S.No.	Course	Code	L T P	Credits
1	Wireless & Mobile Communication	ITT401	3 1 0	4
2	Information Security	ITT402	3 1 0	4
3	Image Processing	ITT403	3 1 0	4
4	Cloud Computing	ITT404	3 1 0	4
5	Information Security Lab	ITL405	0 0 2	1
6	Image Processing Lab	ITL406	0 0 2	1
7	Cloud Computing Lab	ITL407	0 0 2	1
8	Elective II	ITx0xx	Refer to Elective List	3
9	Pre project	ITP408	0 0 4	2
10	Seminar	ITS409	0 0 2	1
	Total credits			**25**

Semester - VIII

S. No.	Course	Code	L T P	Credits
1	Machine Learning	ITT450	3 1 0	4
2	Elective III or SWAYAM Course I	ITx0xx	Refer to Elective List	4
3	Elective IV or SWAYAM Course II	ITx0xx		4
4	Project	ITP451	0 0 20	10
5	Economics & Business Management	HST450	3 0 0	3
	Total credits			**25**

List of Electives

List of Electives

S. No.	Subject	Code	L	T	P	Credits
1.	Green Computing	ITT001	3	0	0	3
2.	Management Information Systems	ITT002	3	0	0	3
3.	Geographic Information System	ITT003	3	0	0	3
4.	E-Health	ITT004	3	0	0	3
5.	Bioinformatics	ITT005	3	0	0	3
6.	Biometrics and Network Security	ITT006	3	0	0	3
7.	Software Project Management	ITT007	3	0	0	3
8.	Cyber Security & Forensics	ITT008	3	0	0	3
9.	Pervasive Computing	ITT009	3	0	0	3
10.	System Design	ITT010	3	0	0	3
11.	Advanced Image Processing	ITT011	3	1	0	4
12.	Virtualization and Cloud	ITT012	3	1	0	4
13.	Ad hoc & Wireless Sensor Networks	ITT013	3	1	0	4
14.	Natural Algorithms	ITT014	3	1	0	4
15.	Natural Language Processing	ITT015	3	1	0	4
16.	Network Management & administration	ITT016	3	1	0	4
17.	Distributed Computing	ITT017	3	1	0	4
18.	Advanced Artificial Intelligence	ITT018	3	1	0	4
19.	Foundations of Automatic Verification	ITT019	3	1	0	4
20.	Realtime Operating System	ITT020	3	1	0	4
21.	Advanced Database Management Systems	ITT021	3	1	0	4
22.	Deep learning	ITT022	3	1	0	4
23.	High Performance Computing	ITT023	3	1	0	4
24.	Synthesis of Digital Systems	ITT024	3	1	0	4
25.	Advanced Algorithms	ITT025	3	1	0	4
26.	Advanced Computer Networks	ITT026	3	1	0	4
27.	Simulation using Matlab and Python	ITL027	1	0	4	3
28.	Blockchain	ITT028	2	0	2	3
29.	Object Oriented Programming using JAVA	ITT029	2	0	2	3
30.	Digital Signal Processing	ITT030	3	1	0	4
31.	Introduction to Logic and Functional Programming	ITT031	3	1	0	4
32.	Advanced Computer Graphics	ITT032	3	1	0	4
33.	Embedded Systems	ITT033	3	0	2	4
34.	Computer vision and Robotics	ITT034	3	0	2	4
35.	Expert Systems	ITT035	3	0	2	4
36.	Open Source and Software development	ITT036	3	0	2	4
37.	Internet of Things	ITT037	3	0	2	4

List of electives from other Departments

S. No.	Subject	Code
1.	Compiler Design	CS0
2.	VLSI Design	EC0
3.	Operations Research	MA0
4.	Optimization Techniques	MA0
5.	Mathematical Modeling & Simulations	MA0
6.	Numerical Methods	MA0

** Electives relevant to the coursework offered by other departments may also be included*

5th Semester

Course Title	Code	L	T	P	Credits
Design & Analysis of Algorithms	**ITT301**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: Understand basics of algorithm efficiency and asymptotic notations.
CO2: Study various divide & conquer and greedy algorithms.
CO3: Understand the concept of dynamic programming with applications.
CO4: Study various graph searching and traversal algorithms.
CO6: Understand various computational complexity measures.

Syllabus:

UNIT I - Introduction
Algorithm Design paradigms - motivation, concept of algorithmic efficiency, run time analysis of algorithms, Asymptotic Notations, Master theorem.

UNIT II - Divide & Conquer methods
Divide & Conquer algorithms: examples, Binary search, Quick sort, Strassen's algorithm for matrix multiplication, analysis of divide and conquer runtime reference relations.

UNIT III - Dynamic Programming and Greedy paradigm
Overview of dynamic programming, difference between dynamic programming and divide and conquer. Dynamic Programming: Matrix Chain Multiplication (MCM), Longest Common Subsequence (LCS), Optimal Binary Search Tree (OBST). Overview of the greedy paradigm. General Greedy approach Vs Dynamic Programming approach Case studies: fractional Knapsack vs 0/1 Knapsack problem.

UNIT IV - Graph searching and traversal
Representation of Graphs, Breadth First Search, Depth First Search, Topological Sort, Strongly Connected Components, examples of exact optimization solution (minimum cost spanning tree), Dijkstra's and Bellman ford algorithm, All pair shortest path, Flyod Warshall Algorithm.

UNIT V - Backtracking and Computational complexity
Back Tracking: Overview, 8-queen problem. Branch & Bound: LC searching, bounding, FIFO branch and bound, Travelling salesman problem. Computational complexity Complexity measures, Polynomial vs non-polynomial time complexity; NP hard and NP complete classes, examples

Text Books:

1. Introduction to Algorithms, by Cormen, Leiserson, Rivest, and Stein, MIT Press.

Reference Books:

1. Algorithms, by Dasgupta, Papadimitrou and Vazirani, McGraw-Hill Education, 2006.
2. Computer Algorithms, by Horowitz, Sahni, and Rajasekaran, Silicon Press, 2007.
3. Algorithm Design, by Kleinberg and Tardos, Pearson, 2005.
4. Algorithm Design, by Goodrich and Tamassia, Wiley, 2001.

Course	**Code**	**L**	**T**	**P**	**Credits**
Microprocessor	**ITT302**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: Describe the general architecture & organization of 8085 and 8086 Microprocessor and understand the difference between 8085 and advanced microprocessor.
CO2: Understand and classify the instruction set of 8085 and 8086 microprocessors and distinguish the use of different instructions and apply it in assembly language programming.
CO3: Ability to understand and write programs for stacks, delays, counters and subroutines.
CO4: Illustrate how the different peripherals (8255, 8279, etc.) are interfaced with Microprocessor
CO5: Analyze the data transfer information through serial and parallel ports.

Syllabus:

UNIT I - MICROPROCESSOR-BASED SYSTEMS: HARDWARE AND INTERFACING:

Microprocessors, Microcomputers, and Assembly Language, Introduction to 8085 Assembly Language Programming, Microprocessor Architecture and Microcomputer Systems, 8085 Microprocessor Architecture and Memory Interfacing Interfacing I/O Devices

UNIT II - PROGRAMMING THE 8085:

Introduction to 8085 Instructions, Programming Techniques with Additional Instructions, Counters and Time Delays, Stack and Subroutines, Code Conversion, BCD Arithmetic, and 16-Bit Data Operations, Software Development, Assemblers, and IDE

UNIT III - INTERFACING PERIPHERALS (I/OS) AND APPLICATIONS:

Interrupts, Interfacing Data Converters, Programmable Interface Devices: 8155 I/O and Timers: 8279 Keyboard / Display Interface, General Purpose Programmable Peripheral Devices, Serial I/O and Data Communication, Microprocessor Applications, Trends in Microprocessor Technology

UNIT IV - MICROPROCESSOR 8086:

Pin diagram, Architecture, Addressing Modes, Timing diagram, Instruction Set, Programming Techniques, Interrupt, Assembler Directives, Memory & I/O mapping

Text Books:

1. Ramesh S.Goankar, Microprocessor Architecture, Programming and Applications with the 8085.

Reference Books:

1. Douglas .V Hall, Microprocessor & Interfacing, Tata McGraw Hill
2. Rafiquzzuman .M, Microprocessor theory & Applications, Prentice Hall of India

3. Yuchenhiu, Glenn A Gibson, Microprocessor Systems - 8086/8088 Family, Prentice Hall of India

Course	Code	L	T	P	Credits
Computer Organisation & Architecture	**IT T303**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: Understand the basics of computer architecture and how it interacts with the software. Understand how computers represent and manipulate data. Understand computer arithmetic.
CO2: Understand how decisions made in hardware affect the software/programmer as well as hardware designer.
CO3: Understand the fundamental principles and tradeoffs in designing the hardware/software interface i.e., instruction set architecture.
CO4: Understand the design of major components of a modern programmable microprocessor.
CO5: Understand the techniques to improve the performance of the modern processors.
CO6: Understand the basics of the memory hierarchy in the high performance computers and the numerous techniques to improve the efficiency of the memory system.

Syllabus:

UNIT I - INTRODUCTION TO COMPUTER ARCHITECTURE AND ORGANIZATION:
Defining computer architecture and computer organization, classes of computers, basic structure of computers, Operational concepts, performance and Amdhal's law.

UNITY II - ARITHMATIC AND LOGIC UNIT:
Microperations and their RTL specifications, Adder/Subtractor, Shifter, Multiplication and division circuits, Arithmatic logic shift unit.
Arithmetic addition & Subtraction of Signed and unsigned numbers-algorithm and hardware, Multiplication and division of Signed and unsigned numbers-algorithm and hardware, IEEE754 representation of Floating Point Numbers & Operations.

UNIT III - CONTROL AND PROCESSOR UNT:
Control Unit: Machine instructions, Execution of a complete Instruction, Multiple Bus organization, Hardwired control, Micro-programmed control.
Processor Unit: Components, organization types, addressing modes, Instruction types, Concept of sub-routine and sub-routine call. Use of stack.

UNIT IV- I/O AND MEMORY UNIT:I/O Unit:

Synchronous vs. Asynchronous I/O, I/O techniques - interrupts, polling, DMA, IOP
Memory unit: Memory organization, Types of memories and performance considerations, organization of memory modules, associative memory, cache memory and related mapping and replacement policies, virtual memory.
Introduction to Pipelining: Concepts, Basic pipelining, Hazards.

Text Books:

1. Computer Organization, Hamachar, Vranesic & Zaky, TMH.
2. Computer Organization & Architecture, M. M. Mano, PHI.

Reference Books:

1. Computer system architecture, Morris Mano, Pearson.
2. Computer organisation & Architecture, Paterson.

Course	Code	L	T	P	Credits
Theory of Computation	**ITT304**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: Explore the different ways to reason about the correctness of algorithms for solving various computer science problems?
CO2: Defining the working and properties of various computational models. How do we mathematically model computers?
CO3: Designing finite automata and regular expressions, writing context-free grammars, reducing problems to one another.
CO4: Explore why some problems are harder to solve than others, and see how to reason with mathematical certainty.
CO5: Find the limits of what problems can be solved by computers. Proving which problems are impossible to solve with computers. Exploring $P \stackrel{?}{=} NP$.

Syllabus:

UNIT I - INTRODUCTION:
Mathematical Preliminaries and Notation, Sets, Relations, and Functions, Graphs, Methods of Proof, Basic Concepts: Languages, Grammars, Automata, some applications. Finite State Automata: Deterministic Finite acceptors, Deterministic acceptors and transitions Graphs, Languages and DFAs, regular languages, Non-deterministic Finite Acceptors, Definition, why Nondeterminism, Equivalence of NFA and DFA, Reduction of finite automata.mealy and Moore machines,

UNIT II - REGULAR LANGUAGES AND REGULAR GRAMMARS:
Regular expressions, definition, language associated with regular expressions, connection between Regular expression and regular languages, regular grammars, right and left linear grammars. Closure properties of regular languages under various operations, identifyingNonregular languages. Pigeonhole principle, pumping lemma.

UNIT III - CONTEXT-FREE LANGUAGES:
Definition of context free grammars, examples, leftmost and rightmost derivations, derivation Tree, Parsing and ambiguity, parsing and membership, ambiguity in grammars and languages. Context Free languages and programming languages. Methods for transforming grammars, substitution rules, removing useless productions, removing **λ**-productions, Removing Unit productions, Normal forms, Chomsky form, Greibach Normal form, Membership algorithms for context fee grammars. Properties of CFL, pumping lemmas, closure properties and decision algorithm properties, decidable properties of CFL.

UNIT IV - PUSHDOWN AUTOMATA:

Definition of Pushdown Automata, Nondeterministic Pushdown Automata, languages accepted by PDA, PDA for CFL,CFL for PDA, DPDA and DCFL. Grammars for CFLs.
Turing Machines: The Standard Turing Machine, Definition of a TuringMachine, Turing Machines as Language AcceptersTuring Machines as Transducers, Combining Turing Machines for Complicated Tasks, Turing's Thesis, variations on Turing machine. Nondeterministic Turing machine

UNIT V - UNDECIDABILITY:
The ChomskyHierarchy, Recursive and Recursively Enumerable Languages, Context-Sensitive (grammars and Languages, A language that is not Recursively Enumerable (RE),problems that cannot be solved by using Turing machine, An undecidable problem that isRE, Undecidable problems about Turing Machine, Post’s Correspondence Problem ,the complexity classes P and NP and language families.

Text Books:

1. Peter Linz, "An Introduction to Formal Language and Automata", Narosa Publishing house.
2. M.Sipser; Introduction to the Theory of Computation; Singapore: Brooks/Cole, Thomson Learning.
3. John.C.martin, "Introduction to the Languages and the Theory of Computation", Tata McGrawHill.
4. K.Krithivasan and R.Rama; Introduction to Formal Languages, Automata Theory and Computation; Pearson Education.
5. J.E.Hopcroft, R.Motwani and J.D.Ullman , "Introduction to Automata Theory Languages and computation", Pearson Education Asia.

Course	Code	L	T	P	Credits
Data Communication	**ITT305**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: Understand the basics of data and signal.
CO2: Study OSI and TCP/IP reference models and compare the two.
CO3: Discuss the different types of network topologies and types of networks based on size with suitable applications.
CO4: Explore the existing types of transmission media and compare them with the state of the art.
CO5: Study various techniques of analog and digital conversions.
CO6: Understand various techniques used in the physical layer and data link layer.

Syllabus:

UNIT I - DATA COMMUNICATION NETWORK: Data communication concept, Basic concept of network, Types of networks (LAN, MAN and WAN), Different network topologies like star, ring, hybrid, tree. Network models (OSI and TCP/IP).
Transmission media: Guided and unguided media, twisted wire pair, co-axial cable, optical fibre, microwave links, satellite microwave link, their characteristic features and applications for data transmission.
Data and signals: Data, Signals, Types of Signals, Bandwidth, spectrum, transmission impairments, Shanon capacity.

UNIT II - DIGITAL TRANSMISSION TECHNIQUES: Digital-to digital conversions: NRZ, RZ, Biphase, Manchester coding, AMI. Analog-to-digital conversions: Nyquist sampling theorem, quantization, Pulse code modulation, Delta modulation.

UNIT III - ANALOG TRANSMISSION TECHNIQUES: Digital-to-analog conversion: ASK, FSK, PSK, QAM. Signal constellation. Analog-to-analog conversion: amplitude modulation, frequency modulation, phase modulation.

UNIT IV - BANDWIDTH UTILIZATION TECHNIQUES: Frequency Division Multiplexing, Time Division Multiplexing, Wavelength division Multiplexing, Spread Spectrum.

UNIT V - ERROR DETECTION AND CORRECTION: Errors in data communication: Types of errors, error detection and correction techniques, simple parity check, computation of CRC, Checksum, Hamming code.

Recommended Books:

1. William Stallings: Data & Computer Communications, PHI.
2. Andrew Tanenbaum, “Computer Networks” PHI
3. Sklar, “Digital Communications fundamentals & Applications”.
4. Keizer, “ Local Area Networks” McGraw Hill

Course	Code	L	T	P	Credits
Introduction to Probability and Statistics	**MAT301**	**3**	**0**	**0**	**3**

Course Outcomes (COs):

CO1: Understand the basic concepts of random variables, probability distribution.

CO2: Understand concepts behind different distributions and their applications.

CO3: Understand the concept of joint probability distribution, Correlation Coefficient, Transformation of random variables,Regression Analysis

CO4: Compute point estimation of parameters, explain sampling distributions, and understand the central limit theorem.

CO5: Construct confidence intervals on parameters for a single sample.

Syllabus:

Unit-I Random variables:

Discrete and Continuous Random variables, Distribution functions, Expectation and Variance of Probability distribution, and Moment Generating function, Moments and properties. Discrete distributions: Binomial, Poisson and Geometric distributions and their applications.

Continuous distribution: Uniform, Exponential and Normal distributions, Normal approximation to Binomial distribution and their applications.

Unit II: Two-Dimensional Random Variables

Bivariate Random Variables, Joint Distribution Functions (Discrete and Continuous), Marginal and Conditional Distributions, Covariance and Correlation Coefficient, Transformation of random variables. Regression Analysis, Linear and Non linear Regression, Multiple regression, Curve fitting by method of least squares, fitting of straight lines, polynomials, exponential curves.

Unit III: Sampling Theory

Population and Sample, Statistical inference, Sampling with and without replacement, Random samples, Population parameters, Sample statics, Sampling distributions, Sample mean, Sampling distribution of means, Sample variances, Sampling distribution of variances, Case where population variances is unknown, Unbiased estimates and efficient estimates, point estimate and Interval Estimates, Confidence Interval estimates of population parameters.

Textbooks Recommnded:

1. Introductory STATISTICS, Neil A. Weiss, 9th Edition. Pearson, 2012.

2. Probability and Statistics for Engineers, Johnson, Miller and Freund, Pearson Education, 8th Edition, 2015.
3. Fundamentals of Statistics, S. C. Gupta, 7th Edition, Himalaya Publishing House 2018.
4. S. Ross: A First Course in Probability, 6th Ed., Pearson Education India, 2002.
5. Fundamentals of Mathematical Statistics, S.C. Gupta, V.K Kapoor, Sultan Chand,
6. Introduction to Mathematical Statistics, Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Second Edition, LPE Pearson Prentice hall, 2007.

References:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Third Edition, Narosa Pub. House, 2008.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000
3. An Introduction to Probability and Mathematical Statistics, V.K. Rohatgi and A. K. Md. Ehsanes Saleh, Second Edition, John Wiley and sons, 2008.
4. Schaum's Outline ofTheory and Problems of Probability, Random Variables, and Random Processes, Hwei P. Hsu, Tata Mc-Graw Hill Edition.

Course Title	Code	L	T	P	Credits
Design & Analysis of Algorithms Lab	**ITL306**	**0**	**0**	**2**	**1**

Course Outcomes (COs):

CO1: Implement various divide and conquer based algorithms.
CO2: Study and implement greedy algorithms for minimum cost spanning tree, Knapsack problem, single source shortest paths.
CO3: Implement dynamic programming.
CO4: Implement various graph searching and traversal algorithms.
CO6: Implement branch and bound algorithm for various problems.

Syllabus:

1.	Divide and conquer algorithms.
2.	Greedy algorithms for minimum cost spanning tree, Knapsack problem, single source shortest paths.
3.	Dynamic Programming with applications.
4.	Graph searching and traversal algorithms.
5.	Backtracking algorithms: 8-queen problem and Knapsack problem.
6.	Branch and bound algorithm with applications.

Course	Code	L	T	P	Credits
Microprocessor Lab	**ITL307**	**0**	**0**	**2**	**1**

Course Outcomes (COs):

CO1: To become familiar with the architecture and Instruction set of Intel 8085 microprocessor
CO2: To provide practical hands on experience with Assembly Language Programming.
CO3: Develop ALP for 8 and 16 bit Arithmetic operations using 8086 microprocessor.
CO4: To familiarize the students with interfacing of various peripheral devices with 8085 microprocessor.
CO5: Analyze the data transfer information through serial & parallel ports.
CO6: To improve programming logic and concepts of 8085 microprocessor by developing programs for various applications.

Syllabus:

i) To develop a program to add two double byte numbers.
ii) To develop a subroutine to add two floating point quantities.
iii) To develop program to multiply two single byte unsigned numbers, giving a 16 bit product.
iv) To develop subroutine which will multiply two positive floating points numbers?
v) To write program to evaluate P* Q*+R* & S are 8 bit binary numbers.
vi) To write a program to divide a 4 byte number by another 4 byte number.
vii) To write a program to divide an 8 bit number by another 8 bit number upto a fractional quotient of 16 bit.
viii) Write a program for adding first N natural numbers and store the results in memory location X.
ix) Write a program which decrements a hex number stored in register C. The Program should half when the program register reads zero.
x) Write a program to introduce a time delay of 100 ms using this program as subroutine display numbers from 01H to OAH with the above calculated time delay between every two numbers.
xi) N hex numbers are stored at consecutive memory locations starting from X. Find the largest number and store it at location Y.
xii) Interface a display circuit with the microprocessor either directly with the bus or by using I/O ports. Write a programme by which the data stored in a RAM table is displayed.
xiii) To design and interface a circuit to read data from an A/D converter, using the 8255 A in the memory mapped I/O.
xiv) To design and interface a circuit to convert digital data into analog signal using the 8255 A in the memory mapped I/O.
xv) To interface a keyboard with the microprocessor using 8279 chip and transfer the output to the printer.

xvi) To design a circuit to interface a memory chip with microprocessor with given memory map.

6th Semester

Course	Code	L	T	P	Credits
Computer Networks	**ITT350**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: Understand the need for networking in general and computer networks in particular.
CO2: Study the prevalent TCP/IP reference model and understand various error, flow and access control strategies.
CO3: Study the IPV4 addressing and the strategies to delay the transition to IPV6 using techniques like subnetting, VLSM, NAT.
CO4: Understand routing in networks and study various routing algorithms.
CO5: Study the mechanism for connection establishment, termination between the nodes and the ways of reducing network congestion.
CO6: Understand various application layer services.

Syllabus:

UNIT I - INTRODUCTION:
History and development of computer networks, networks topologies. Layering and protocols.

UNIT II - PHYSICAL LAYER:
Different types of transmission media, errors in transmission: attenuation, noise. Encoding (NRZ, NRZI, Manchester, AMI, etc.).

UNIT III - DATA LINK LAYER AND SWITCHING:
MAC Layer: Aloha, CSMA, CSMA/CD, CSMA/CA protocols. Data Link Layer: Error detection (Parity, CRC), Framing, Sliding Window, Stop and Wait protocols, HDLC. Switching Theory: Circuit Switching, Message switching, Packet switching.

UNIT IV - NETWORK LAYER:
Network layer: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Dijkstra, Bellman-Ford Algorithms. Subnetting, Classless addressing, Network Address Translation.

UNIT V - TRANSPORT AND APPLICATION LAYER:
Transport layer: UDP, TCP. Connection establishment and termination, sliding window revisited, flow and congestion control, timers, retransmission, TCP extensions.

Application layer: DNS, SMTP, IMAP, HTTP, etc.

Recommended Books:

1. JF Kurose, KW Ross, Computer Networking: A Top-Down Approach.
2. Behrouz A. Forouzan, Data communications and Networking.
3. Andrew S. Tanenbaum, Computer Networks.
4. William Stallings, Data and Computer Communications.

Course	Code	L	T	P	Credits
Artificial Intelligence	**ITT351**	**3**	**0**	**0**	**3**

Course Outcomes (COs):

CO1: Gain historical perspective of AI and its formation.
CO2: Introduce the basic principles of AI problem solving.
CO3: Apply basic principles in problem solving, inference, perception, knowledge representation and learning.
CO4: Investigate applications of AI techniques in intelligent agents, expert systems, machine learning models.
CO5: AI development tools and techniques.

Syllabus:

UNIT I - INTRODUCTION:
Introduction to AI and intelligent agents.Problem Solving : Solving Problems by Searching, heuristic search techniques, constraint satisfaction problems, stochastic search methods, adversarial search,Game playing : minimax, alpha-beta pruning.

UNIT II - KNOWLEDGE REPRESENTATION AND REASONING:
Building a Knowledge Base : Propositional logic, first order logic, Theorem Proving in First Order Logic. Production Systems, Semantic Nets, Frames and Scripts Formalisms. Resolution in Predicate Logic, Unification, Strategies for Resolution by Refutation. Knowledge Acquisition and learning: Learning from examples and analogy, Rote learning, Neural Learning, Integrated Approach. Planning, partial order planning. Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks.

UNIT III - INTRODUCTION TO MACHINE LEARNING:
Machine Learning, Supervised Learning, Unsupervised Learning, Reinforcement Learning. Introduction to Probability, Basics Linear Algebra, Statistical Decision Theory – Regression & Classification, Bias – Variance, Overfitting and complexity; training, validation, test data.

UNIT IV - EXPERT SYSTEM:
Existing Systems (DENDRAL, MYCIN), domain exploration, Meta Knowledge, Expertise Transfer, Self Explaining System.Fuzzy logic: Fuzzy Logic Propositional logic, Membership functions, Fuzzy logic, Fuzzy rule generation, De-fuzzification, Time dependent fuzzy logic, Temporal fuzzy logics, Case study-to use fuzzy logic for processes control problem
Programming Language: Introduction to programming Language- LISP, PROLOG

UNIT V - NEURAL NETWORKS:
Overview of different forms of learning, Learning Decision Trees, Neural Networks- Basics of

Neural Networks: Perceptrons, Feedforward nets Backpropagation algorithm, preliminary understanding of unsupervised learning.
Pattern Recognition: Introduction to Pattern Recognition, Structured Description, Symbolic Description, Machine perception, Line Finding, Interception, Semantic & Model, Object Identification, Speech Recognition.

Text Books:

1. Rich & Knight, “Artificial Intelligence”.
2. Elamie, “artificial Intelligence”, Academic Press.

Reference Books:

1. Char nick “Introduction to Artificial Intelligence”, Addision Wesley.
2. Winston, “LISP”, Addison Wesley.

Course	Code	L	T	P	Credits
Computer Graphics	**ITT352**	**3**	**0**	**0**	**3**

Course Outcomes (COs):

CO1: Understand the basics of computer graphics, different graphics systems and applications of computer graphics.
CO2: Provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.
CO3: Use of geometric transformations on graphics objects and their application in composite form.
CO4: Extract scene with different clipping methods and its transformation to graphics display device.
CO5: Explore projections and visible surface detection techniques for display of 3D scene on 2D screen.
CO5: Render projected objects to naturalize the scene in 2D view and use of illumination models for this.

Syllabus:

UNIT I - INTRODUCTION:
computer graphics, Co-ordinate representation, Pixel, Raster Scan & Random Scan methods, color, CRT Raster, scan basics, video basics, interactive devices, graphics input and output devices, mouse, track ball, light pen, digitizer, thumb wheel, raster scan graphics, applications.

UNIT II - Line GENERATION:
Points and lines generation algorithm, DDAlines drawing algorithm, Bresenham's lines drawing algorithm, circle generating algorithm, midpoint circle algorithm,midpoint ellipse generating algorithm, other curves, conic sections, polynomial and spline curves, Pixels addressing, filled-area primitives, scan-line polygon filled algorithms, inside-outside tests, scan-line fill of curved boundary algorithms,boundary fill algorithms,flood-fill algorithms, fill-area functions, character generation.

UNIT III - SEGMENTS:
Segments table, Creating, Deleting and renaming a segment Visibility, Image transformation.

UNIT IV - TRANSFORMATION:
2D Transformation, An introduction to 3D transformation, Projections, Light, color and shading.

UNIT V - WINDOWING AND CLIPPING:
Viewing transformation, Clipping. Generalized clipping IN 2D.
Hidden line and surfaces: Back-face Removal Algorithms, Hidden line methods
Rendering and Illumination: Introduction to curve generation, Bezier, Hermite and B-spline algorithms and their Comparisons

Text Books:

1. Computer Graphics (Principles and Practice) by Foley, van Dam, Feinerand Hughes, Addisen Wesley.
2. Computer Graphics by D Hearn and P M Baker, Printice Hall of India.
3. Mathematical Elements for Computer Graphics by D F Rogers, McGraw Hill
4. Procedural Elements for Computer Graphics by D F Rogers, McGraw Hill

Course	Code	L	T	P	Credits
Big Data	**ITT353**	**3**	**0**	**2**	**4**

Course Outcomes (COs):

CO 1: Understand Big Data, its platform and its use cases .
CO 2: Provide an overview of Apache Hadoop ,HDFS Concepts and Interfacing with HDFS
CO 3: Understanding Data Sciences and Data life cycle
CO 4: Understanding and Using Supervised and Unsupervised Learning Algorithms
CO 5: Tools and Technologies for Unstructured Data Analytics
CO 6: Implementing Machine Learning algorithms using Python

Syllabus:

Unit I - INTRODUCTION:
Big Data Overview, Introduction to the Big Data problem. Current challenges, trends, and applications, Algorithms for Big Data analysis. Data sets, Mining and learning algorithms that deal with large datasets Technologies for Big Data management. Big Data technology and tools, special consideration made to the Map-Reduce paradigm and the Hadoop ecosystem.

Unit II - DATA SCIENCE:
What is data sciences, The rising and importance of data sciences, Big data analytics in industry verticals, Data Analytics Lifecycle and methodology, Data Understanding, Data Preparation.

Unit III - MODELING:
Evaluation, Communicating results, Deployment, Data exploration & preprocessing.

Unit IV - MEASURES AND EVALUATION:
Data Analytics: Theory & Methods, Supervised learning, Linear/Logistic regression, Decision trees, Naïve Bayes, Unsupervised learning, K-means clustering, Association rules

Unit V - UNSTRUCTURED DATA ANALYTICS:
Technologies & tools, Text mining, Web mining, Operationalizing an Analytics project, Data Visualization Techniques, Creating final deliverables
Term project: Using Amazon AWS, BlueMix, Cognos, Biginsights.

Text Books:

1. Big Data: A Revolution That Will Transform How We Live, Work, and Think by Viktor Mayer-Schönberger, Kenneth Cukier.

2. Hadoop: The Definitive Guide by Tom White (Goodreads Author), Doug Cutting , oreily Publiactions.
3. Real-Time Big Data Analytics: Emerging Architecture [Kindle Edition], Mike Barlow

Course	Code	L	T	P	Credits
Object-Oriented Programming II with Java	**ITT354**	**3**	**0**	**0**	**3**

Course Outcomes (COs):

CO1: Understand various basics related to java programming, object-oriented programming and other concepts like JVM, JVM architecture, JIT compilation.

CO2: Understand the underlying principles of object-oriented programming like abstraction, polymorphism etc and getting familiar with various java classes. Learn to define and import packages, implement interfaces.

CO3: Getting familiar with exception and string handling in java. Study creation, concatenation and conversion of a string, searching and modification, string comparison. String Buffer and StringBuilder classes and Date class.

CO4: Have detailed knowledge on concurrent programming and file handling. Study various data collectors available in java like ArrayList, LinkedList, Queue etc. Understanding thread execution, multithreading, thread priorities and scheduling, synchronization. Understanding file handling, creating, writing, reading, updating, touching and deleting files, Byte Streams and Character Streams, InputStream & OutputStream classes and their subclasses, Reader and Writer classes and their subclasses.

CO5: Be familiar with graphical components like buttons, labels, events, windows etc through which user can interact with the applications. Working with controls and layout managers, event handling and data validation.

Syllabus:

UNIT I - INTRODUCTION:

What is Java? Background/History of Java, Java Virtual Machine, JVM Architecture, Byte code, HotSpot JVM and JIT Compilation, Basics of OOP. Introduction to Classes and Objects. Data types. Garbage collection: Eden space, Survivor Space, Tenured generation, Permanent generation, Code cache, loops and flow control.

UNIT II - OBJECT ORIENTED PROGRAMMING CONCEPTS:

Abstraction, Encapsulation, Polymorphism and Overloading, Constructors and destructors scope of declarations, Access Control, Nested and Inner classes. Array handling. Using extends keyword, subclass, super-class, over- riding methods, dynamic method dispatch, The Object class, Abstract and final classes. Packages: defining, importing, Access Control. Interface: Defining, Implementing and applying interface. Wrapper classes.

UNIT III - EXCEPTION AND STRING HANDLING:

Basic exceptions, user defined exceptions, catching exceptions – try, catch and multi try catch, throwing and re-throwing, finally clause. String Handling: Creation, concatenation and conversion of a string, searching and modification, string comparison. StringBuffer and StringBuilder classes and Date class.

UNIT IV - CONCURRENT PROGRAMMING AND FILE HANDLING:

Generics & Collections: List interface, ArrayList, LinkedList, Queue, Stack,
Threads: Create new threads – extending java.lang.Thread, implementing java.lang.Runnable Interface, Understanding thread execution, multithreading, thread priorities and scheduling, synchronization Introduction to java.util.concurrent classes and interface and using java.util.concurrent.Callable interface. Introduction to Fork-Join Framework.
File handling, Creating, writing, reading, updating, touching and deleting files, Byte Streams and Character Streams, InputStream & OutputStream classes and their subclasses, Reader and Writer classes and their subclasses.

UNIT V - GUI COMPONENTS:
Introduction to AWT and Swing, frames, panels, buttons and events, layout managers, text fields, labels. Working with controls and layout managers, event handling and data validation, Applets. Introduction to JavaFx.

Text Books:

1. Java for Programmers, P.J. Dietel, H. M. Dietel, Pearson Education.
2. Java SE 6, Joel Murach, A. Steelman, SPD Pvt. Ltd.
3. Head first java, Kathy Sierra, Bert Bates, Oreilly.
4. Core Java, Cay Horstman and Gary Cornell, Prentice Hall

Course	Code	L	T	P	Credits
Computer Networks Lab	**ITL355**	**0**	**0**	**2**	**1**

Course Outcomes (COs):

CO1: Understand colour coding of guided media and create crossover and straight through cable.
CO2: Implement basic network utilities and analyse network traffic using Wireshark tool.
CO3: Hands-on Cisco Packet Tracer by building basic networks and configuring internetworking devices like router, switch.
CO4: Implement static and dynamic routing in Packet Tracer and configure access control lists.
CO5: Simulate wireless networks using NS3.

Syllabus:

1. Study and implementation of colour coding standards of guided media (UTP).
2. Implementation and understanding of basic network utilities: ping, ipconfig/ifconfig, mstsc, nslookup, tracert.
3. Network traffic capture and analysis using Wireshark.
4. Introduction to Cisco Packet Tracer: Building a LAN with HUBs and Switches, understand and implement address learning in switches.
5. Router Configuration Using Packet Tracer, IP addressing (static and dynamic), subnetting.
6. Static/Dynamic Route Configuration.
7. Implementation of routing protocols (RIP, OSPF, BGP).
8. Standard access control list (ACL) configuration, Extended access control list (ACL) configuration.
9. Implementation of flow control protocols.

Course	Code	L	T	P	Credits
Artificial Intelligence Lab	**ITL356**	**0**	**0**	**2**	**1**

Course Outcomes (COs):

CO1: Understand simple facts and variables.
CO2: Implement and apply simple predicates, predicate inference and goal queries
CO3: Demonstrate the proficiency in applying scientific methods to models of machine learning.

Syllabus:

AI PYTHON LAB CONTENTS

1. Input & Output
2. Operators and Arithmetic
3. Facts & Variables
4. Simple facts and facts with arguments
5. Rules & Predicates
6. Simple Predicates, Predicate Inference, Goal queries
7. Recursion
8. Graph Traversal
9. Depth First Search, Breadth First Search

Course	**Code**	**L**	**T**	**P**	**Credits**
Computer Graphics Lab	**ITL357**	**0**	**0**	**2**	**1**

Course Outcomes (COs):

CO1: Understand the basic concepts of computer graphics.
CO2: Design scan conversion problems using C programming.
CO3: Apply clipping and filling techniques for modifying an object.
CO4: Understand the concepts of different type of geometric transformation of objects in 2D and 3D.
CO5: Understand the practical implementation of modeling, rendering, viewing of objects in 2D

Syllabus:

1. Point drawing to understand co-ordinate system of display device.
2. To implement Bresenham's algorithms for line generation.
3. To implement DDA algorithm for line generation.
4. To implement midpoint circle generation algorithm
5. To implement midpoint ellipse generation algorithm
6. To implement flood-fill and boundary fill algorithm.
7. To perform 2D Transformations such as translation,
8. To perform 2D Transformations such as rotation,
9. To perform 2D Transformations such as scaling,
10. To perform 2D Transformations such as reflection
11. To perform 2D Transformations such as shearing.
12. To implement Cohen-Sutherland 2D clipping and window-viewport mapping.
13. To perform 3D Transformations such as translation, rotation and scaling.
14. To visualize projections of 3D images.
15. To convert between color models.
16. To implement text compression algorithm using librarires.
17. To implement image compression algorithm using librarires.
18. To perform animation using any Animation software.
19. To perform basic operations on image using any image editing software.

20. Implementation of viewing/rendering pipeline.

Course	Code	L	T	P	Credits
Object-Oriented Programming II with Java Lab	**ITL358**	**0**	**0**	**2**	**1**

Course Outcomes (COs):

CO1: Implementing the underlying principles of object-oriented programming like abstraction, polymorphism etc and various java classes.
CO2: Learn to define and import packages, implement interfaces.
CO3: Implementing exception handling, creating user defined exceptions, catching exceptions. Creation, concatenation and conversion of a string, searching and modification, string comparison. Implementing String Buffer and StringBuilder classes and Date class.
CO4: Using various data collectors available in java like ArrayList, LinkedList, Queue etc. Implementing multithreading, thread priorities and scheduling, synchronization. Implementing various file handling, creating, writing, reading, updating, touching and deleting files, Byte Streams and Character Streams, InputStream & OutputStream classes and their subclasses, Reader and Writer classes and their subclasses.
CO5: Executing graphical components like buttons, labels, events, windows etc through which user can interact with the applications.

Syllabus:

1. Java package with simple stack and queue class
2. Complex number manipulation
3. Date class similar to java.util package
4. Implementing dynamic polymorphism in java
5. Java interface for ADT stack
6. Developing a simple paint like program using applet
7. Developing a scientific calculator
8. Developing a template for linked list
9. Develop a multi threaded producer consumer Application
10. Generating prime numbers and Fibonacci series
11. Multithreaded GUI application

7th Semester

Course	Code	L	T	P	Credits
Wireless & Mobile Communication	**ITT401**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: Understand the need for wireless communication
CO2: Study cellular concepts design capacity and different methods to eliminate interference.
CO3: Study various access techniques like FDMA, TDMA, etc and wireless networks and wireless protocols like WAP
CO4: Understanding wireless standards like GSM, CDMA etc.
CO5: Understanding various security issues and methods to increase security in wireless systems

Syllabus:

UNIT I - INTRODUCTION TO WIRELESS NETWORKS:
Introduction-Evolution of mobile radio communications-Differences Between Wireless And Fixed Telephone Networks-Development Of Wireless Networks- Traffic Routing In Wireless Networks-Integrated Services Digital Network (ISDN)- Protocols For Network Access

UNIT II - PRINCIPLES OF CELLULAR WIRELESS NETWORKS:
Introduction- Frequency Reuse- Channel Assignment Strategies-Handoff Strategies- Interference And System Capacity- Trunking And Grade Of Service-Improving Capacity In Cellular Systems.

UNIT III - MULTIPLE ACCESS TECHNIQUES:
Introduction-Multiple Access Techniques: FDMA,TDMA, CDMA- Space Division Multiple Access- Spread Spectrum - Packet Radio

UNIT IV - WIRELESS SYSTEMS AND STANDARDS:
Global System for Mobile communication - CDMA Digital Cellular Standard (IS-95) - CT2 Standard for Cordless Telephones- Digital European Cordless Telephones (DECT). Mobile communication: Mobile data management in 1G,2G,3G, Frequency reuse, sectoring, GSM and CDMA architecture, EDGE technology, Mobile IP, Mobile Agents.

UNIT V - MOBILE AND WIRELESS SECURITY:
Creating Secure Environment- Security Threats-WAP Security: TLS-WTLS-IPSec- Application Level Security- Smart Client: Architecture, Security-Firewalls- VPNs-Two factor Authentication. Mobile Communication & application development.

Text Books:

1. Theodore.S.Rappaport, *Wireless Communications-Principles and practice*, Prentice Hall Communications Engineering and Emerging Technologies Series, Upper Saddle River, New Jersey
2. Martyn Mallick, *Mobile and Wireless Design Essentials*, Wiley Dreamtech India pvt ltd.
3. Geoff Varall, Roger Belcher,*3G Handset & Network Design*, Wiley Dreamtech India pvt ltd.

References:

1. Jochen Schiller, *Mobile Communications*, Addision Wesley
2. William C.Y.Lee, *Mobile Communication Design Fundamentals*, John Wiley

Course	**Code**	**L**	**T**	**P**	**Credits**
Information Security	**ITT402**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: To study the history, need, and various approaches to Information security.
CO2: To understand the use of encryption and decryption
CO3: To study the various technical aspects and strategies of implementation of Symmetric Encryption
CO4: To study the various technical aspects and strategies of implementation of Asymmetric Encryption
CO5: Achieving Authentication using keys

Syllabus:

UNIT I - INTRODUCTION TO INFORMATION SECURITY:
Introduction, the History of Information Security, What Is Security, CNSS Security Model, Components of an Information System, Balancing Information Security and Access, Approaches to Information Security, the Systems Development Life the Security Systems, Development Life Cycle, Security Professionals and the Organization.

UNIT II - THE NEED FOR SECURITY:
Introduction, Business Needs First, Threats, Attacks, And Secure Software Development. Planning for Security: Introduction, Information Security Planning and Governance, Information Security Governance, Information Security Policy, Standards, and Practices, The Information Security Blueprint ,Security Education, Training, and Awareness Program, Continuity Strategies, Model for a Consolidated Contingency Plan, Law Enforcement Involvement.

UNIT III - IMPLEMENTING AND MAINTENANCE:
Introduction, Information Security Project Management, Developing the Project Plan, Project Planning Considerations, Scope Considerations, the Need for Project Management, Technical Aspects of Implementation, Conversion Strategies,the Bull's-Eye Model, Considerations for Organizational Change, Information Systems Security Certification and Accreditation.

UNIT IV - CRYPTOGRAPHY:
Introduction, Foundations of Cryptology, Cipher Methods, Substitution Cipher, Transposition Cipher, Exclusive OR, Vernam Cipher, Book or Running Key Cipher, Hash Functions, Cryptographic Algorithms, Symmetric Encryption, Asymmetric Encryption, Examples, Encryption Key Size, Cryptographic Tools, Public-Key Infrastructure (PKI), Digital signature ,Digital Certificates, Hybrid Cryptography Systems, Steganography, Attacks on Cryptosystems, Man-in-the-Middle Attack, Correlation Attacks, Dictionary Attacks, Timing Attacks, Defending Against Attacks, Protocols for Secure Communications, S-HTTP and SSL, S/MIME, PEM, and PGP, SET, WEP and WPA,IEEE 802.1x based authentication, IPSec and PGP.

Text Books:

1. Michael E. Whitman, Herbert J. Mattord, "Principles of information security",Course Technology, Cengage Learning.

Reference Books:

1. William Stallings, “Cryptography and Network Security – Principles and Practices”.
2. Michael E. Whitman, Herbert J. Mattord, “Hands-On Information Security Lab Manual” Course Technology, Cengage Learning.

Course	Code	L	T	P	Credits
Image Processing	**ITT403**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: To understand what a digital image is and the steps involved in image processing.
CO2: To understand image acquisition process and develop any image processing application.
CO3: To learn different techniques employed for the enhancement of image.
CO4: To understand different color image models and learn different causes of image degradation and overview of image restoration.
CO5: To understand the need for image compression and to learn spatial and frequency domain techniques for image compression, segmentation of image and understand morphological image processing

Syllabus:

UNIT I - INTRODUCTION:
What is digital image processing? The origins of digital image processing, Fundamental steps in digital image processing, components of an image processing system.

UNIT II - DIGITAL IMAGE FUNDAMENTALS:
Image sensing and acquisition, Image sampling and quantisation, basic relationships between pixels, linear and non-linear operations.

UNIT III - IMAGE ENHANCEMENT IN THE SPATIAL DOMAIN:
Gray level transformations, histogram processing, enhancement using arithmetic/logic operations, spatial filtering, smoothing and sharpening.
Image enhancement in Frequency Domain: Fourier transform and frequency domain, smoothing and sharpening frequency domain filters
Image Restoration: A Model of the Image Degradation/Restoration Process. Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering. Constrained Least Squares Filtering, Geometric Mean Filter, Geometric Transformations.

UNIT IV - COLOUR IMAGE PROCESSING:
Fundamentals, models, colour transformations, smoothing and sharpening, colour segmentation and noise.
Image Segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding, region based segmentation, morphological watersheds.
Representation and description: Representation, boundary descriptors, regional descriptors, relational descriptors.

UNIT V - IMAGE COMPRESSION:
Morphological Image Processing, Representation and Description.

Text Books:

1. Rafael C Gonzalez, Richard E Woods, Digital Image Processing - Pearson Education
2. Rafael C Gonzalez, Richard E Woods, Digital Image Processing with MATLAB- Pearson Education.

Reference Books:

1. William K Pratt, Digital Image Processing, John Willey
2. A.K. Jain, PHI, Fundamentals of Digital Image Processing, pearson Education.
3. Chanda & Majumdar, “Digital Image Processing and Analysis” , PHI.
4. Mark Nelson, Jean-Loup Gailly “The Data compression Book”, bpb Publications.

Course	**Code**	**L**	**T**	**P**	**Credits**
Cloud Computing	**ITT404**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: Understand various basic concepts related to cloud computing technologies.
Understand the architecture and concept of different cloud models: IaaS, PaaS, SaaS
Understand big data analysis tools and techniques.
CO2: Understand the underlying principle of web services, cloud virtualization, cloud storage, data management and data virtualization.
CO3: Understand different Multi-tenant software, Be familiar with cloud file systems.
CO4: Have detailed knowledge on cloud computing security challenges and other issues.
CO5: Be familiar with setting up cloud. Understanding integrating tools.

Syllabus:

UNIT I - INTRODUCTION TO CLOUD COMPUTING:

Definition, Characteristics, Components, Cloud provider, SAAS, PAAS, IAAS and Others, Virtualization concepts; Types of Virtualization & its benefits, Introduction to Various Virtualization OS(Vmware , KVM etc), HA/DR using Virtualization, Moving VMs ,SAN backend concepts,Cloud Fundamentals; Cloud Building Blocks, Understanding Public & Private cloud environments.
Cloud Technologies, Study of Hypervisors.

UNIT II - WEB SERVICES, AJAX AND MASHUPS:

Web services: SOAP and REST, SOAP versus REST, AJAX: asynchronous 'rich' interfaces, Mashups: user interface services.
Virtualization Technology: Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization.

UNIT III - MULTI TENANT SOFTWARE:

Multi-entity support, Multi-schema approach, Multi-tenance using cloud data stores, Data access control for enterprise applications.Data in the cloud Relational databases,
Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo. Map-Reduce and extensions: Parallel computing, The map-Reduce model, Parallel efficiency of Map-Reduce, Relational operations using Map-Reduce, Enterprise batch processing using Map-Reduce.

UNIT IV - CLOUD COMPUTING SECURITY CHALLENGES:

Issues in cloud computing, Implementing real time application over cloud platform Issues in Intercloud environments, QOS Issues in Cloud, Dependability, data migration, streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment .Vulnerability assessment tool for cloud, Privacy and Security in cloud Virtualization security management- virtual threats, VM Security Recommendations, VM-Specific Security techniques, Secure Execution Environments and Communications in cloud.

UNIT V - SETTING UP CLOUD:

How to build private cloud using open source tools, Understanding various cloud plugins, Setting up your own cloud environment; Auto provisioning, Custom images, Integrating tools like Nagios ,Integration of Public and Private cloud.

Text Book:

1. Cloud Computing for Dummies by Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper
2. Enterprise Cloud Computing by Gautam Shroff,Cambridge
3. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley-India

Reference Book:

1. Google Apps by Scott Granneman,Pearson
2. Cloud Security & Privacy by Tim Malhar, S.Kumaraswammy, S.Latif (SPD,O'REILLY)
3. Cloud Computing : A Practical Approach, Antohy T Velte, et.al McGraw Hill,
4. Cloud Computing Bible by Barrie Sosinsky, Wiley India

Course	**Code**	**L**	**T**	**P**	**Credits**
Information Security Lab	**ITL405**	**0**	**0**	**2**	**1**

Course Outcomes (COs):

CO1: To create and understand use of vulnerable machines
CO2: To use traffic analysis, enumeration and fingerprinting tools
CO3: To understand use of password cracking tools
CO4: To deploy tools to protect a system

Syllabus:

1. Deploying virtual machines testbed over virtualization software such as: VMPlayer or VirtualBox
2. Creating test machines including Kali/Backtrack and vulnerable machine.
3. Configure and demonstrate use of Traffic monitoringtool such as: Wireshark and tcpdump
4. Configure and demonstrate use of basic Enumeration tools such as: Ping,traceroute, nslookup,dig, nmap
5. Configure and demonstrate use of fingerprinting tools such as: Nmap(Zenmap) ,hping3,DMitry.
6. Configure and demonstrate use of vulnerability assessment tool such as: Nessus, openVAS.
7. Configure and demonstrate use exploit tool such as: metasploit framework.
8. Demonstrate use of a password cracking tool using brute force attack, dictionary attack rainbow tables.
9. Configure and demonstrate use of computer forensics tool.
10. Configuring and deploying Firewall.
11. Configure and demonstrate use of IDS tool such as snort.
12. Configuring and deploying IDPS.

Course	Code	L	T	P	Credits
Image Processing Lab	**ITL406**	**0**	**0**	**2**	**1**

Course Outcomes (COs):

CO1: Display image, its histogram, zoom and shrink image
CO2: Perform enhancing operations on the image using spatial filters and frequency domain filters. Remove noise from image
CO3: Use transforms and analyze the characteristics of the image.
CO4: Perform segmentation operations in the images.

Syllabus:

1. Display an image and its histogram.
2. Perform shrinking, zooming and cropping of an image.
3. Perform the experiment for histogram equalization.
4. Perform blurring and de-blurring on an image.
5. Implement the spatial image enhancement functions on a bitmap image – Mirroring (Inversion).
6. Implement the spatial image enhancement functions on a bitmap image – Rotation (Clockwise).
7. Implement the spatial image enhancement functions on a bitmap image – Enlargement (Double Size).
8. Implement (a) Low Pass Filter (b) High Pass Filter.
9. Implement (a) Arithmetic Mean Filter (b) Geometric Mean Filter.
10. Removal of salt and pepper noise.
11. Implement Smoothing and Sharpening of an eight bit color image.
12. Implement (a) Boundary Extraction Algorithm (b) Graham's Scan Algorithm.
13. Implement (a) Edge Detection (b) Line Detection.

Course	**Code**	**L**	**T**	**P**	**Credits**
Cloud Computing Lab	**ITL407**	**0**	**0**	**2**	**1**

Course Outcomes (COs):

CO1: Student should understand and appreciate cloud architecture.
CO2: Student can create and run virtual machines on open source OS
CO3: Student can implement Infrastructure, storage as a Service.
CO4: Student can install and configure Hadoop and Map/Reduce.
CO5: Students can install and appreciate security features and user management for cloud using web application.

Syllabus:

1. Introduction to cloud computing.
2. Implementation of SOAP Web services in C#/JAVA Applications.
3. Implementation of para-virtualization using VM Ware's Workstation/Oracle's Virtual Box and Guest O.S.
4. Implementation of IAAS, SAAS.
5. Installation and Configuration of Hadoop.
6. Create an application (Ex: Word Count) using Hadoop Map/Reduce.
7. Case Study: PAAS (Facebook, Google App Engine)
8. Case Study: Amazon Web Services

8th Semester

Course	Code	L	T	P	Credits
Machine Learning	**ITT450**	**3**	**1**	**0**	**4**

Course Outcomes (COs):

CO1: Develop an appreciation for what is involved in learning models from data.
CO2: Understand a wide variety of learning algorithms.
CO3: Understand how to evaluate models generated from data.
CO4: Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models

Syllabus:

UNIT I - INTRODUCTION:
Machine Learning, Supervised Learning, Unsupervised Learning, Reinforcement Learning. Introduction to Probability, Basics Linear Algebra, Statistical Decision Theory – Regression & Classification, Bias – Variance, Overfitting and complexity; training, validation, test data.

UNIT II - SUPERVISED LEARNING
Regression:-Linear Regression-Cost Function, Gradient Descent with single and multivariable, Normal Equation, Regularization Techniques (LASSO), Polynomial Regression
Classification:- Logistic Regression-Hypothesis Representation, Decision boundary, Cost Function, Multi class Classification, KNN, Ensemble methods, Decision Trees, Naïve Bayes,

UNIT III- ARTIFICIAL NEURAL NETWORKS AND SVMs
Neurons and biological motivation. Linear threshold units. Perceptrons: representational

limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks, SVMs:-(Maximum margin linear separators), optimization objectives,. Kernels for learning non-linear functions.

UNIT IV - UNSUPERVISED LEARNING

Clustering:-K-Means, K Nearest Neighbours, Association Rule Learning
Dimensionality Reduction, PCA, SVD, tSNE
Markov Models

UNIT V - MACHINE LEARNING APPLICATIONS

Healthcare, Retail, Financial Services, Manufacturing, Hospitality, Cloud Based ML Offerings
Developing and Evaluating an Anomaly Detection System, Recommender Systems.

Text Books:

1. Machine Learning by Tom Mitchell (ML)
2. Introduction to Machine Learning by Ethem Alpaydin (IML)
Elements of Statistical Learning by Trevor Hastie, Robert Tibshirani and Jerome Friedman (available online for free) (ESL)
3.Pattern Recognition and Machine Learning by Christopher Bishop (PRML)

Department of Mechanical Engineering Department

Semester-V

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET301	Heat Transfer	3	1	0	4	4
2.	MET302	Design of Machine Elements	3	1	0	4	4
3.	MET303	Mechanical Vibrations	3	1	0	4	4
4.	MET304	Industrial Engineering - I	3	1	0	4	4
5.	MET305	IC Engines	3	1	0	4	4
6.		Microprocessors in Automation	3	0	0	3	3
7.	MEL310	Heat Transfer Lab	0	0	2	2	1
8.	MEL311	Mechanisms and Vibrations Lab	0	0	2	2	1
						Total Credits	**25**

Semester-VI

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET351	Production Engineering	3	1	0	4	4
2.	MET352	Mathematical Methods	3	0	0	3	4
3.	MET353	Control Systems	3	1	0	4	4
4.	MET354	Fluid Mechanics - II	3	1	0	4	4
5.	MET3XX	Elective - I	3	1	0	4	3
6	MET4XX	Elective-II –(Design, Ther. & Pro.)	2	1	0	3	3
7.	MEL361	Applied Thermodynamics Lab	0	0	2	2	1
8.	MEL362	Industrial Engineering – I Lab	0	0	2	2	1
9.	MEI364	Tour & Training	-	-	-	-	1
						Total Credits	**25**

Semester-VII

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET401	Mechatronics and Measurement Systems	3	1	0	4	4
2.	MET402	Industrial Engineering - II	3	1	0	4	4
3.	MET403	Machine Design	3	1	0	4	4
5.	MET4XX	Elective-III–(Design, Ther. & Pro.)	3	1	0	4	4
6	MET4XX	Elective –IV (Swayam Course)	3	1	0	4	4
6.	MEL411	Mechatronics and Measurement Systems Lab	0	0	2	2	1
7.	MEL412	Industrial Engineering – II Lab	0	0	2	2	1
8.	MES463	Seminar	0	0	4	4	1
9.	MEP413	Major Project – Stage I	0	0	6	-	2
						Total Credits	**25**

Semester-VIII

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET451	Operations Research	**3**	**1**	**0**	**4**	**4**
2.	MEL4XX	Elective-V–(Design, Ther. & Pro.)	**3**	**1**	**0**	**4**	**4**
3.	MEL4XX	Elective-Vi–(Swayam Course)	**3**	**1**	**0**	**4**	**4**
4.	MEL4XX	Elective-VIi–(Design, Ther. & Pro.)	**3**	**1**	**0**	**4**	**4**
5.	MEP463	Major Project – Stage II	**0**	**0**	**18**	**-**	**9**
						Total Credits	**25**

<table>
<tr><td rowspan="3">Subject: Heat Transfer (Code: MET301)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering 3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

After the completion of course, students will be able,

CO1	Identify, formulate and solve steady, transient and multidimensional heat conduction problems.
CO2	Understand the phenomenon of convection and be able to evaluate heat transfer coefficients for natural and forced convection.
CO3	Calculate radiation heat exchange between black as well as non-black surfaces
CO4	Be able to solve a wide range of real world problems involving conduction, convection and radiation

Unit I

Introduction, Physical origins and rate equations, conduction, convection, radiation, relationship to thermodynamics, Combined conduction-convection-radiation problems, Importance of heat transfer, conduction rate equation, thermal conductivity, general heat conduction equation, boundary and initial conditions, one dimensional steady heat conduction, plane wall, thermal resistance, composite wall, contact resistance, alternate conduction analysis, one dimensional steady heat conduction in cylinders and spheres, critical radius of insulation, one dimensional steady state heat conduction with heat generation in plane walls, cylinders and spheres, heat transfer from extended surfaces, fins with constant area, fin performance.

Unit 2

Two-dimensional steady state heat conduction, method of separation of variables, conduction shape factor and dimensionless conduction heat rate, unsteady heat conduction, Lumped capacity analysis, criteria for lumped capacity analysis, transient heat conduction in a semi-infinite solid, Biotand Fourier numbers, transient heat conduction in large plane walls, long cylinders and spheres with spatial effects, transient heat conduction in multi-dimensional systems.

Unit 3

Convection boundary layers, Velocity and thermal boundary layer, local and average heat transfer convection coefficients, derivation of differential convection equations, solutions of convection equations for a flat plate, Nusselt and Prandtl numbers, relation between fluid friction and heat transfer, Turbulent-boundary-layer heat transfer, flow across cylinders and spheres, flow across tube banks, Internal forced convection, mean velocity, mean temperature, empirical relations for pipe and tube flows, Free convection heat transfer on a vertical flat plate, Grashof and Raleigh numbers, Empirical relations for free convection, Combined free and forced convection.

Unit 4

Thermal radiation, black and gray surfaces, Radiation laws, Radiation shape factor, relation between shape factors, Radiation heat exchange between black bodies, Radiation heat exchange between non-black bodies, Radiation shields, Condensation heat transfer phenomenon, condensation number, film condensation inside horizontal tube, boiling heat transfer, simplified relations for boiling heat transfer with water, heat exchangers, overall heat transfer coefficient, fouling, types of heat exchangers, log mean temperature difference, Effectiveness-NTU method, Compact heat exchangers.

Textbooks:

1. Incropera, F.P., Dewitt, D.P., Bergman, T.L., Lavine, A.S., “Principles of Heat and Mass Transfer”, Wiley, 2017.
2. Holman, J.P., “Heat Transfer, McGraw Hill, 2011.

Reference Books:

1. Bejan, A., “Heat Transfer”, John Wiley, 1993.
2. Cengal, Y.A., Ghajar, A.J., “Heat Transfer”, McGraw Hill, 2020.

DESIGN OF MACHINE ELEMENTS

Course No.: MET 302 **C L T (4 3 1)**

Core Course Pre-requisites: Engineering mechanics, Mechanics of solids and Engineering materials science.

Course objective: To teach Mechanical Engineering Students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.

Course Content:

UNIT I

Design requirements, Selection of materials and manufacturing considerations in design.
Riveted joints: Introduction, Types of riveted joints, Failures of riveted joints, Strength of riveted joint, Efficiency of riveted joint. Design of longitudinal butt joint and circumferential lap joint for a Boiler.
Bolts, Nuts & Screws: Introduction, Advantages & disadvantages, Definitions, Forms of screw threads, Common types of screw fastenings, locking devices. Designation of screw threads, Stresses in screwed fastening due to static loading.
Welded connections: Introduction, Advantages & disadvantages of welded joints, welding processes, fusion welding, thermit welding, gas welding, Electric arc welding, forge welding. Types of welding joints, Lap joint, Butt joint, Strength of transverse fillet welded joints, strength of parallel fillet welded joints, special cases of fillet welded joints, axially loaded unsymmetrical welded sections.

UNIT II

Stress concentration: Theoretical or form stress concentration factor, Stress concentration factor due to holes and notches, Methods of reducing stress concentration. Cyclic loading and endurance limit: Completely Reversed or cyclic stresses, Fatigue and endurance limit, effect of loading on endurance limit, Effect of surface finish, size and miscellaneous factors on endurance limit. Combined steady and variable stress: Gerber method for combination of stresses, Goodman method for combination of stresses, Soderberg method for combination of stresses.

UNIT III

Cotter and Couplings: Types of cotter joints, Socket and spigot cotter joint, Design of socket and spigot cotter joint, Design of sleeve and cotter joint. Types of shaft couplings, Design of sleeve and muff coupling, Design of flange coupling.
Power Screws: Types of screw threads used for power screws, Torque required to raise load on square threaded screws, torque required to lower load by square threaded screws, Efficiency of square threaded screws, Maximum efficiency of a square threaded screw. Over Hauling and Self locking screws. Design of screw jack.
Shafts: types of shafts, design of shafts, shafts subjected to twisting Moment only, Shafts subjected to bending moment only, shafts subjected to combined twisting moment and bending moment.

Course Outcomes:
On successful completion of the course, Students should be able to:
1. Demonstrate knowledge on basic machine elements used in machine design.

2. Understand the stress and strain on machine components and identify and quantify failure modes for machine parts.

3. Design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.

4. Approach a design problem successfully, taking decisions when there is not a unique answer.

Course Assessment:

Students will be assessed on:

1. Continuous assessment in the form of homework, assignments, attendance, and presentations (10% weightage).

2. One and half hour written exams designated as Mid-term (30% weightage).

3. Two hour written exams designated as End-term (60% weightage).

Text Books:

1. Ullman D.G., "The Mechanical Design process", 3rd edition, McGraw Hill, 2009.

2. Mott, R.L, "Machine Elements in Mechanical Design", 4th edition, Prentice Hall, Singapore, 2005.

3. Shigley, J.E., Mischke, C. Brown T., "Standard Hand book of Machine Design", McGraw Hill.

Reference Books:

Shigley, J.E., "Hand Book of Machine Design", McGraw Hill, 2004

<table>
<tr><td rowspan="3">Subject: Mechanical Vibrations (Code: MET303)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering 3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, a student should be able to:

CO1: Develop the mathematical models of vibrating systems, determine their DOF, and determine the free and forced vibration response of such systems.
CO2: Determine the response of linear time-invariant systems to arbitrary forcing conditions using the convolution integral and the Laplace Transform method.
CO3: Formulate the equations of motion of multiple degree of freedom systems, express it as an eigen value problem and determine the free and force vibration response.
CO4: Derive the equations of motion of a continuous system, determine its natural frequencies and mode shapes, and obtain the free vibration response to given initial conditions.

Detailed Syllabus:

UNIT I

Harmonic Motion, Vibration Terminology, Complex Methods of Representing Harmonic Motion, Fourier Series and Harmonic Analysis, Free and Forced Vibrations, Degrees of Freedom, Mathematical Modeling of Vibrating Systems, Differential Equations of Motion, Solution of the Differential Equation of Motion, Torsional Vibrations, Various Types of Damping, Dry Friction or Coulomb Damping, Structural Damping, Viscous Damping. Logarithmic Decrement, Energy Dissipated By Damping, Equivalent Viscous Damping, Introduction to Energy Methods.

UNIT II

Forced Harmonic Vibrations, Rotating Unbalance, Support Motion, Vibration Isolation and Control, Vibration Measuring Instruments, Vibration Pickups, Vibrometers and Accelerometers, Vibrations under General Forcing Conditions, Impulse Excitation, Arbitrary Excitation, Convolution Integral, Use of Laplace Transforms, Pulse Excitation and Rise Time, Shock Response Spectrum, Shock Isolation.

UNIT III

Two-Degree-of-Freedom Systems, Normal Mode Analysis, Coordinate Coupling and Principal Coordinates, Forced Harmonic Vibration, Vibration Absorbers and Vibration Dampers, Generalized Coordinates, Natural Frequencies and Mode Shapes, Modal Analysis, Multi-degree-of-Freedom Systems

UNIT IV

Continuous Systems, Longitudinal Vibration of a Bar, Equation of Motion and Solution, Orthogonality of Normal Functions, Lateral Vibration of Beams, Equation of Motion, Initial Conditions, Boundary Conditions, Effect of Axial Force, Effects of Rotary Inertia and Shear Deformation, Whirling of Shafts, Critical Speeds, Balancing of Rotating Shafts, Single-Plane Balancing, Two-Plane Balancing

Text Book:

1. Grover, G. K., Mechanical Vibrations, 7th edition, Nem Chand and Bros, New Delhi, India 1996.

Reference Books:

1. Thomson, W. T., Theory of Vibrations with applications, Fifth Edition, Pearson Education, 2004.
2. Rao, S. S., Mechanical Vibrations, Sixth Edition, Pearson Education.

Course No.: MET 304 **INDUSTRIAL ENGINEERING -I** **C L T (4 3 1)**

COURSE OUTCOMES:

1. **Understanding the concept and applications of industrial engineering with a focus on productivity, work design and work study.**
2. **Analysing & applying the method study techniques in relation to a particular job environment.**
3. **Analysing & evaluating various engineering work measurement techniques designed to establish the time for a qualified worker to carry out a specific job at a defined level of performance.**
4. **Attain a grasp of the fundamental principles of experimental design, collection of data related to work study, their analysis and interpretation.**

UNIT I

Concept of industrial productivity**:** Introduction and significance of Industrial engineering with brief explanation of its techniques, Functions of Industrial Engineering, Definitions and explanation of Productivity with significance in Industries, Productivity measurements, Factors affecting productivity, Basic work content and excess work content, Industrial applications to calculate total and partial productivities, Introduction to Work study and its basic procedures, definitions and concept of work study with examples, Human factor in the application of work study, Factors for selecting the work study, Ergonomics**:** scope and objectives of ergonomics, application of human factors in engineering work place design, etc.

UNIT II

Introduction to Method study and the selection of jobs, Record, Examine and Develop, Objectives and basic procedure of Method study, Recording techniques (Process Charts (PC), and Diagrams),Outline PC, Flow process charts, Two hand process charts, MAC (??), Simo chart, Flow diagram, String diagram, Cycle graph, Chronocycle graph, Travel chart, Define, Install and Maintain, the principles of motion economy,

UNIT III

Work measurement and its applications, Time study, Work Sampling, Rating and their methods, Breaking the jobs into Elements, types of Elements, Allowances and their calculations, Calculation of Standard time, Examples of Time study, PMT (??) systems, synthetic data, Various applications and examples.

Text Book:

1. Barnes, R.L., "Motion and Time Study, Design & Measurement of Work*" 7th edition, John Wiley & Sons, New York, 1980.*

Reference Books:

1. International Labor Office, Geneva, "Introduction to Work Study" 4th Edition, Geneva, *1985*.

2. Currie R.M, "Work study", ELBS *& Pitman, London, 1977.*

3. Mundel, M.E., "Motion and Time Study", 5th Edition, *Prentice Hall, Englewood Cliff, NewYork, 1978.*

C L T (4 3 1)

MET305	**INTERNAL COMBUSTION ENGINES**	**3-1-0**	**Credits: 4**

Prerequisites: Thermodynamics, Heat Transfer

Course Outcomes: At the end of the course, the student should be able to:

CO1:	To understand the internal combustion engine design as the largest prime mover for all applications in the world.
CO2:	To understand combustion related characteristics of engine and its fuels.
CO3:	To understand the essential systems of IC engines.
CO4:	To understand numerical on engine design, engine emissions, emissions measurement and its control.

Unit 1

Introduction : Engine classification.

Design and operating parameters: Geometry and geometrical properties, working principle of Two stroke and Four stroke engines, Analysis of air-standard cycles, fuel-air cycles and actual engine cycles, Thermodynamics of actual working fluids, Air capacity of four stroke engines: Ideal air capacity , Volumetric efficiency , ideal induction process , actual induction process, Effect of operating conditions on volumetric efficiency, Effect of design on volumetric efficiency , estimating air capacity. Valve and port timing diagram.

Supercharging and Scavenging in IC engine : Methods of supercharging and turbo-charging in SI and CI engine, limits of supercharging in SI and CI engine. Scavenging in two stroke cycle engines, scavenging parameters and efficiency

Unit 2

Combustion in SI and CI Engine: Classification of fuel, solid, liquid and gaseous fuels, fuel properties and fuel rating, Alternative fuels, mixture requirements, characteristics of SI and CI engine fuels. Combustion and detonation: chemistry of combustion, normal combustion in S.I engines , pre-ignition and auto-ignition comparison, detonation in S.I engines, combustion in C.I engines, detonation in C.I engines, Methods of reducing detonation , preliminary detonation, preliminary facts about fuel and dopes, octane and cetane numbers, effect of design on detonation. Mixture requirements: Steady running, mixture requirements, transient mixture requirements, mixtures requirements for fuel injection engines, mixture requirements for S.I engines. Use of combustion charts for burned mixture Appropriate treatment of fuel air mixtures.

Unit 3

Fuel Injection system: Types of carburetor, mixture requirements, single point and multipoint injection system in SI engine, rate of fuel injection in CI engine, fuel injection pumps and nozzle. Current injection systems in I C engines.
Ignition System: Battery ignition, Magneto ignition and Electronic ignition, factors affecting spark advance, spark advance mechanism. Current ignition systems.
Engine friction and lubrication: Components of engine friction, friction mean effective pressure, Blow by losses, effect of engine variables on friction, side thrust on piston. lubrication principle, types of lubrication ,properties of lubricant.
Heat transfer and Cooling system: Engine temperature distribution, heat transfer consideration, gas temperature variation, effects of operating variables on heat transfer , air cooling and liquid cooling systems, concept of adiabatic engine, Numerical on heat transfer in IC engines.

Unit 4

Engine Testing and performance: Measurement of indicated power, brake power, fuel consumption, air flow rate, engine speed, spark timing, performance characteristics, Numerical on engine design, determination of main dimensions, Numerical on two stroke engines and four stroke engines. Numerical on heat transfer in IC engines, Engine design and principles of similitude. Numerical on alternative fuels, Numerical on diesel fuel injection system, Numerical on verification of engine commercial specifications.
Exhaust Emissions: Pollutants from IC engines. mechanism of pollution formation, methods of emission control, Effect of alternative fuels, Emission norms.
Measurement Of Exhaust Emissions. NDIR, FID, CLA, measurement of exhaust smoke, gas chromatography, effect of operating variables on SI and CI engine pollutant.

Text Book:

1. Heywood, John B. Internal Combustion Engine Fundamentals. McGraw-Hill Book Company.

Reference Books:

1. V. Ganeshan: I. C. Engines: Tata McGraw Hill, New Delhi, 4/e
2. W. W. Pulkrabek: Engineering Fundamentals of I. C. Engines, Prentice Hall India
3. M K Gajendra Babu and K A Subramanian; Alternative Transportation Fuels; CRC Press.

Course No.: XXXX **MICROPROCESSORS IN AUTOMATION** **C L T (3 3 0)**

COURSE OUTCOMES: (To be given by ECE dept., not obtained by the mechanical Dept. till date)

(To be obtained from ECE Department)

<table>
<tr><td rowspan="3">Subject:
HEAT TRANSFER LAB
(Code: MEL310)</td><td rowspan="3" colspan="2">Year & Semester: B. Tech Mechanical Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td></td><td></td><td colspan="3"></td></tr>
<tr><td></td><td></td><td colspan="3"></td></tr>
</table>

After the completion of course, students will be able,

CO1	Acquire a thorough outlook regarding the steps to design and conduct experiments for measuring specific physical variables
CO2	To apply the concepts learnt in Heat Transfer theory subject to do hands on experiments
CO3	To calculate the thermal conductivity, heat transfer coefficient, and other parameters relevant in heat transfer
CO4	Communicate effectively in completing written reports of laboratory work

List of Experiments

1. To determine the thermal conductivity of a metal bar
2. To determine the thermal conductivity of a liquid
3. To study the heat transfer through the insulating medium
4. To study heat conduction in a composite wall
5. To study heat transfer from a pin fin
6. To study heat transfer in natural convection
7. To study heat transfer in forced convection
8. To study the heat transfer phenomena in a heat exchanger with parallel / counter flow arrangements
9. To determine Stefan Boltzmann constant

MEL 311 MECHANISMS AND VIBRATIONS LAB C P (1 2)

COURSE OUTCOMES:

1. **The student should be able to prepare technical reports and documents detailing the experimental methodology.**
2. **Determine the time period of a simple and compound pendulum and visualize the basic characteristics of a simple harmonic motion.**
3. **Determine the mass moment of inertia (ROG) of irregularly shaped objects using bifilar and trifilar suspensions.**
4. **Analyze the free and forced vibration characteristics of an equivalent spring mass system and determine its frequency response function.**

1. Determine the time period of a simple pendulum. Verify that the time period is independent of the mass of the bob.
2. Determine the radius of gyration of a compound pendulum.
3. Determine the radius of gyration of a given bar by using a Bifilar suspension.
4. Study the undamped free vibration of an equivalent spring mass system.
5. Study the forced vibration of an equivalent spring mass system.
6. Study the torsional vibration of a single rotor shaft system.
7. Determine the frequency response function of an equivalent spring- mass- dashpot system.
8. Pressure profile measurement on Journal bearing.

<table>
<tr><td rowspan="3">Subject: Production Engineering
(Code: MET351)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, a student should be able to:

CO1: Determine the shear angle and cutting force in machining and understand the basics of metal cutting.
CO2: Estimate tool life and explain the tool wear mechanisms and abrasive machining process.
CO3: Analyze the forming process behavior for conventional and advanced metal forming processes.
CO4: Understand the basics of limits, fits and tolerances in manufacturing.

Detailed Syllabus:

UNIT I

Introduction to machining; Orthogonal cutting; Oblique cutting; Types of chips; Mechanics of chip formation; chip breakers; Mechanics of Metal Cutting: Merchant's circle diagram; Determination of cutting and thrust forces; Coefficient of friction; strain rate; Measurement of shear angle, Thermal aspects of machining, Numerical problems.

UNIT II

Mechanisms of tool wear; Types of tool wear, Tool life: Variables affecting tool life-Cutting conditions; Tool angles specification systems; Tool materials; Desirable Properties of Cutting Tool; Determination of tool life; Machinability, Economics of machining.
Abrasive Machining Process: Introduction; Grinding: Characteristics of a grinding wheel; Specification of grinding heels; Mechanics of grinding process; Grinding operations; Wheel wear; Surface Finish; Selection of grinding wheels.

UNIT III

Metal Forming: Hot and cold working, Rolling; Forging; Extrusion; Sheet metal working. Introduction to high energy rate forming processes, their advantages and application. Electromagnetic forming, Explosive forming, Electrohydraulic forming.

UNIT IV

Metrology: Introduction to Metrology, Accuracy and Precision. Limits, fits and tolerances, need of providing tolerance, unilateral and bilateral system, Taylor's principles of gauge design, Sine bars and gauge blocks manufacturing method and their applications, Numerical problems.

Text Book:

1. Manufacturing Science-A. Ghosh and A.K. Malik, Affiliated East Press, New-Delhi.

Reference Book:

1. Campbell, J.S., Principles of Manufacturing Materials and Processes, McGraw-Hill, New-York,
2. Engineering Metrology and Measurements by N.V. Raghavendra and L. Krishnamurthy, 1st Edition, Oxford University Press
3. Rao, P.N., Manufacturing Technology, Volume 2, McGraw-Hill Education, New Delhi.
4. Lindberg, R.A., Processes and Materials of Manufacturing, Allyn and Bacon, Boston

Course No.: MET 352 **MATHEMATICAL METHODS**

C L P (3 3 0)

COURSE OUTCOMES:

1. **Able to solve non-linear equations using, R.F, Newton Rapson methods.**
2. **Able to solve linear system of equations using Gauss elimination, Gauss-Jourdan, Gauss siedel & LU decomposition**
3. **Able to use interpolation formulas; and linear & non linear curve fitting.**
4. **Able to use numerical differentiation & integration methods. Solve ODEs & PDEs using numerical methods.**
5. **Able to develop computer programmes for the above methods and interpret them graphically.**

UNIT I

Flow charts. Computer languages. Constants and variables. Arithmetic expressions. Input/ output, control statements. Introduction to programming.Types of errors. Computational algorithms and computer arithmetic. Iterative methods. Solution of equations: Bisection method, Regula-falsi method, Newton Raphson method. Solution of linear system of equations: Gauss elimination, Gauss-Jordan, Gauss- Siedel method, LU decomposition.

UNIT II

Interpolation and approximation of functions, Newtons forward formula (equal and unequal intervals) Curve fitting (straight line, nonlinear, exponential) differentiation, integration (Trapezoidal/Simpson's rule, Weddle's) and program.

UNIT III

Numerical solution of ordinary different equations. Runge- Kutta methods, Types of PDEs, boundary value problems, solution of parabolic PDEs using finite differences and program.

- Examples to be taken from Mechanical engineering applications.

Text Book:

1. Sastry,S. " Numerical Methods", *Printice Hall of India, New Delhi*.

2. Chapra & Chapra Numerical methods for Engineers. Mc. Graw Hill.

Reference Books:

1. Veerarajan, " Numerical Methods", *Tata Mc-GrawHill, New Delhi, 2000.*

Course No.: MET 353 **CONTROL SYSTEMS** **C L T(4 3 1)**

COURSE OUTCOME:

1. **Develop the mathematical models of LTI dynamic systems, determine their transfer functions, describe quantitatively the transient response of LTI systems, interpret and apply block diagram representations of control systems and understand the consequences of feedback.**
2. **Use poles and zeroes of the transfer functions to determine the time response and performance characteristics and design PID controllers using empirical tuning rules.**
3. **Determine the stability of linear control systems using the Routh-Hurwitzcriterion and classify systems as asymptotically and BIBO stable or unstable.**
4. **Determine the effect of loop gain variations on the location of closed-loop scales, sketch the root locus and use it to evaluate parameter values to meet the transient reponse specification od closed loop systems.**
5. **Define the frequency response and plot asymptotic approximations to the frequency response fumction of a system. Sketch a Nyquist diagram and use the Nyquist criterion to determine the stability of a system.**

UNIT I

Introduction: Concept of automatic control, open loop and closed loop systems, servo mechanism, block diagram, transfer function.

Representation of control components and systems: Translation and rotational mechanical components, electrical components -series and parallel combinations, comparators for rotational and linear motions, integrating devices, hydraulic servomotor temperature control systems ,speed control systems.

UNIT II

System response: First and second order systems, response to step, pulse, ramp and sinusoidal inputs, systems with distance velocity lag.

Modes of controls: Proportional control, Proportional pulse reset control, proportional pulse rate control, proportional reset rate control, two position control.

Controller Mechanism: Pneumatic, hydraulic and electric controllers, general principles and circuits for generating various control actions.

UNIT III

Control system analysis: Transient response of simple control systems, stability of control systems, Mouths criterion. Frequency response analysis, polar rectangular and logarithmic plots, experimental determination of frequency response, Bode and Inquest stability criteria, gain and phase margins. Root locus plots of simple transfer function, transient response from root locus.

Electronic Analogue computers: Elements of analogue computers, solution of simple differential equations.

Text Book:

1. Ogata,K., " Modern Control engineering", *Prentice Hall of India, 3rd edition, New Delhi, 1997*.

Reference Book:

1. Raven, F., "Automatic Control" *McGraw Hill Int., 1999.*

Course No.: MET 354 **FLUID MECHANICS- II** **C L T (4 3 1)**

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand the working of gas turbine plant components and analyse their performance.
CO2	Differentiate ideal and practical gas turbine cycles.
CO3	Analyze the operations of centrifugal air compressor and axial air compressor.
CO4	Design the working proportions of hydraulic machines.

Unit-I

Review of Basics: Introduction to Prime Movers, Gas Turbines, Review of Basic principles - Thermodynamics, Review of Basic principles - Fluid Dynamics and Heat Transfer, Fundamentals of Rotating Machines - Energy Equation, Dimensional Analysis, Aerofoil Theory.
Ideal Gas Turbine Cycles: Analysis of Ideal Gas Turbine Cycles, Simple Cycle, Regeneration Cycle, Reheat Cycle, inter cooling Cycle.
Practical Gas Turbine Cycles: Analysis of Practical Gas Turbine Cycles, Methods of accounting for component losses, Efficiencies, change in the composition of the working fluid. Combustion Chambers:Gas turbine combustion systems - Introduction, Geometry, Factors affecting Design & Performance, Requirements of the Combustion Chamber, Gas Turbine Combustion Emissions.

Unit-II

Centrifugal Compressors: Centrifugal Compressors- Principle of Operation, T-s diagram, Energy equation, velocity triangles, types of blades. Analysis of Flow, Performance Characteristics.
Axial Flow Compressors: Axial Flow Compressors - Construction, Principle of Operation, T-s diagram, Energy equation, velocity triangles. Analysis of Flow. Work done factor, Stage efficiency, Degree of reaction, Performance characteristics.

Unit-III

Hydraulic Turbines: Principle of impingements of jets, Euler equation, classification of Hydraulic Turbines, Constructional Details, Analysis, Efficiencies & Design Parameters of Impulse (Pelton Turbine) and Reaction Turbines (Francis, Kaplan& Propeller Turbine), Draft Tube, Cavitation, Governing of Hydraulic Turbines, Characteristics of the Hydraulic Turbine

Unit-IV

Centrifugal pumps: Advantages of Centrifugal Pumps over Reciprocating Pumps, Construction and Working of a Centrifugal Pump, Classification of Centrifugal Pumps, Different Heads of Centrifugal Pumps, Different Efficiencies of a Centrifugal Pump, Analysis of a Centrifugal Pump, Minimum Starting Speed of a Centrifugal Pump, Maximum Suction Lift and Net Positive Suction Head, Cavitation, Priming, Pumps in Series and in Parallel
Fluid System: Hydraulic press, Hydraulic accumulator, hydraulic intensifier, Fluid coupling, torque convertor, hydraulic ram, hydraulic actuator, airlift pump.

Reading:

1. Ganesan, V., Gas Turbines 3/e, Tata McGraw Hill Book Company, New Delhi, 2010.

2. Vasandani, V.P. and Kumar, D.S., Treatise on Heat Engineering, Chand and Co Publishers, New Delhi, 2011.
3. Saravanmuttoo, H.I.H., Rogers, G.F.C. and Cohen H., Gas Turbine Theory, 6/e. Pearson Prentice Education, 2008.
4. Applied Thermodynamics for Engineering Technologists 5th Edition (English, Paperback, Eastop T.D.).

MET3XX ELECTIVE-1 CLT (4 3 1)

Course No.: MET 355 FINITE ELEMENT METHOD C L T (4 3 1)

Course Outcomes: Upon successful completion of this course students should be able to:

1. Understand the concepts behind formulation methods in FEM.

2. Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.

3. Develop element characteristic equation and generation of global equation.

4. Able to apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow problems and solve them & find displacements, stress and strains induced.

UNIT I

Basic Concept, Historical background, Engineering applications, general description, Comparison with other methods. Need for weighted-integral forms, relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, Rayleigh-Ritz method, and weighted residual approach.

UNIT II

Model boundary value problem, finite element discretization, element shapes, sizes and node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solution, post-processing, compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Langrange and Hermite polynomials.

UNIT III

External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis-symmetric and three dimensional stress-strain problems, strain displacement relations, boundary conditions, compatibility equations, computer programs.

Variational approach, Galerkin approach, one-dimensional and two-dimensional steady-state problems for conduction, convection and radiation, transient problems.

Inviscid incompressible flow, potential function and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and stream function-vorticity formulation, Solution of incompressible and compressible fluid film lubrication problems.

Text Books:

1. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5 th Edition, Pergaman Int. Library of Science,

2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.

Reference Books:

1. J.N.Reddy, “Finite Element Method”- McGraw -Hill International Edition.
2. Bathe K. J. Finite Elements Procedures, PHI. 2. Cook R. D., et al. “Concepts and Application of Finite Elements Analysis”- 4th Edition, Wiley & Sons, 2003.

MET3XX ELECTIVE-1 CLT (4 3 1)

Course No.: MET 356 ADDITIVE MANUFACTURING PROCESSES C L T (4 3 1)

COURSE OUTCOMES: At the end of this course, the students shall be able to:

1. Understand the basics of additive manufacturing (AM) and working principles of different AM processes.
2. Explore the applications of different AM processes in various fields.
3. Analyze various AM processes to understand their relative merits and demerits.
4. Design and develop functional models using different AM techniques.

Unit-I

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, AM vs traditional manufacturing, advantages and limitations of AM over conventional manufacturing, nomenclature of AM machines, prototyping, tooling and manufacturing. Classification of AM processes, common AM processes, generalized AM process chain and steps in AM, types of materials for AM.

Unit-II

Vat Photo polymerization AM Processes: Introduction, materials for AM processes utilizing Vat Photo polymerization, Stereo-lithography (SL), photo polymerization process, process modeling, variants and classification of VAT photo polymerization process, Advantages and drawbacks of vat photo polymerization processes.

Powder Bed Fusion (PBF) AM Technique: Introduction to PBF, materials, powder fusion mechanism, process parameters and modeling, powder handling, powder fusion techniques, PBF process variants, Advantages and drawbacks of PBF.

Extrusion Based AM Processes: Introduction, basic principles of extrusion-based processes, Fused Deposition Modeling (FDM), materials, Bio extrusion, Contour Crafting, Non-Planar systems, RepRap FDM systems, process benefits and drawbacks.

Unit-III

Material Jetting (MJ) and Binder Jetting (BJ) AM Processes: Introduction to MJ and BJ, materials, process description to MJ and BJ, variants of MJ and BJ, comparison between MJ and BJ, benefits and drawbacks.

Sheet Lamination AM Processes: Introduction, Variants of sheet lamination, Laminated Objected Manufacturing (LOM), Ultrasonic additive manufacturing (UAM), benefits and drawbacks of UAM.

Directed Energy Deposition (DED) AM Processes: Introduction to DED, process description, classification of DED techniques, benefits and drawbacks of DED.

Recommended Texts:

1. Manu Srivastava, Sandeep Rathee, Sachin Maheshwari, TK Kundra**,** "Additive Manufacturing: Fundamentals and Advancements", Ist ed.2019, Boca Raton: CRC Press, Taylor & Francis group.

2. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.

Recommended References:

1. Sandeep Rathee, Manu Srivastava, Sachin Maheshwari, TK Kundra, Arshad Noor Siddiquee, "Friction Based Additive Manufacturing Technologies: Principles for Building in Solid State, Benefits, Limitations, and Applications", Ist ed.2018, Boca Raton: CRC Press, Taylor & Francis group.

2. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015.

3. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.

4. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

MET3XX ELECTIVE-1 CLT (4 3 1)

Course No.: MET 357 Advanced Thermodynamics C L T (4 3 1)

<table>
<tr><td rowspan="3">Subject:
Advanced Thermodynamics
(Code: MET3XX)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech
Mechanical Engineering
3rd Year &6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

After the completion of course, students will be able,

CO1	To extend the in-depth knowledge in the application of the laws of thermodynamics
CO2	To apply concepts of entropy generation and exergy to practical applications/systems
CO3	To have a coherent knowledge about the evaluation of the thermodynamic properties
CO4	To identify, formulate and solve a wide range of real world problems involving energy transfer

Unit 1

Scope and methods of thermodynamics, Review of Thermodynamics, Mathematical background, Macroscopic and Microscopic approaches in thermodynamics, Energy and first law of thermodynamics, First law for closed and open systems, Broadening understanding of energy transfer by work and heat, Structured presentation of First law of Thermodynamics.

Unit 2

Second law of thermodynamics, Traditional formulation of Second law of thermodynamics, logical relation between alternative statements of the second law, Mathematical formulation of second law of thermodynamics, Entropy maximum and Energy Minimum principle, Born-Caratheodory formulation of second law.

Unit 3

Entropy Generation, Concept of Exergy of system, Exergy balance of closed and open systems, Second Law efficiency (of heat engines, heat pumps, refrigerators, work producing and consuming devices, heat exchangers), Thermoeconomics, Exergy account of a vapour power plant (Case study), Thermodynamics of a Biological System.

Unit 4

Thermodynamic properties of pure fluid, ideal gas properties, State relationships for real gases and liquids, Two-constant and Multiconstant Equation of state, Virial Equations, Vander Waals Equation of State, Redlich-Kwong Equation of state, Compressibility charts, Generalized Equation of state, Maxwell's relations, Generalized relations, Evaluation of Thermodynamic properties, p-v-t relations for gas mixtures, Multicomponent systems, Chemical potential (Fugacity).

Textbooks:

1. Bejan, A., "Advanced Thermodynamics" John Wiley & Sons, 2006.
2. Moran, M.J., Shapiro, H.N., Boettner, D.D., Bailey, M.B., "Principles of Engineering Thermodynamics", Wiley India, 2017.

Reference Books:

1. Kestin, J., "A Course in Thermodynamics", McGraw Hill, 1979.
2. Wark, K., "Advanced Thermodynamics", McGraw Hill, 1995.

MEL361	APPLIED THERMODYNAMICS LAB	0-0-2	Credits: 1

Prerequisites: Thermodynamics, Fluid Mechanics, Applied Thermodynamics, Hierodulic machines

Course Outcomes: At the end of the course, the student should be able to:

CO1: To investigate the performance and emission testing of SI Engine.

CO2: To investigate the performance and emission testing of CI Engine.

CO3: To acquire knowledge of working principle of compressors.

CO4: To gain knowledge of Turbines,

List of Experiments:

1. Study of different internal combustion engine models.
2. Experimental study of characteristic performance curves & emission of spark ignition engine using gasoline as fuel.
3. Experimental study of characteristic performance curves & emission of compression ignition engine using diesel as fuel.
4. Study of working of compressors using different compressor models.
5. Experimental study of characteristic performance curves of single cylinder reciprocating compressors.
6. To study the constructional details of hermetically sealed reciprocating compressor.
7. Study of the Pelton wheel Turbine.
8. Study of the Francis Turbine.

MEL 362 INDUSTRIAL ENGINEERING-I LAB C P (1 2)

COURSE OUTCOMES:

1. **Demonstrate human factors/ergonomic principles (HF/E) that influence the design, performance and safety of work systems.**
2. **Apply HF/E guidelines and use standard HF/E in the design of work systems.**
3. **Model work systems using standard techniques, such as flow diagrams, process charts, operation charts, activity charts, block diagrams, and process maps, for purposes of work system documentation, analysis, and design.**
4. **Determine the time required to do a job using standard data, occurrence sampling, time study, and predetermined time systems.**

1. Ergonomic design study (Present/proposed/new) of a product, equipment or work environment (human-machine interface) – (This involves about four to five laboratory classes / sessions)
2. To assembly a product (electrical holder, etc.), record the cycle time and draw learning curve of the operator performing the assembly.
3. Draw Out line process chart and two hand flow process charts for the assembly performed in experiment no. 2, and analyse the present method and also suggest improved method/s.
4. Study and draw of flow process charts (some suitable assembly operation)
5. Study and draw multi activity chart of a suitable method and propose better method/s.(Man and machine)
6. Study suitable movements/travel of man, material or equipment, and draw string diagram, travel chart and flow diagrams.
7. To calculate the standard time of a suitable job, using predetermined time standard techniques.

MES 363 SEMINAR CP (2 4)

CO1	Review literature on a given advanced topic related to the specific stream.
CO2	Summarise the concept of the chosen topic systematically after considerable study of the content from primary as well as secondary sources
CO3	Learn and present the structure and format of technical reports as per specified norms
CO4	Interpret graphs of various kinds and discuss the concept & conclusion in an open seminar.

MEI 364 INDUSTRIAL TRAINNING C (2)

CO1	To study the concept of Facility, Location & Layout & implement in their Industrial training Project work.
CO2	An understanding of the impact of engineering solutions and industrial safety in a global and social context.
CO3	Develop the ability to work as an individual and in group with the capacity to be a leader or manager as well as an effective team member.
CO4	Demonstrate competence in mechanical engineering fields through problem identification, formulation and solution.

Course Code: MET 401 **Mechatronics and Measurement Systems** **C L T (4 3 1)**

Mechatronics and Measurement Systems

COURSE OUTCOMES:

CO1 Identify and develop operational research models from the verbal description of the real system.

CO2 Understand the mathematical tools that are needed to solve optimisation problems.

CO3 Use mathematical software to solve the proposed models.

CO4 Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

UNIT I

Measurement and Instrumentation; definitions, significance, Fundamental methods, generalized measurement system, Functional elements, Types of input quantities, standards, calibration, uncertainty, Errors, Classification of instruments, Input-output configuration, Interfering and modifying inputs, methods of correction, Generalized performance characteristics, static characteristics, static calibration, Dynamic characteristics, zero and first order instruments, time constant, Second-order instruments, transient response characteristics. Relative and absolute motion devices, relative displacement, Resistive potentiometers, bridge circuit, LVDT, Variable inductance and variable capacitance pick-ups, Piezoelectric transducers, fibre optic displacement transducer, Resistance strain gage, Relative velocity-translational and rotational, Mechanical revolution counters and timers, stroboscopic method, Moving coil and moving magnet pickups, DC and AC tachometers, Eddy current drag-cup tachometer, acceleration measurement.

UNIT II

Hydraulic and pneumatic load cells, flapper nozzle principle, Force transducers with elastic members, Proving ring transducer, cantilever beam transducer, electromagnetic balance, Dynamometers – Absorption, driving and transmission type, reaction forces in shaft bearings, prony brake, eddy current brake dynamometer, Instruments for high, mid and low pressure measurement, dead weight and null type, Elastic element gages, Differential pressure cell, high pressure measurement, Low pressure measurement –, Pirani gages & McLeod pressure gauge.

UNIT III

Orifice meters, Venturimeter, Pitot tube, Flow nozzle, Variable area meters, rotameter, design and accuracy, Positive displacement flow meter, turbine flow meter, Electromagnetic flow meter, ultrasonic flow meters, Temperature sensing techniques, liquid-in-glass and bimetallic thermometers, Pressure thermometers, electrical resistance thermometers, Thermistors, Thermocouples, thermopiles, Radiation pyrometers, Optical pyrometer.

Text Book:

1. Beckwith, B., "Mechanical Measurements", 6th edition, *Pearson Education Int. ,2008.*

Reference Book:

1. Nakra B.C. "Instrumentation, Measurements & Analysis", 2nd edition, *Tata McGrawHill, N.Delhi, 2008.*

2. Doeblin, E.O., "Measurement systems",5th edition, *McGraw Hill, New Delhi, 2004.*

Course No.: MET402 INDUSTRIAL ENGINEERING – II **C L T (4 3 1)**

INDUSTRIAL ENGINEERING – II

COURSE OUTCOMES:

1. Grasp the concept of organizational design with emphasis on organization principles & work design.
2. Analyse & design facility location and layout using various techniques and softwares.
3. Demonstrate the ability to use the methods of statistical quality control and process control for effective designing of Industrial Quality Monitoring Systems.
4. Demonstrate the ability to apply the techniques of material management and inventory control for effective designing and systematic implementation of various MM methods and inventory systems in manufacturing set-up.

UNIT I

Factory organization**:** Introduction to Plant organization, Principles of Organizational structure, Organization charts, Types of Organizations, Developing an organization structure, Results of good organization,, Informal organization, advantages and disadvantages.

Location and Layout analysis: Introduction to Facility location problems, Factors affecting the plant location. Break even analyses and their application, Subjective, qualitative and semi-Quantitative techniques of facility location, Single facility Location problem, Minimax Location problem, Gravity problem and their applications. Line balancing, Introduction to facility layout and their objectives, Classification of Layouts, with advantages and disadvantages of each, Layout design procedures(CRAFT,CORELAP,ALDEP), Material handling systems, Make or Buy decisions, Planning and control of Batch Production,. Characteristics of Batch Production, Determination of Batch size, Minimum Cost batch Size, Maximum Profit Batch size, Sequencing and scheduling for Batch Production, Line of Balance technique.

UNIT II

Inspection and quality control**:** Concept and Definition of Quality, Concepts of Inspection and quality control, Objectives of inspection, Function of Inspection and their types, Concept of statictical quality control (SQC), Process variation, Sampling inspection. Concepts and types of Control charts, Acceptance sampling, application of control charts and sampling plans.

UNIT III

Materials management and inventory control**:** Integrated materials management and their components, Functions and objectives of material management, Introduction and concepts of Inventory management, Purchase model with instantaneous replenishment and without shortage, Manufacturing model without shortages, Purchase model with shortages, Manufacturing model with shortages, Probabilistic inventory concepts with lead time., Selective inventory management- ABC , FSN, VED analyses.

Text Book:

1. Everett, E.A., Ronald J.E, "Production and Operations Management" *Prentice Hall of India, 5th edition, New Delhi, 2001.*

Reference Books:

1. Claude, S.G., "Management for Business & Industry" *Prentice Hall of India*, New Delhi, 2000.

2. Everett, E.A., Ronald J.E, "Production and Operations Management", *Prentice Hall of India, 5th Edition, New Delhi, 2001*.

3. Grant, E.L; Leavenworth R.S, "Statistical Quality Control", *Tata Mcgraw Hill, 7th Edition*, New Delhi, 1996.

4. Apple, J.M, "Plant Layout & Material Handling", *John Wiley & Sons, New York.*

5. Maynard, Industrial Engineering Hand Book, *McGraw Hill, New York.*

Course No.: MET403 MACHINE DESIGN **C L T (4 3 1)**

MACHINE DESIGN

COURSE OUTCOME:

1. Analyse the stress and strain of mechanical components.
2. Demonstrate knowledge of basic machine elements used in machine design.
3. Design machine elements to perform functions in order to obtain desired objectives under various operating conditions.
4. Conduct a failure analysis for the design of mechanical components to select the suitable materials and manufacturing considerations.

UNIT I

Design of friction elements, various types of brakes, design equations for various types of brakes, design analysis of all types of brakes, e.g., band brake, long shoe brake, etc. design analysis of all types of clutches, design of couplings and keys for shafts, etc, design and analysis of flat and V-belt, equations for power, slip, etc, design of chain drive.

UNIT II

Introduction to gear design, design of spur gear, equation for σ_b and σ_c for spur gear, design analysis for bending, force analysis for Helical gear, design analysis for helical gear, design of bevel gear, determination of bearing forces, horizontal and vertical shafts, design analysis for bevel gear , design analysis for worm gear.

UNIT III

Introduction to Plain bearings, Bearing surface at Micro level, Derivation of Energy equation and PV factor , PV graph, Values of PV , Derivation of Wear coefficient equation, Step-by-step procedure for Plain bearing design, Self lubricating bearings and use of clearance for life of bearing, Design of Hydrodynamic bearings, Derivation of Reynolds equation for three dimensional case, Journal bearing geometry,Variation of viscosity with pressure and temperature, Viscosity index, Sommerfeld number, Analysis of ho, h_{min}, Q_{in}, Q_{loss}, T_{in} , T_{out}, Introduction to Rolling element bearings, Design of AFB (??) , Equations for L_{10} life, Static loading and dynamic loading ,Use of AFB catalogue, Determination of Load based on radial and thrust load for ball bearings, Derivation of Load equation for Tapered AF bearings, Design analysis on the basis of loads and selection of AFB from a catalogue.

Text Books:

1. Mot, R.L., “Machine Elements in Mechanical Design”, *Maxwell Macmillan Intl. edition N.York , USA, 1992.*

2. Shigley, J.E., “Machine Engineering Design*”, McGraw Hill, higher education,2004.*

Reference Books:

Shigley, J.E., Mischke, C. Brown T., “Standard Hand book of Machine Design” *McGraw Hill.*

Elective II: Design

Course No.: MET404 ADVANCED MECHANICS OF SOLIDS **C L T (4 3 1)**

Course Title: ADVANCED MECHANICS OF SOLIDS

Pre-requisite(s): Strength of Materials

Course Outcomes:

At the end of the course, a student should be able to:

CO1 Understand the concept of tensor.

CO2 Analyse advanced concept of stress and strain in structural problems.

CO3 Apply the concept of different elastic functions to solve complex problems.

CO4 Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.

UNIT 1

Mathematical Preliminaries: Introduction to tensor algebra: symmetric and skew-symmetric tensor, summation convention, eigenvalue and eigenvector of tensor, spectral theorem, polar decomposition theorem, product of tensor, principal invariants of tensor, coordinate transformation of tensor, Tensor calculus: gradient, divergence, curl, differentiation of scalar function of a tensor. (8 L)

UNIT 2

Analysis of Stress and Strain: Definition and notation of stress, Cauchy stress tensor, equations of equilibrium, principal stresses and stress invariants, stress deviator tensor, octahedral stress components, General deformations, small deformation theory, strain transformation, principal strains, spherical and deviatoric strains, Strain-displacement relations, strain compatibility, stress and strain in curvilinear, cylindrical, and spherical coordinates, fundamental equations of plasticity. (8 L)

UNIT 3

Problem formulation and solution strategies: Field equations, boundary conditions, stress and displacement formulation, Beltrami-Michell compatibility equations, Lame-Navier’s equations, principle of superposition, uniqueness theorem, Saint-Venant’s principle, Brief descriptions about general solution strategies - direct, inverse, semi-inverse, analytical, approximate, and numerical methods. (8 L)

UNIT 4

Two-dimensional problems: Plane stress and plane strain problems, generalized plane stress, Antiplane strain, Airy stress function, polar coordinate formulation and solutions, Cartesian coordinate solutions using polynomials and Fourier series method. (8 L)

Text Books:

1. Elasticity, Theory, Applications, and Numerics by Martin H. Sadd

2. Theory of Elasticity by Stephen Timoshenko and , J. N. Goodier

3. Advanced Mechanics of Solids, Otto T. Bruhns, Springer publications.

Reference Books:

1. Continuum Mechanics, A.J.M Spencer, Dover Publications, INC

2. Advanced Mechanics of Materials by H. Ford and J. M. Alexander 3. The Linearized Theory of Elasticity, W. S. Slaughter, Springer Science + Business Media, LLC

Elective II: Thermal

Course No.: MET 405 **Refrigeration and Air Conditioning** **C L T (4 3 1)**

Course Outcomes:

1. To Identify the need and importance of various refrigeration and air conditioning cycles, the typical and some advanced and innovative schematic designs, and the goals of R&AC systems.
2. To design the VCRS and VARS with improving performance parameters.
3. To describe the working of different types of air conditioning systems.
4. To evaluate the actual applications of R&AC.

UNIT-I

Introduction

Basics of refrigerator and heat pump, Carnot refrigeration and heat pump, units of refrigeration, COP of refrigerator and heat pump, Carnot COP, Ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, vapor refrigeration system, steam jet refrigeration, thermo- electric cooling, adiabatic demagnetization

Basic Principle of operation of air refrigeration system, Bell Coleman air refrigerator, advantages of using air refrigeration in air craft, disadvantage of air refrigeration in comparison to other cold producing methods, simple air refrigeration in air craft, simple evaporative type, air refrigeration in air craft, necessity of cooling the air craft.

UNIT-II

Vapor Compression refrigeration system

Simple vapour compression cycle, Methods of improving COP, flash chamber, flash inter cooler, optimum inter stage pressure for two stage refrigeration system, single expansion and multi expansion cases, basic introduction of single load and multi load systems, cascade systems, Nomenclature of refrigerants.

Vapor absorption refrigeration system and special topics

Basic absorption system, COP and maximum COP of the absorption system. Actual NH_3 absorption system, function of various components, Li-Br absorption system, Selection of refrigerant and absorbent pair in vapor absorption system, Electro-Lux refrigerator, comparison of compression and absorption refrigeration system, , desirable properties of refrigerants, cold storage and Ice Plants.

UNIT-III

AIR CONDITIONING

Psychrometric properties of moist air, By- pass factor of coil, sensible heat factor, ADP of cooling coil, Air washer. Air conditioning systems: Classification, factors affecting air conditioning systems, comfort air conditioning system, winter air conditioning system, summer Air Conditioning system, year-round air-conditioning system, unitary air conditioning system, central air conditioning system, Room sensible heat factor, Grand sensible heat factor, effective room sensible heat factor, Industrial application of Air conditioning.

Text Books:

1. Refrigeration and Air Conditioning - C.P. Arora, Tata McGraw-Hill
2. Refrigeration and Air- Condition by W. Stoecker Mc Graw Hill

Reference Books:

1. Basic Refrigeration and Air Conditioning- Ananthana and Rayanan, McGraw-Hill
2. Refrigeration and Air Conditioning- Arora and Domkundwar, Dhanpat Rai.

Elective II: Production

Course No.: MET406 **Material Testing, Inspection and Characterization** **C L T (4 3 1)**

COURSE OUTCOMES:

By successful completion of this course, the student will be able to

1. Understand various destructive and non destructive methods of testing materials.

2. Explain the principles of metallurgical microscope, X-ray Diffractrometer (XRD), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Thermal analysis and dilatometer.

3. Describe the various sample/specimen preparation techniques for XRD, SEM, TEM and thermal analysis and quantitative metallography.

4. Apply knowledge to select appropriate tool to characterize the material by knowing its merits and demerits.

UNIT I

Purpose and importance of destructive tests – Concepts, and method of Tensile, hardness, bend, torsion, fatigue and creep testing.

UNIT II

Purpose and limitations of NDT, Concepts, operating principles, liquid penetrant test, magnetic particle testing, eddy current testing, ultrasonic testing radiography, acoustic emission, thermal imaging method. Comparison of NDT methods and selection of NDT methods.

UNIT III

Tools of characterisation - Light microscopy, basic principles and special techniques. X-ray diffraction and its applications in materials characterization.

Electron microscopy, Construction, operation and applications of scanning electron microscope (SEM), transmission electron microscope (TEM)

UNIT IV

Thermal analysis: Thermo gravimetric analysis, differential thermal analysis, differential scanning calorimetry &dilatrometry.

TEXT BOOKS:

1. Non-destructive testing, B.Hull And V.John, Macmillan, 1988.

2. Modern Physical Metallurgy and Materials Engineering, R. E. Smallman, R. J. Bishop, sixth edition, Butterworth-Heinemann, 1999.

3. Materials Characterisation, P.C.Angelo, Elsevier (India) Pvt. Ltd, Haryana, 2013,

Elective III: Design :-

Course No.: MET407 **BASIC FRACTURE MECHANICS** **C L T (4 3 1)**

COURSE OUTCOMES:

1. Identify and describe different failure mechanisms in materials and engineering structures.
2. Explain how a crack affect an engineering structure and describe the state of stress and strain that may arise in the vicinity of the crack front in different materials
3. Evaluate fracture toughness for structures with cracks using LEFM and EPFM techniques.
4. Analyze the crack growth in materials subjected to fatigue loads.

UNIT I

Mechanisms of fracture and crack growth, cleavage fracture, ductile fracture, fatigue cracking, Summary of basic problems and concepts in fracture, a crack in a structure, theoretical strength of a material, Inglis's solution, crack tip stresses, the Griffith criterion, Modified Griffith's theory

UNIT II

The elastic crack-tip stress field, Stress Intensity factor, the effect of finite size, Some special cases, elliptic cracks the energy principles, the concept of energy release rate, the criterion for crack growth, the crack resistance, the concept of J-integral, crack opening displacement criterion, K_{IC} and G_{IC} test methods

UNIT III

Crack-tip plastic zone, Irwin's plastic zone correction, The Dugdale approach, Plane stress versus plane strain, plastic constraint factor, the thickness effect, application of von Mises and Tresca yield criteria to obtain plasticity effected regions, Fatigue failure, S-N curve, Crack initiation and propagation, effect of overload, crack closure, Environmental assisted cracking, service failure analysis

Text Book:

1. Anderson T.L., "Fracture Mechanics Fundamentals and applications", *CRC, Taylor & Francis, 2005.*

Reference Book:

Janssen, M. J., Zuidema, J., Wanhill R.J.H., "Fracture Mechanics", *Spon Press, 2004.*

1. Prashant Kumar, "Elements of Fracture Mechanics", *McGraw Hill Education, 2017*

Elective Thermal

Course No.: MET408 **Design of Fluid Thermal Systems** **C L T (4 3 1)**

COURSE OUTCOMES:
After the completion of course, students will be able,

CO1	To understand thermal system engineering design process
CO2	To learn the characteristics of the components of the thermal system and their effects on overall system performance
CO3	To simulate a thermal system and solve for a workable solution
CO4	To identify, formulate and solve a wide range of real world thermal related problems

UNIT 1

Introduction, Design versus Analysis, Synthesis versus Design, Optimal and Nearly Optimal designs, Life Cycle Design, Thermal design aspects, Concept, creation and assessment, Thermal system (Basic Characteristics, Analysis), some typical examples, formulation of the design problem, Steps in design process, Material selection.

UNIT 2

Modelling of thermal systems, types of models, Mathematical modeling, General procedure (Transient/steady state, spatial dimensions, lumped mass approximation, simplification of boundary conditions, negligible effects, idealizations, material properties, conservation laws, simplification of governing equations), final model and validation, physical modeling and dimensional analysis, curve-fitting, Numerical modeling and simulation, Solution procedures, methods for numerical simulation,

UNIT 3

Formulation of problem for optimization, optimized design, objective function, constraints, operating conditions versus hardware, optimization methods (Calculus methods, Search methods, etc.), Optimization of thermal systems, Considerations of Second law of Thermodynamics, Economic analysis, Estimation of total capital cost, principles of economic evaluation,Thermoeconomic analysis and evaluation.

UNIT 4

Applications with Thermodynamics, Heat and Fluid flow, Cogeneration system Exergy analysis, Thermal insulation, Fins, Electronic packages, Refrigeration, Power Generation, Energy Storage by Sensible heating.

Textbooks:

1. Bejan, A., Tsatsaronius, G., Moran, M., “Thermal Design and Optimization”, John Wiley, 2013.
2. Stoecker, W.F., “Design of Thermal Systems”, McGraw Hill, 2017.

Elective Production

Course No.: MET409 ADVANCED MANUFACTURING TECHNOLOGY **C L T (4 3 1)**

ADVANCED MANUFACTURING TECHNOLOGY

Course Outcomes:

CO1	Identify the use of advanced manufacturing processes in industries and explain the process of micro machining.
CO2	Identify the need of super finishing processes and understand the process of super finishing.
CO3	Understand the process of non-conventional forming.
CO4	Apply knowledge to select appropriate surface processing technique to get the desired surface properties.

UNIT I

Introduction to Advanced manufacturing processes, Advantages of advanced manufacturing processes. Advances in Machining: High speed machining, hard turning. Micro machining: Introduction and need of micro machining, Diamond Micro- grinding/turning, Abrasive Micro machining, Ultrasonic Micromachining, Electric-discharge Micro-machining, Laser Micro-machining, Electrochemical Micro-machining.

UNIT II

Super finishing processes:Introduction to finishing processes, Need and application of superfinishing processes, Abrasive flow finishing, Magnetic Abrasive flow finishing, Magneto rheological abrasive flow finishing.

UNIT-III

Advances in forming: Introduction and application of non-conventional forming, need of non-conventional forming, Electro Magnetic forming, Hydro forming, explosive forming. Advantages of non-conventional forming.

UNIT IV

Surface processing: Introduction and need of surface processing, surface properties, cladding, chemical vapour deposition, physical vapour deposition, shot peening, surface modification by severe plastic deformation. Strategies for improving surface properties.

	• Rao, P.N., Manufacturing Technology, Volume 2, McGraw-Hill Education, New Delhi. • Serop K. Steven, “Manufacturing Processes for Engineering Materials”, Prentice Hallof India,2004

Elective Production

Course No.: MET410 Conduction Heat Transfer **C L T (4 3 1)**

CONDUCTION HEAT TRANSFER

COURSE OUTCOME

CO1 To formulate and solve one dimensional steady state heat conduction problems

CO2 To formulate and solve two-dimensional steady state and transient heat conduction problems

CO3 To solve heat conduction problems involving phase change

CO4 To identify, formulate and solve real world problems related to heat conduction

UNIT I

Introduction, Fourier's law of heat conduction, thermal conductivity, Differential formulation of heat conduction in rectangular, cylindrical and spherical coordinates, General boundary conditions and initial condition, non-dimensional analysis of the heat conduction equation, heat conduction for anisotropic medium, one-dimensional steady state heat conduction, Extended surfaces, Constant area fins, Variable area fins, moving fins, Bessel differential equations and Bessel functions.

UNIT II

Two-dimensional steady state heat conduction, Separation of variable method, Homogeneous differential equations and boundary conditions, Sturm-Liouville boundary valve problems, Non-homogeneous differential equations, Non-homogeneous boundary conditions, Method of superposition, Solution to problems in Cartesian and cylindrical coordinates, Unsteady heat conduction, lumped heat capacity system, Non homogeneous equations and boundary conditions, Transient conduction in plates, Transient conduction in cylinders, Transient conduction in spheres, Duhamel's Superposition Integral, Conduction in Semi-infinite regions.

UNIT III

Heat conduction involving phase change, Moving interface boundary condition, non-linearity of the interface energy equation, Simplified model (Quasi-Steady approximation), Exact solutions, Stefan's solution, Solidification of semi-infinite region, Melting of semi-infinite region.

UNIT IV

Heat Transfer in living tissue, Mathematical modeling of vessel-Tissue heat transfer, Microscale heat conduction, physics of energy carriers, Limitations of Fourier's law, Hyperbolic heat conduction, Solutions and approximations for the microscale heat transfer, Inverse heat transfer, parameter estimation, applications to heat transfer, method of sensitivity coefficients, Least squares approach, linear and non-linear inverse problems.

Textbooks:

1. Jiji, L.M., "Heat Conduction", Springer, 2009.
2. Kakac, S., Yener, Y., Naveira-Cotta, C.P., "Heat Conduction", CRC Press, 2018.

Reference Books:

1. Ozisik, M.N., Hahn, D.W., "Heat Conduction", John Wiley, 2012.
2. Muralidhar, K., Banerjee, J., "Conduction and Radiation", Naraosa Publishing House, 2010.
3. Poulikakos, D., "Conduction Heat Transfer", Prentice Hall, 1993.

Course No.: MEL411 **MECHATRONICS LAB.** **C L T (1 2)**

MECHATRONICS LAB.

COURSE OUTCOME:

1. Identify and use basic modern tools for measurement of electrical and electronic signals.
2. Identify and use different types of sensors and actuators for designing a mechatronic product.
3. Design basic circuits utilizing modern electrical and electronic components including operational amplifiers and integrated circuits.
4. Write basic microcontroller programs for controlling a mechatronic product.

LIST OF EXPERIMENTS

1. Sensor/Actuator - Interfacing, calibration, frequency domain characterization, MATLAB serial interface, and serial LCD display
2. Design of electropneumatic circuits for L (??) and square cyles using PLC's.
3. Sorting of components on an intelligent a conveyor system.
4. Modelling of DC Motor System.
5. DC Motor position tracking.
6. DC Motor position set-point control via PID controller, using relay automatic tuning technique7.
7. Disection of an existing system.
8. Demonstration of recent projects on Mechatronics.
9. Mini Project on Independent modeling, analysis, and design of a mechatronic control system (Select one “mechatronic plant” from the Quanser, rotary family).

Course No.: MEL412 INDUSTRIAL ENGINEERING-II LAB **C L T (1 2)**

INDUSTRIAL ENGINEERING-II LAB.

COURSE OUTCOMES:

1. Present a numerical and graphical characterization of quantitative data assuming the quantitative data are observations from a normal distribution to compute the Probability of specific numerical outcomes. Construct and interpret normal Probability plots of quantitative data.
2. Construct, implement and interpret X-bar and R control charts for variables from Standards and from data; and demonstrate how to use the corresponding OC curves.
3. Construct, implement and interpret p, c, and u control charts for attributes from Standards or data; and demonstrate how to use the corresponding OC curves.
4. Demonstrate and simulate layouts to determine optimum material flow rate and cycle time of a job using witness software.

List if experiments:

1. To study the layout of a shop in an organization and draw existing and proposed layouts.
2. To measure the variable characteristics (diameter of pins, with micrometer) and prepare a frequency histogram. Calculate values of X bar and sigma.
3. Verify that when random samples are taken from a lot with a certain percentage of defective, same %age lands to appear in random sampling by using Shewart's kit.
4. Simulate an inspection situation with the help of a Schewhart's bowl and plot X bar, and R charts using computed data.
5. To conduct Process capability study of a machine tool and to specify the tolerances for a job.
6. To verify the theorem "the standard deviation of the sum of any number of independent variables is the square root of the sum of the squares of the S.Ds of the independent variable. Determine statistically, the permissible tolerance of mating components, when the tolerance of the assembly is given.
7. To draw control chart for percent defectives after inspecting a sample and sorting out the defective units.

Course No.: MEP413	**MAJOR PROJECT – Stage 1**	**C L T (3 0 0)**

CO1 Identify a topic in advanced areas of Mechanical Engineering.

CO2 Review literature to identify gaps and define objectives & scope of the work.

CO3 Generate and implement innovative ideas for social benefit.

CO4 Develop prototypes/models, experimental set-up and software systems necessary to meet the objectives.

Course No.: MET 451 Operation Research **C L T (4 3 1)**

OPERATION RESEARCH

COURSE OUTCOMES:

1. Illustrate knowledge of fundamental concepts about operation research.
2. Compare and categorize the knowledge of different approaches to operational performance improvement.
3. Appraise the ability to work effectively in a team and in group and use of business tools.
4. Outline the various Japanese techniques for justify the knowledge and performance improvement in industrial cost control.

UNIT I

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Simplex Method, Graphical solution of LPP., Artificial variables, big-M method, two-phase method, degeneracy and unbound solutions.

UNIT II

Transportation Problem. Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.

UNIT III

Assignment model. Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem. Sequencing models. Solution of Sequencing Problem – Processing and Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machines.

UNIT IV

Inventory models. Inventory costs. Models with deterministic demand – model (a) demand rate uniform and production rate infinite, model (b) demand rate non-uniform and production rate infinite, model (c) demand rate uniform and production rate finite.

Replacement Models. Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fail suddenly: individual replacement policy, group replacement policy.

TEXT BOOKS:

1. P. Sankara Iyer, ”Operations Research”, Tata McGraw-Hill, 2008.

2. A.M. Natarajan, P. Balasubramani, A. Tamilarasi, “Operations Research”, Pearson Education, 2005.

REFERENCE BOOKS:

1. J K Sharma., “Operations Research Theory & Applications , 3e”, Macmillan India Ltd, 2007.

2. P. K. Gupta and D. S. Hira, “Operations Research”, S. Chand & co., 2007.

3. J K Sharma., “Operations Research, Problems and Solutions, 3e”, Macmillan India Ltd.

4. N.V.S. Raju, “Operations Research”, HI-TECH, 2002.

Elective IV: Design

Course No.: MET 452 **Theory of Thin Plates and Shells** **C L T (4 3 1)**

THEORY OF THIN PLATES AND SHELLS

Course Outcomes:

At the end of the course, students will be able to

1. Use analytical methods for the solution of thin plates and shells.

2. Use analytical methods for the solution of shells.

3. Apply the numerical techniques and tools for the complex problems in thin plates.

4. Apply the numerical techniques and tools for the complex problems in shells.

UNIT I

Introduction: Space Curves, Surfaces, Shell Co-ordinates, Strain Displacement Relations, Assumptions in Shell Theory, Displacement Field Approximations, Stress Resultants, Equation of Equilibrium using Principle ofVirtual Work, Boundary Conditions.

UNIT II

Static Analysis of Plates: Governing Equation for a Rectangular Plate, Navier Solution for Simply-Supported Rectangular Plate under Various Loadings, Levy solution for Rectangular Plate with other Boundary Conditions.

UNIT III

Circular Plates: Analysis under Axi- Symmetric Loading, Governing Differential Equation in Polar Co-ordinates. Approximate Methods of Analysis- Rayleigh-Ritz approach for Simple Cases in Rectangular Plates.

UNIT IV

Static Analysis of Shells: Membrane Theory of Shells- Cylindrical, Conical and Spherical Shells, Shells of Revolution with Bending Resistance - Cylindrical and Conical Shells, Application to Pipes and Pressure Vessels. Thermal Stresses in Plate/ Shell

Text books:

• Theory of Plates and Shells, Timoshenko S. and KriegerW., McGraw Hill.

• Stresses in Plates and Shells, UguralAnsel C., McGraw Hill.

References:

• Thin Elastic Shells, KrausH., John Wiley and Sons.

• Theory of Plates, ChandrashekharaK., Universities Press.

• Design and Construction of Concrete Shells, Ramaswamy G.S.

Elective IV: Thermal-

Course No.: MET 453 Power Plant Engineering **C L T (4 3 1)**

POWER PLANT ENGINEERING

Course Outcomes:

1. Identify the different types of power plants and understand the layout of steam power plant.
2. Understanding of Hydroelectic Power plant and Coordination of different types of power plants.
3. Able to descibe the working operations of Nuclear, Diesel, Gas and Steam power plants.
4. To apply & analyses the economics of power plant and able to decides the tariffs for different power plants.

UNIT I

Introduction:- Energy source for generation of electric power. Principle types of power plants, their special features and applications, major power plants in India.
Steam Power Plants :- Selection of site, general layout of the power plant, special features of the modern steam boilers, circulation principle, steam separation and purification, economizers and air pre-heater types and estimation of performance, super-heater and superheat control, feed water heaters, cooling tower , temperature and pressure control. Introduction to hydro electric power plant, types of hydro-electric plant in combination with steam plant, Runoff river plant in combination with steam plant, storage plant in combination with steam or nuclear plant, Coordination of hydro-electric and gas turbine stations, coordination of different types of power plants.

UNIT II

Nuclear Power Plants :- Nuclear fuel, nuclear energy by fission, main components of nuclear reactors, pressurized water, boiling water, liquid metal and gas nuclear reactors.

Diesel Power Plants :- Plant layout , two and four stroke cycle diesel engines, fuel injection, lubrication and cooling systems, supercharging and starting systems. Gas and Steam Turbine combined Cycles:- Simple gas and steam combined cycle power generation.

UNIT III

Economic Analysis of Power Plants and Tariffs :- The cost of electrical energy , selection of types of generating equipment , performance and operating characteristics of power plant , load division among generators , Tariff methods of electrical energy .Combined operation of different power plants :- Advantages of combined working , Load division among power stations , Storage

Text Book:

1. Rajput R.K., "A text book of power plant engineering", *Laxmi Publication, Pvt. Ltd., New Delhi, 2007.*

Reference Books:

1. Thermal Engineering by Ballaney, Khanna Publisher
2. Thermal Engineering by Domkundar& Arora, Dhanpat Rai
3. Steam Turbine Theory & Practice by Kearton, W.J. Pitman.
4. Power Plant Engineering by Morse
5. Power Plant Engineering by Domkundwar
6. Power Plant Technology by El-Wakil

Elective IV: Production-

Course No.: MET 454 **ENTREPREUNERSHIP DEVELOPMENT AND RISK MANAGEMENT** **C L T (4 3 1)**

ENTREPREUNERSHIP DEVELOPMENT AND RISK MANAGEMENT

COURSE OUTCOME:

On completion of the course, the students will be able to:

1. Understanding the dynamic role of entrepreneurship and small businesses
2. Organize and Manage a Small Business
3. Understand Financial Planning, Control and Strategic Marketing Planning
4. Explain New Product or Service Development and Business Plan Creation

UNIT-1

Introduction to Entrepreneurship: Meaning, Role of Entrepreneur, Entrepreneur Process: different approaches, Motivation for becoming an Entrepreneur. SME Concept, its role, status, prospects and policies for promotion of SMEs. Importance of Entrepreneurship: innovations, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Issues & Problems Entrepreneurial Practices, 11 Contribution of Entrepreneurs: Towards R&D, creates Wealth of Nation & Self prospect with Challenge, Entrepreneur Carrier: Different Stages, Entrepreneur Development Programmers (EDPs).

UNIT-II

Characteristics of Entrepreneurship: Risk taker, Perceptive, Curious, Imaginative, Persistent, Goal setting, Hardworking, Research & Management Skill, Soft skills and Feasibility, Women Entrepreneurship: Opportunities, promotion Hurdles and Prospects of women Entrepreneurs.Factors & Models of Entrepreneurial Development, Social Entrepreneurial Initiative: Solving social Problems, Business plan, Strategic Plan vs Business Plan, Technical and Financial Feasibility study and analysis of projects under self employment scheme including small entrepreneur. The World of Opportunity, Idea versus Opportunity, sources of ideas and idea generation techniques, sources of opportunities, identification and selection of opportunities, the Business Plan, Components of a business plan, How to develop a good business plan?, Role of Entrepreneurial Institutions in Entrepreneurship Development, Various Schemes and Incentives.

UNIT-III

Farm based enterprises for production and post production of Agri-produce: Crops: Cereals, Legumes, Oilseeds; Horticulture crops : Fruits and vegetables; Livestock production : Poultry, Fishery, Medicinal and Aromatic plants. Handlooms & Sericulture; Handicraft, coir, jute & leather Agro-Eco Tourism, Micro entrepreneurial skills development and good production practices, Role of

Ministry of MSME, Registration Process of MSME, Emerging Technologies & Business Opportunities in India.

UNIT-IV

Risk Management: Risk Factor, Sensitivity Analysis, Vulnerability Analysis, External Risk, Internal Risk, Environmental Risk. Financial planning . Forecasting inputs and outputs, Components of the financial plan, Bootstrapping ,Venture and Growth Capital, Managing a Micro Enterprise, Human resource development for enterprise growth; delegation, motivation and leadership in microenterprises.

REFERENCE BOOKS

1. Byrd Megginson, Small Business Management An Entrepreneur’s Guidebook 7th ed, McGraw-Hill, Irwin
2. N. V. R. Naidu, Naidu I. K, Management and Entrepreneurship. International Pvt Ltd, 01- Jan-2008
3. Frank Martin and Marcus Thompson Palgrave, Social Enterprise Developing Sustainable Businesses Macmillan
4. David R. Stokes, Nicholas Wilson Cengage, Small Business Management and Entrepreneurship Learning EMEA, 2006 - Business & Economics
5. Donald F. Kuratko Cengage, Learning Entrepreneurship: Theory, Process, Practice Business & Economics 14-Nov-2008
6. Timmons, Jerry A., and Spinelli, Stephen, 2009. New Venture Creation: Entrepreneurship for the 21st Century, 8th Edition, Boston, MA: Irwin McGraw-Hill
7. Carree, M.A., and A.R. Thurik „Impact of Economic Growth,’Hand Book of Entrepreneurship Research, New York:Springer

Elective V: Design –

Course No.: MET 455 Theory of Elasticity **C L T (4 3 1)**

THEORY OF ELASTICITY

Course Outcomes:

1. Explain the fundamental concept of stress & strain followed by an analytical expression relating the stress & strain in 3-D systems.
2. Apply the compatibility equations & boundary conditions to solve the problems of T.O.E in practices.
3. Analyze the structural members subjected to pure bending using the fundamental concept of stress,strain & elastic behaviours of materials.
4. Apply analytical techniques to predict the ffects of stress concentration in simple solids & structural components.

UNIT I

Introduction: Elasticity, stress components of stress and strain, Hooks law. Equations in polar coordinates, Plane stress and plane strain: Strain at a point, Mohr circle for strain rosette, differential equation of equilibrium, boundary conditions, compatibility equations, overview of Airys stress functions.

UNIT II

Two dimensional problems in rectangular coordinates: solution by polynomials, St Venants principles, determination of displacement, bending of beams, solution by Fourier series. Two dimensional problems in polar coordinates: Equations in polar coordinates, equation about 1- axis, and pure bending in curved bars.

UNIT III

Determination of strains and displacement, effect of circular hole on stress distribution in plate concentrated and vertical loading of a straight boundary, circular disc, general solution and its applications, Analysis of stress and strain in thee dimensions: stress at a point, principal stress, stress ellipsoid and stress director surface, homogenous deformation, strain at a point, principle strain rotation.

Text Books:

1. Timoshanko, S.P. and Goodier, J.N., “Theory of Elasticity,” *Mc-Graw Hill Book Company, N.Y. , USA, 1970.*

Reference Books:

1. Love, A.E.H., “The Mathematical Theory of Elasticity,” *Dover Publications, NewYork, USA, 1944.*

Elective V: Thermal –

Course No.: MET 456 Renewable Energy Systems **C L T (4 3 1)**

RENEWABLE ENERGY SYSTEMS

COURSE OUTCOMES:

1. To compare aware about different renewable energy resources.
2. To know the conversion of energy from one form to other.
3. To know the importance the solar radiation and its utilization.
4. To analyze of different energy conversion energy systems.

COURSE CONTENT:-

UNIT-I

Introduction

Introduction to energy, Relevance of energy in the development of country, conventional, non-conventional and renewable sources of energy. Status of conventional sources of energy and their conservation, Exploring renewable sources of energy.

UNIT-II

Solar Radiation and Applications of Solar Heat

Extraterrestrial solar radiation, components of radiation, geometry of earth and sun, geometry of collector and the solar beam, effects of earth's atmosphere, measurements of solar radiation, type of water heaters, selective surfaces, space heating, space cooling, water desalination, solar ponds, solar concentrators, thermos- electric power system, problems.

Photovoltaic Generation

Introduction, the silicon p-n junction, photon absorption solar radiation input, photovoltaic circuit properties and loads, limits to cell efficiency, solar cell construction, other types of photoelectric and thermo-electric generation.

UNIT-III

Hydro and Wind Powers

Principle of hydro power conversion, impulse turbine, reaction turbines, wind turbine types, linear momentum and basic theory, dynamic matching, characteristics of the wind, power extraction by a turbine, electricity generation, mechanical power, problems.

Bio-Fuels

Introduction, Bio fuels, classification, bio-mass production for energy farming, direct combustion for heat, pyrolysis (destructive distillation), alcoholic fermentation, anaerobic digestion for bio-gas, agrochemical fuel extractions.

UNIT-IV

Wave Energy and Tidal Power

Introduction, wave motion, wave energy and power, wave patterns, devices, the causes of tides, enhancement of tides flow power, tidal range, power, world tidal power sites.

OTEC and Geothermal Energy

Principles of Ocean Thermal Energy Conversion (OTEC), Claude cycle, Andersan cycle, Introduction to geothermal energy, dry rock and hot aquifer analysis, harnessing geothermal resources

Text Books:

1. Solar Energy by S P Sukhatme, Publisher Tata Mc Graw- Hill New Delhi

Reference Books:

1. Renewable Energy Rsources by john W. Twidell and Anthony D. Weir, published by E.& F. N. SponLtd,Lndon.
2. Renewable energy by Bent Sorensen by Academic press
4. Non-conventional Energy Sources by G D Rai by Khanna Publishers Delhi

Elective V: Production

Course No.: MET 457 Advanced Welding and Allied Processes **C L T (4 3 1)**

ADVANCED WELDING AND ALLIED PROCESSES

Course Outcomes:

CO1	Identify the use of welding processes in manufacturing industries.
CO2	Apply knowledge to select appropriate welding process based on the application.
CO3	Explain welding of plastics and underwater welding.
CO4	Understand the process of thermal spraying and thermal cutting.

UNIT I

Introduction to welding

Welding Principle, Application of welding in industries, Weld ability of Material, Arc welding consumables, Shielding gases and association mixtures. Weld bead geometry and shape factors. Weld dilution,weld joint configurations, liquation cracking, hot cracking.Automation in welding.

UNIT II

Fusion and Solid state welding

Fusion Welding Processes:Classification of fusion welding processes, Submerged Arc Welding, Electroslag welding, Plasma arc welding.

Solid state welding: Introduction, Advantages of solid state welding over fusion welding processes, Explosive welding, Ultrasonic welding, Friction welding, Friction stir welding, Welding zones in FSW.

UNIT III

Welding of Plastics and Underwater welding

Plastics, Types of plastics,Welding of Plastic: Introduction, Classification of plastic welding, Hot plate welding, Hot gas welding, Ultrasonic welding, Friction welding, Applications of plastic welding.

Underwater Welding: Need and application of underwater welding, Dry underwater welding, wet underwater welding. Advantages and Limitations of dry and wet underwater welding.

UNIT IV

Thermal Spraying and Thermal Cutting

Thermal spraying: Introduction,Thermal spray processes, Application of thermal spraying, Thermal Cutting of Metals: Introduction, Methods and applications.Oxy-Fuel Gas Cutting, cutting torch, Oxygen-Lance Cutting, Plasma Arc cutting.

- Rao, P.N., Manufacturing Technology, Volume 2, McGraw-Hill Education, New Delhi.
- Lindberg, R.A., Processes and Materials of Manufacturing, Allyn and Bacon, Boston
- Khan N. Z, Siddiquee A. N. and Khan Z. A., Friction stir welding of dissimilar Aluminium alloys, CRC Press, Boca Raton, 2017.

Elective VI: Design

Course No.: MET 458 **MECHANICS OF COMPOSITE MATERIALS** **C L T (4 3 1)**

MECHANICS OF COMPOSITE MATERIALS

COURSE OUTCOMES

On completion of this subject students will be able to:

1. To identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.

2. To predict the failure strength of a laminated composite plate

3. Understand the linear elasticity with emphasis on the difference between isotropic and anisotropic material behaviour.

4. Acquire the knowledge for the analysis, design, optimization and test simulation of advanced composite structures and Components.

UNIT -1

Definition and classification of composite materials: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, CarbonComposites. Reinforcements and Matrix Materials. Manufacturing Techniques of Composites: Fiber Reinforced Plastic (FRP) Processing: Layup and curing, fabricating process, open and closed mould process, Hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding. Fabrication Process for Metal Matrix Composites (MMC's): Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

UNIT -2

Density, Mechanical Properties; Prediction of Elastic Constants, Micromechanical Approach, Halpin-Tsai Equations, Transverse Stresses.Thermal Properties; Expression for Thermal Expansion Coefficients of Composites, Expression for Thermal Conductivity of Composites, Hygral and Thermal Stresses.Mechanics of Load Transfer 15 from Matrix to Fiber; Fiber elastic-Matrix Elastic, Fiber Elastic-Matrix Plastic. Load transfer in Particulate Composites. Numerical Problems.

UNIT -3

Elastic Constants of an Isotropic Material, Elastic Constants of a Lamina, Relationship between Engineering Constants and Reduced Stiffnesses and Compliances, Variation of Lamina Properties with Orientation, Analysis of Laminated Composites, Stresses and Strains in Laminate Composites, Inter-laminar Stresses and Edge Effects. Numerical Problems.

UNIT -4

Tensile and Compressive strength of Unidirectional Fiber Composites. Fracture Modes in Composites; Single and Multiple Fracture, Debonding, FiberPullout and Delamination Fracture. Strength of an Orthotropic Lamina; Maximum Stress Theory, Maximum Strain Criterion, Tsai-Hill Criterion, Quadratic Interaction Criterion, Comparison of Failure Theories.Fatigue; S-N Curves, Fatigue Crack Propagation Tests, Damage Mechanics of Fatigue, Thermal Fatigue. Creep behavior of Composites.

UNIT -5

Symmetric Laminates, Cross-ply laminates, Angle ply Laminates, Antisymmetric Laminates, Balanced Laminate. Failure Criterion for a Laminate.Design of a Laminated Composite.Numerical Problems.

TEXT BOOKS:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Taylor & Francis, 2nd Ed, 2005

2. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012 3. Robert M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1999.

REFERENCE BOOKS:

1.MadhijitMukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004

2. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009

3. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993 4. Hand Book of Composites, P.C. Mallik, Marcel Decker, 1993

Elective VI: Thermal

Course No.: MET 459 **Advanced Fluid Mechanics** **C L T (4 3 1)**

After the completion of course, students will be able,

CO1	To have a good knowledge of the methods and techniques in viscous flows theory and be in a position tointerpret viscous flow phenomena
CO2	To writeNavier-Stokes equations (conservation laws for mass, momentum, and energy) for simple fluids
CO3	To solve for velocity and pressure fields in a viscous flow subjected to steady and transient conditions and formulate boundary layer approximations
CO4	To identify, formulate and solve flow problems by applying knowledge of fluid mechanics and mathematics

UNIT I

Introduction, Concept of a fluid, Concept of Viscosity, Concept of Continuum, Properties of a fluid, Historical outline, Flow analysis Techniques, Eulerian and Langrangian flow description, Classification of fluid flows, Velocity and acceleration field, Material derivative, Control Volume and differential element approach, Reynolds Transport Theorem, Conservation of mass, Linear Momentum Equation, Energy Equation, Fluid Element kinematics, Linear motion and deformation, Angular motion and deformation.

UNIT II

Vectors and Tensors, Representation of second order tensor, Addition, subtraction and multiplication of tensors, Transpose of a tensor, Symmetric and Unsymmetric tensor, Unit tensor, Dyadic product, Divergence, Curl, Gradient of a vector and tensor, Significance of Gradient of velocity vector, Deformation, rotation, Divergence Theorem, Constitutive Equations for fluids, Stress Tensor for a simple flow, Stoke's Principle, Navier-Stokes Equation.

UNIT III

Exact Solutions of the Navier-Stokes Equations, Flow between through a straight stationary channel, Couette Flow, Hagen-Poiseulle flow, Flow between two concentric rotating cylinders, Axially moving concentric cylinders, Unsteady parallel flow (Stoke's first problem), Flow near an oscillating flat plate (Stoke's second problem), start-up of Couette flow, Transient axisymmetric Poiseulle flow, Flow of two immiscible fluids in a channel, Fully developed flow of a power law fluid, Superposition of Poiseuille and Couette flows.

UNIT IV

Laminar Boundary layers, Boundary-layer equations, Flow over a Flat plate, Blasius flow, Momentum-Integral Equation for the Boundary layer, Approximate methods for Boundary layer equations, Karman-Pohlhausen Method for Flow over a Flat Plate, Turbulent boundary layers, Characteristics of Turbulent flow, Laminar-Turbulent Transition, Engineering implications of turbulence, Correlation functions, Reynolds decomposition, Governing Equations for Turbulent flow, Measurement of Turbulence quantities, Shear-stress models, Prandtl's Mixing Length Hypothesis.

Textbooks:

1. White, F.M., "Viscous Fluid Flow", McGraw Hill, 2013.
2. Schlicting, H., "Boundary Layer Theory", McGraw Hill, 1979.

Reference Books:

1. Muralidhar, K., Biswas, B., "Advanced Engineering Fluid Mechanics", Narosa Publishing House, 2015.
2. Graebel, W.P., "Advanced Fluid Mechanics", Academic Press, 2009.
3. Aris, R., "Vectors, Tensors and Basic Equations of Fluid Mechanics", Dover Publications, 1962.
4. Munson, B.R., Young, D.F., Okiishi, T.H., Fundamentals of Fluid Mechanics, Wiley, 2017.

Elective VI: Production

Course No.: MET 460 Value Engineering **C L T (4 3 1)**

VALUE ENGINEERING

UNIT I:

Introduction to value engineering (VE) & value analysis (VA), Life Cycle of a product, Methodology of VE, Reasons for the existence of unnecessary costs. Quantitative definition of Value, use Value and Prestige value, Estimation of product Quality/Performance, Types of functions, Relationship between use functions and Esteem Functions in product design, Functional cost and functional worth, Effect of value improvement on profitability, Tests for poor value, Aims of VE systematic approach.

UNIT II

Elementary introduction to VE, Job plan functional approach to value improvement, Various phases and techniques of the job plan, Factors governing project selection, Types of projects, Life cycle costing for managing the total value, concepts in LCC, Present value concept, Annuity concept, net present value, Pay Back period, internal rate of return on investment (1RR), Examples and Illustrations. Creative thinking and creative judgement, positive or constructive discontent, Tangible and intangible costs of implementation, False material, Labour and overhead saving, VE/VA yardsticks, Relationship between savings and probability of success, Reliability Estimation, system Reliability, Reliability elements in series andparallel.

UNIT III

PHASES AND TECHNIQUES OF VE JOB PLAN:

General Phase, Information phase, Function phase, Creativity/Speculation Phase, Evaluation Phase, Investigation Phase and Recommendation Phase***:*** Value improvement recommendation theory, determination of cut-off point (cop), road blocks in implementation. Decision Matrix/Evaluation Matrix, Quantitative comparison of Alternatives, Estimation of weights factors and efficiencies, Utility transformation functions, Bench marking, Perturbation of weight factors (sensitivity analysis), and Examples.

FAST Diagramming: Critical path of functions, HOW, WHY & WHEN Logic, Supporting and all time functions.

Reference Books:

2. Arthur E. Mudge, “Value Engineering- A Systematic Approach”,*McGraw Hill Book Co.* 1971.

3. Miles L.D., “Techniques of value Analysis and Engineering”, *McGraw Hill Book Co., New York, 1970.*

4. ASTME-American society for Tool and Manufacturing Engineers,” Value

engineering in Manufacturing", *Prentice Hall Inc. USA, 1967.*

Course No.: MEP463 **MAJOR PROJECT – Stage II** **C L T (9 0 0)**

CO1 Identify methods and materials to carry out experiments/develop code.

CO2 Reorganize the procedures with a concern for society, environment and ethics.

CO3 Analyze and discuss the results to draw valid conclusions.

CO4 Prepare a report as per recommended format and defend the work.

CO5 Explore the possibility of publishing papers in peer-reviewed journals/conference proceedings.

Department of Mechanical Engineering

Semester-V

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET301	Heat Transfer	3	1	0	4	4
2.	MET302	Design of Machine Elements	3	1	0	4	4
3.	MET303	Mechanical Vibrations	3	1	0	4	4
4.	MET304	Industrial Engineering - I	3	1	0	4	4
5.	MET305	IC Engines	3	1	0	4	4
6.		Microprocessors in Automation	3	0	0	3	3
7.	MEL310	Heat Transfer Lab	0	0	2	2	1
8.	MEL311	Mechanisms and Vibrations Lab	0	0	2	2	1
						Total Credits	**25**

Semester-VI

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET351	Production Engineering	3	1	0	4	4
2.	MET352	Mathematical Methods	3	0	0	3	4
3.	MET353	Control Systems	3	1	0	4	4
4.	MET354	Fluid Mechanics - II	3	1	0	4	4
5.	MET3XX	Elective - I	3	1	0	4	3
6	MET4XX	Elective-II –(Design, Ther. & Pro.)	2	1	0	3	3
7.	MEL361	Applied Thermodynamics Lab	0	0	2	2	1
8.	MEL362	Industrial Engineering – I Lab	0	0	2	2	1
9.	MEI364	Tour & Training	-	-	-	-	1
						Total Credits	**25**

Semester-VII

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET401	Mechatronics and Measurement Systems	3	1	0	4	4
2.	MET402	Industrial Engineering - II	3	1	0	4	4
3.	MET403	Machine Design	3	1	0	4	4
5.	MET4XX	Elective-III–(Design, Ther. & Pro.)	3	1	0	4	4
6	MET4XX	Elective –IV (Swayam Course)	3	1	0	4	4
6.	MEL411	Mechatronics and Measurement Systems Lab	0	0	2	2	1
7.	MEL412	Industrial Engineering – II Lab	0	0	2	2	1

8.	MES463	Seminar	**0**	**0**	**4**	**4**	**1**
9.	MEP413	Major Project – Stage I	**0**	**0**	**6**	**-**	**2**
						Total Credits	**25**

<u>Semester-VIII</u>

S. No.	**Course Code**	**Course Title**	**Hours Per Week**			**Total Contact Hours**	**Credits**
			L	**T**	**P**		
1.	MET451	Operations Research	**3**	**1**	**0**	**4**	**4**
2.	MEL4XX	Elective-V–(Design, Ther. & Pro.)	**3**	**1**	**0**	**4**	**4**
3.	MEL4XX	Elective-Vi–(Swayam Course)	**3**	**1**	**0**	**4**	**4**
4.	MEL4XX	Elective-VIi–(Design, Ther. & Pro.)	**3**	**1**	**0**	**4**	**4**
5.	MEP463	Major Project – Stage II	**0**	**0**	**18**	**-**	**9**
						Total Credits	**25**

<table>
<tr><td rowspan="3">Subject: Heat Transfer
(Code: MET301)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

After the completion of course, students will be able,

CO1	Identify, formulate and solve steady, transient and multidimensional heat conduction problems.
CO2	Understand the phenomenon of convection and be able to evaluate heat transfer coefficients for natural and forced convection.
CO3	Calculate radiation heat exchange between black as well as non-black surfaces
CO4	Be able to solve a wide range of real world problems involving conduction, convection and radiation

Unit I

Introduction, Physical origins and rate equations, conduction, convection, radiation, relationship to thermodynamics, Combined conduction-convection-radiation problems, Importance of heat transfer, conduction rate equation, thermal conductivity, general heat conduction equation, boundary and initial conditions, one dimensional steady heat conduction, plane wall, thermal resistance, composite wall, contact resistance, alternate conduction analysis, one dimensional steady heat conduction in cylinders and spheres, critical radius of insulation, one dimensional steady state heat conduction with heat generation in plane walls, cylinders and spheres, heat transfer from extended surfaces, fins with constant area, fin performance.

Unit 2

Two-dimensional steady state heat conduction, method of separation of variables, conduction shape factor and dimensionless conduction heat rate, unsteady heat conduction, Lumped capacity analysis, criteria for lumped capacity analysis, transient heat conduction in a semi-infinite solid, Biotand Fourier numbers, transient heat conduction in large plane walls, long cylinders and spheres with spatial effects, transient heat conduction in multi-dimensional systems.

Unit 3

Convection boundary layers, Velocity and thermal boundary layer, local and average heat transfer convection coefficients, derivation of differential convection equations, solutions of convection equations for a flat plate, Nusselt and Prandtl numbers, relation between fluid friction and heat transfer, Turbulent-boundary-layer heat transfer, flow across cylinders and spheres, flow across tube banks, Internal forced convection, mean velocity, mean temperature, empirical relations for pipe and tube flows, Free convection heat transfer on a vertical flat plate, Grashof and Raleigh numbers, Empirical relations for free convection, Combined free and forced convection.

Unit 4

Thermal radiation, black and gray surfaces, Radiation laws, Radiation shape factor, relation between shape factors, Radiation heat exchange between black bodies, Radiation heat exchange between non-black bodies, Radiation shields, Condensation heat transfer phenomenon, condensation number, film condensation inside horizontal tube, boiling heat transfer, simplified relations for boiling heat transfer with water, heat exchangers, overall heat transfer coefficient, fouling, types of heat exchangers, log mean temperature difference, Effectiveness-NTU method, Compact heat exchangers.

Textbooks:

3. Incropera, F.P., Dewitt, D.P., Bergman, T.L., Lavine, A.S., “Principles of Heat and Mass Transfer”, Wiley, 2017.
4. Holman, J.P., “Heat Transfer, McGraw Hill, 2011.

Reference Books:

3. Bejan, A., “Heat Transfer”, John Wiley, 1993.
4. Cengal, Y.A., Ghajar, A.J., “Heat Transfer”, McGraw Hill, 2020.

DESIGN OF MACHINE ELEMENTS

Course No.: MET 302 **C L T (4 3 1)**

Core Course Pre-requisites: Engineering mechanics, Mechanics of solids and Engineering materials science.

Course objective: To teach Mechanical Engineering Students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.

Course Content:

UNIT I

Design requirements, Selection of materials and manufacturing considerations in design.
Riveted joints: Introduction, Types of riveted joints, Failures of riveted joints, Strength of riveted joint, Efficiency of riveted joint. Design of longitudinal butt joint and circumferential lap joint for a Boiler.
Bolts, Nuts & Screws: Introduction, Advantages & disadvantages, Definitions, Forms of screw threads, Common types of screw fastenings, locking devices. Designation of screw threads, Stresses in screwed fastening due to static loading.
Welded connections: Introduction, Advantages & disadvantages of welded joints, welding processes, fusion welding, thermit welding, gas welding, Electric arc welding, forge welding. Types of welding joints, Lap joint, Butt joint, Strength of transverse fillet welded joints, strength of parallel fillet welded joints, special cases of fillet welded joints, axially loaded unsymmetrical welded sections.

UNIT II

Stress concentration: Theoretical or form stress concentration factor, Stress concentration factor due to holes and notches, Methods of reducing stress concentration. Cyclic loading and endurance limit: Completely Reversed or cyclic stresses, Fatigue and endurance limit, effect of loading on endurance limit, Effect of surface finish, size and miscellaneous factors on endurance limit. Combined steady and variable stress: Gerber method for combination of stresses, Goodman method for combination of stresses, Soderberg method for combination of stresses.

UNIT III

Cotter and Couplings: Types of cotter joints, Socket and spigot cotter joint, Design of socket and spigot cotter joint, Design of sleeve and cotter joint. Types of shaft couplings, Design of sleeve and muff coupling, Design of flange coupling.
Power Screws: Types of screw threads used for power screws, Torque required to raise load on square threaded screws, torque required to lower load by square threaded screws, Efficiency of square threaded screws, Maximum efficiency of a square threaded screw. Over Hauling and Self locking screws. Design of screw jack.
Shafts: types of shafts, design of shafts, shafts subjected to twisting Moment only, Shafts subjected to bending moment only, shafts subjected to combined twisting moment and bending moment.

Course Outcomes:
On successful completion of the course, Students should be able to:

5. Demonstrate knowledge on basic machine elements used in machine design.

6. Understand the stress and strain on machine components and identify and quantify failure modes for machine parts.

7. Design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.

8. Approach a design problem successfully, taking decisions when there is not a unique answer.

Course Assessment:

Students will be assessed on:

4. Continuous assessment in the form of homework, assignments, attendance, and presentations (10% weightage).

5. One and half hour written exams designated as Mid-term (30% weightage).

6. Two hour written exams designated as End-term (60% weightage).

Text Books:

4. Ullman D.G., "The Mechanical Design process", 3rd edition, McGraw Hill, 2009.

5. Mott, R.L, "Machine Elements in Mechanical Design", 4th edition, Prentice Hall, Singapore, 2005.

6. Shigley, J.E., Mischke, C. Brown T., "Standard Hand book of Machine Design", McGraw Hill.

Reference Books:

Shigley, J.E., "Hand Book of Machine Design", McGraw Hill, 2004

<table>
<tr><td rowspan="3">Subject: Mechanical Vibrations (Code: MET303)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering 3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, a student should be able to:

CO1: Develop the mathematical models of vibrating systems, determine their DOF, and determine the free and forced vibration response of such systems.
CO2: Determine the response of linear time-invariant systems to arbitrary forcing conditions using the convolution integral and the Laplace Transform method.
CO3: Formulate the equations of motion of multiple degree of freedom systems, express it as an eigen value problem and determine the free and force vibration response.
CO4: Derive the equations of motion of a continuous system, determine its natural frequencies and mode shapes, and obtain the free vibration response to given initial conditions.

Detailed Syllabus:

UNIT I

Harmonic Motion, Vibration Terminology, Complex Methods of Representing Harmonic Motion, Fourier Series and Harmonic Analysis, Free and Forced Vibrations, Degrees of Freedom, Mathematical Modeling of Vibrating Systems, Differential Equations of Motion, Solution of the Differential Equation of Motion, Torsional Vibrations, Various Types of Damping, Dry Friction or Coulomb Damping, Structural Damping, Viscous Damping. Logarithmic Decrement, Energy Dissipated By Damping, Equivalent Viscous Damping, Introduction to Energy Methods.

UNIT II

Forced Harmonic Vibrations, Rotating Unbalance, Support Motion, Vibration Isolation and Control, Vibration Measuring Instruments, Vibration Pickups, Vibrometers and Accelerometers, Vibrations under General Forcing Conditions, Impulse Excitation, Arbitrary Excitation, Convolution Integral, Use of Laplace Transforms, Pulse Excitation and Rise Time, Shock Response Spectrum, Shock Isolation.

UNIT III

Two-Degree-of-Freedom Systems, Normal Mode Analysis, Coordinate Coupling and Principal Coordinates, Forced Harmonic Vibration, Vibration Absorbers and Vibration Dampers, Generalized Coordinates, Natural Frequencies and Mode Shapes, Modal Analysis, Multi-degree-of-Freedom Systems

UNIT IV

Continuous Systems, Longitudinal Vibration of a Bar, Equation of Motion and Solution, Orthogonality of Normal Functions, Lateral Vibration of Beams, Equation of Motion, Initial Conditions, Boundary Conditions, Effect of Axial Force, Effects of Rotary Inertia and Shear Deformation, Whirling of Shafts, Critical Speeds, Balancing of Rotating Shafts, Single-Plane Balancing, Two-Plane Balancing

Text Book:

2. Grover, G. K., Mechanical Vibrations, 7th edition, Nem Chand and Bros, New Delhi, India 1996.

Reference Books:

3. Thomson, W. T., Theory of Vibrations with applications, Fifth Edition, Pearson Education, 2004.
4. Rao, S. S., Mechanical Vibrations, Sixth Edition, Pearson Education.

Course No.: MET 304 **INDUSTRIAL ENGINEERING -I** **C L T (4 3 1)**

COURSE OUTCOMES:

5. **Understanding the concept and applications of industrial engineering with a focus on productivity, work design and work study.**
6. **Analysing & applying the method study techniques in relation to a particular job environment.**
7. **Analysing & evaluating various engineering work measurement techniques designed to establish the time for a qualified worker to carry out a specific job at a defined level of performance.**
8. **Attain a grasp of the fundamental principles of experimental design, collection of data related to work study, their analysis and interpretation.**

UNIT I

Concept of industrial productivity**:** Introduction and significance of Industrial engineering with brief explanation of its techniques, Functions of Industrial Engineering, Definitions and explanation of Productivity with significance in Industries, Productivity measurements, Factors affecting productivity, Basic work content and excess work content, Industrial applications to calculate total and partial productivities, Introduction to Work study and its basic procedures, definitions and concept of work study with examples, Human factor in the application of work study, Factors for selecting the work study, Ergonomics**:** scope and objectives of ergonomics, application of human factors in engineering work place design, etc.

UNIT II

Introduction to Method study and the selection of jobs, Record, Examine and Develop, Objectives and basic procedure of Method study, Recording techniques (Process Charts (PC), and Diagrams),Outline PC, Flow process charts, Two hand process charts, MAC (??), Simo chart, Flow diagram, String diagram, Cycle graph, Chronocycle graph, Travel chart, Define, Install and Maintain, the principles of motion economy,

UNIT III

Work measurement and its applications, Time study, Work Sampling, Rating and their methods, Breaking the jobs into Elements, types of Elements, Allowances and their calculations, Calculation of Standard time, Examples of Time study, PMT (??) systems, synthetic data, Various applications and examples.

Text Book:

1. Barnes, R.L., "Motion and Time Study, Design & Measurement of Work*" 7th edition, John Wiley & Sons, New York, 1980.*

Reference Books:

4. International Labor Office, Geneva, "Introduction to Work Study" 4th Edition, Geneva, *1985*.

5. Currie R.M, "Work study", ELBS *& Pitman, London, 1977.*

6. Mundel, M.E., "Motion and Time Study", 5th Edition, *Prentice Hall, Englewood Cliff, NewYork, 1978.*

C L T (4 3 1)

MET305	INTERNAL COMBUSTION ENGINES	3-1-0	Credits: 4

Prerequisites: Thermodynamics, Heat Transfer

Course Outcomes: At the end of the course, the student should be able to:

CO1:	To understand the internal combustion engine design as the largest prime mover for all applications in the world.
CO2:	To understand combustion related characteristics of engine and its fuels.
CO3:	To understand the essential systems of IC engines.
CO4:	To understand numerical on engine design, engine emissions, emissions measurement and its control.

Unit 1

Introduction : Engine classification.

Design and operating parameters: Geometry and geometrical properties, working principle of Two stroke and Four stroke engines, Analysis of air-standard cycles, fuel-air cycles and actual engine cycles, Thermodynamics of actual working fluids, Air capacity of four stroke engines: Ideal air capacity , Volumetric efficiency , ideal induction process , actual induction process, Effect of operating conditions on volumetric efficiency, Effect of design on volumetric efficiency , estimating air capacity. Valve and port timing diagram.

Supercharging and Scavenging in IC engine : Methods of supercharging and turbo-charging in SI and CI engine, limits of supercharging in SI and CI engine. Scavenging in two stroke cycle engines, scavenging parameters and efficiency

Unit 2

Combustion in SI and CI Engine: Classification of fuel, solid, liquid and gaseous fuels, fuel properties and fuel rating, Alternative fuels, mixture requirements, characteristics of SI and CI engine fuels. Combustion and detonation: chemistry of combustion, normal combustion in S.I engines , pre- ignition and auto-ignition comparison, detonation in S.I engines, combustion in C.I engines, detonation in C.I engines, Methods of reducing detonation , preliminary detonation, preliminary facts about fuel and dopes, octane and cetane numbers, effect of design on detonation. Mixture requirements: Steady running, mixture requirements, transient mixture requirements, mixtures requirements for fuel injection engines, mixture requirements for S.I engines. Use of combustion charts for burned mixture Appropriate treatment of fuel air mixtures.

Unit 3

Fuel Injection system: Types of carburetor, mixture requirements, single point and multipoint injection system in SI engine, rate of fuel injection in CI engine, fuel injection pumps and nozzle. Current injection systems in I C engines.
Ignition System: Battery ignition, Magneto ignition and Electronic ignition, factors affecting spark advance, spark advance mechanism. Current ignition systems.
Engine friction and lubrication: Components of engine friction, friction mean effective pressure, Blow by losses, effect of engine variables on friction, side thrust on piston. lubrication principle, types of lubrication ,properties of lubricant.
Heat transfer and Cooling system: Engine temperature distribution, heat transfer consideration, gas temperature variation, effects of operating variables on heat transfer , air cooling and liquid cooling systems, concept of adiabatic engine, Numerical on heat transfer in IC engines.

Unit 4

Engine Testing and performance: Measurement of indicated power, brake power, fuel consumption, air flow rate, engine speed, spark timing, performance characteristics, Numerical on engine design, determination of main dimensions, Numerical on two stroke engines and four stroke engines. Numerical on heat transfer in IC engines, Engine design and principles of similitude. Numerical on alternative fuels, Numerical on diesel fuel injection system, Numerical on verification of engine commercial specifications.
Exhaust Emissions: Pollutants from IC engines. mechanism of pollution formation, methods of emission control, Effect of alternative fuels, Emission norms.
Measurement Of Exhaust Emissions. NDIR, FID, CLA, measurement of exhaust smoke, gas chromatography, effect of operating variables on SI and CI engine pollutant.

Text Book:

2. Heywood, John B. Internal Combustion Engine Fundamentals. McGraw-Hill Book Company.

Reference Books:

4. V. Ganeshan: I. C. Engines: Tata McGraw Hill, New Delhi, 4/e
5. W. W. Pulkrabek: Engineering Fundamentals of I. C. Engines, Prentice Hall India
6. M K Gajendra Babu and K A Subramanian; Alternative Transportation Fuels; CRC Press.

Course No.: XXXX **MICROPROCESSORS IN AUTOMATION** **C L T (3 3 0)**

COURSE OUTCOMES: (To be given by ECE dept., not obtained by the mechanical Dept. till date)

(To be obtained from ECE Department)

<table>
<tr><td rowspan="3">Subject:
HEAT TRANSFER LAB
(Code: MEL310)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech
Mechanical Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td></td><td></td><td colspan="3"></td></tr>
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</table>

After the completion of course, students will be able,

CO1	Acquire a thorough outlook regarding the steps to design and conduct experiments for measuring specific physical variables
CO2	To apply the concepts learnt in Heat Transfer theory subject to do hands on experiments
CO3	To calculate the thermal conductivity, heat transfer coefficient, and other parameters relevant in heat transfer
CO4	Communicate effectively in completing written reports of laboratory work

List of Experiments

10. To determine the thermal conductivity of a metal bar
11. To determine the thermal conductivity of a liquid
12. To study the heat transfer through the insulating medium
13. To study heat conduction in a composite wall
14. To study heat transfer from a pin fin
15. To study heat transfer in natural convection
16. To study heat transfer in forced convection
17. To study the heat transfer phenomena in a heat exchanger with parallel / counter flow arrangements
18. To determine Stefan Boltzmann constant

MEL 311 MECHANISMS AND VIBRATIONS LAB C P (1 2)

COURSE OUTCOMES:

5. **The student should be able to prepare technical reports and documents detailing the experimental methodology.**
6. **Determine the time period of a simple and compound pendulum and visualize the basic characteristics of a simple harmonic motion.**
7. **Determine the mass moment of inertia (ROG) of irregularly shaped objects using bifilar and trifilar suspensions.**
8. **Analyze the free and forced vibration characteristics of an equivalent spring mass system and determine its frequency response function.**

9. Determine the time period of a simple pendulum. Verify that the time period is independent of the mass of the bob.
10. Determine the radius of gyration of a compound pendulum.
11. Determine the radius of gyration of a given bar by using a Bifilar suspension.
12. Study the undamped free vibration of an equivalent spring mass system.
13. Study the forced vibration of an equivalent spring mass system.
14. Study the torsional vibration of a single rotor shaft system.
15. Determine the frequency response function of an equivalent spring- mass- dashpot system.
16. Pressure profile measurement on Journal bearing.

<table>
<tr><td rowspan="3">Subject: Production Engineering
(Code: MET351)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, a student should be able to:

CO1: Determine the shear angle and cutting force in machining and understand the basics of metal cutting.
CO2: Estimate tool life and explain the tool wear mechanisms and abrasive machining process.
CO3: Analyze the forming process behavior for conventional and advanced metal forming processes.
CO4: Understand the basics of limits, fits and tolerances in manufacturing.

Detailed Syllabus:

UNIT I

Introduction to machining; Orthogonal cutting; Oblique cutting; Types of chips; Mechanics of chip formation; chip breakers; Mechanics of Metal Cutting: Merchant's circle diagram; Determination of cutting and thrust forces; Coefficient of friction; strain rate; Measurement of shear angle, Thermal aspects of machining, Numerical problems.

UNIT II

Mechanisms of tool wear; Types of tool wear, Tool life: Variables affecting tool life-Cutting conditions; Tool angles specification systems; Tool materials; Desirable Properties of Cutting Tool; Determination of tool life; Machinability, Economics of machining.
Abrasive Machining Process: Introduction; Grinding: Characteristics of a grinding wheel; Specification of grinding heels; Mechanics of grinding process; Grinding operations; Wheel wear; Surface Finish; Selection of grinding wheels.

UNIT III

Metal Forming: Hot and cold working, Rolling; Forging; Extrusion; Sheet metal working. Introduction to high energy rate forming processes, their advantages and application. Electromagnetic forming, Explosive forming, Electrohydraulic forming.

UNIT IV

Metrology: Introduction to Metrology, Accuracy and Precision. Limits, fits and tolerances, need of providing tolerance, unilateral and bilateral system, Taylor's principles of gauge design, Sine bars and gauge blocks manufacturing method and their applications, Numerical problems.

Text Book:

2. Manufacturing Science-A. Ghosh and A.K. Malik, Affiliated East Press, New-Delhi.

Reference Book:

5. Campbell, J.S., Principles of Manufacturing Materials and Processes, McGraw-Hill, New-York,
6. Engineering Metrology and Measurements by N.V. Raghavendra and L. Krishnamurthy, 1st Edition, Oxford University Press
7. Rao, P.N., Manufacturing Technology, Volume 2, McGraw-Hill Education, New Delhi.
8. Lindberg, R.A., Processes and Materials of Manufacturing, Allyn and Bacon, Boston

Course No.: MET 352 **MATHEMATICAL METHODS**

C L P (3 3 0)

COURSE OUTCOMES:

6. **Able to solve non-linear equations using, R.F, Newton Rapson methods.**
7. **Able to solve linear system of equations using Gauss elimination, Gauss-Jourdan, Gauss siedel & LU decomposition**
8. **Able to use interpolation formulas; and linear & non linear curve fitting.**
9. **Able to use numerical differentiation & integration methods. Solve ODEs & PDEs using numerical methods.**
10. **Able to develop computer programmes for the above methods and interpret them graphically.**

UNIT I

Flow charts. Computer languages. Constants and variables. Arithmetic expressions. Input/ output, control statements. Introduction to programming.Types of errors. Computational algorithms and computer arithmetic. Iterative methods. Solution of equations: Bisection method, Regula-falsi method, Newton Raphson method. Solution of linear system of equations: Gauss elimination, Gauss-Jordan, Gauss- Siedel method, LU decomposition.

UNIT II

Interpolation and approximation of functions, Newtons forward formula (equal and unequal intervals) Curve fitting (straight line, nonlinear, exponential) differentiation, integration (Trapezoidal/Simpson's rule, Weddle's) and program.

UNIT III

Numerical solution of ordinary different equations. Runge- Kutta methods, Types of PDEs, boundary value problems, solution of parabolic PDEs using finite differences and program.

- Examples to be taken from Mechanical engineering applications.

Text Book:

1. Sastry,S. " Numerical Methods", *Printice Hall of India, New Delhi*.

2. Chapra & Chapra Numerical methods for Engineers. Mc. Graw Hill.

Reference Books:

2. Veerarajan, “ Numerical Methods”, *Tata Mc-GrawHill, New Delhi, 2000.*

Course No.: MET 353 **CONTROL SYSTEMS** **C L T(4 3 1)**

COURSE OUTCOME:

6. **Develop the mathematical models of LTI dynamic systems, determine their transfer functions, describe quantitatively the transient response of LTI systems, interpret and apply block diagram representations of control systems and understand the consequences of feedback.**
7. **Use poles and zeroes of the transfer functions to determine the time response and performance characteristics and design PID controllers using empirical tuning rules.**
8. **Determine the stability of linear control systems using the Routh-Hurwitzcriterion and classify systems as asymptotically and BIBO stable or unstable.**
9. **Determine the effect of loop gain variations on the location of closed-loop scales, sketch the root locus and use it to evaluate parameter values to meet the transient reponse specification od closed loop systems.**
10. **Define the frequency response and plot asymptotic approximations to the frequency response fumction of a system. Sketch a Nyquist diagram and use the Nyquist criterion to determine the stability of a system.**

UNIT I

Introduction: Concept of automatic control, open loop and closed loop systems, servo mechanism, block diagram, transfer function.

Representation of control components and systems: Translation and rotational mechanical components, electrical components -series and parallel combinations, comparators for rotational and linear motions, integrating devices, hydraulic servomotor temperature control systems ,speed control systems.

UNIT II

System response: First and second order systems, response to step, pulse, ramp and sinusoidal inputs, systems with distance velocity lag.

Modes of controls: Proportional control, Proportional pulse reset control, proportional pulse rate control, proportional reset rate control, two position control.

Controller Mechanism: Pneumatic, hydraulic and electric controllers, general principles and circuits for generating various control actions.

UNIT III

Control system analysis: Transient response of simple control systems, stability of control systems, Mouths criterion. Frequency response analysis, polar rectangular and logarithmic plots, experimental determination of frequency response, Bode and Inquest stability criteria, gain and phase margins. Root locus plots of simple transfer function, transient response from root locus.

Electronic Analogue computers: Elements of analogue computers, solution of simple differential equations.

Text Book:

1. Ogata,K., " Modern Control engineering", *Prentice Hall of India, 3rd edition, New Delhi, 1997*.

Reference Book:

1. Raven, F., "Automatic Control" *McGraw Hill Int., 1999.*

Course No.: MET 354 FLUID MECHANICS- II C L T (4 3 1)

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand the working of gas turbine plant components and analyse their performance.
CO2	Differentiate ideal and practical gas turbine cycles.
CO3	Analyze the operations of centrifugal air compressor and axial air compressor.
CO4	Design the working proportions of hydraulic machines.

Unit-I

Review of Basics: Introduction to Prime Movers, Gas Turbines, Review of Basic principles - Thermodynamics, Review of Basic principles - Fluid Dynamics and Heat Transfer, Fundamentals of Rotating Machines - Energy Equation, Dimensional Analysis, Aerofoil Theory.
Ideal Gas Turbine Cycles: Analysis of Ideal Gas Turbine Cycles, Simple Cycle, Regeneration Cycle, Reheat Cycle, inter cooling Cycle.
Practical Gas Turbine Cycles: Analysis of Practical Gas Turbine Cycles, Methods of accounting for component losses, Efficiencies, change in the composition of the working fluid. Combustion Chambers:Gas turbine combustion systems - Introduction, Geometry, Factors affecting Design & Performance, Requirements of the Combustion Chamber, Gas Turbine Combustion Emissions.

Unit-II

Centrifugal Compressors: Centrifugal Compressors- Principle of Operation, T-s diagram, Energy equation, velocity triangles, types of blades. Analysis of Flow, Performance Characteristics.
Axial Flow Compressors: Axial Flow Compressors - Construction, Principle of Operation, T-s diagram, Energy equation, velocity triangles. Analysis of Flow. Work done factor, Stage efficiency, Degree of reaction, Performance characteristics.

Unit-III

Hydraulic Turbines: Principle of impingements of jets, Euler equation, classification of Hydraulic Turbines, Constructional Details, Analysis, Efficiencies & Design Parameters of Impulse (Pelton Turbine) and Reaction Turbines (Francis, Kaplan& Propeller Turbine), Draft Tube, Cavitation, Governing of Hydraulic Turbines, Characteristics of the Hydraulic Turbine

Unit-IV

Centrifugal pumps: Advantages of Centrifugal Pumps over Reciprocating Pumps, Construction and Working of a Centrifugal Pump, Classification of Centrifugal Pumps, Different Heads of Centrifugal Pumps, Different Efficiencies of a Centrifugal Pump, Analysis of a Centrifugal Pump, Minimum Starting Speed of a Centrifugal Pump, Maximum Suction Lift and Net Positive Suction Head, Cavitation, Priming, Pumps in Series and in Parallel
Fluid System: Hydraulic press, Hydraulic accumulator, hydraulic intensifier, Fluid coupling, torque convertor, hydraulic ram, hydraulic actuator, airlift pump.

Reading:

5. Ganesan, V., Gas Turbines 3/e, Tata McGraw Hill Book Company, New Delhi, 2010.

6. Vasandani, V.P. and Kumar, D.S., Treatise on Heat Engineering, Chand and Co Publishers, New Delhi, 2011.
7. Saravanmuttoo, H.I.H., Rogers, G.F.C. and Cohen H., Gas Turbine Theory, 6/e. Pearson Prentice Education, 2008.
8. Applied Thermodynamics for Engineering Technologists 5th Edition (English, Paperback, Eastop T.D.).

MET3XX ELECTIVE-1 CLT (4 3 1)

Course No.: MET 355 FINITE ELEMENT METHOD C L T (4 3 1)

Course Outcomes: Upon successful completion of this course students should be able to:

1. Understand the concepts behind formulation methods in FEM.

2. Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.

3. Develop element characteristic equation and generation of global equation.

4. Able to apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow problems and solve them & find displacements, stress and strains induced.

UNIT I

Basic Concept, Historical background, Engineering applications, general description, Comparison with other methods. Need for weighted-integral forms, relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, Rayleigh-Ritz method, and weighted residual approach.

UNIT II

Model boundary value problem, finite element discretization, element shapes, sizes and node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solution, post-processing, compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Langrange and Hermite polynomials.

UNIT III

External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis-symmetric and three dimensional stress-strain problems, strain displacement relations, boundary conditions, compatibility equations, computer programs.

Variational approach, Galerkin approach, one-dimensional and two-dimensional steady-state problems for conduction, convection and radiation, transient problems.

Inviscid incompressible flow, potential function and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and stream function-vorticity formulation, Solution of incompressible and compressible fluid film lubrication problems.

Text Books:

1. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5 th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.

Reference Books:

1. J.N.Reddy, “Finite Element Method”- McGraw -Hill International Edition.
2. Bathe K. J. Finite Elements Procedures, PHI. 2. Cook R. D., et al. “Concepts and Application of Finite Elements Analysis”- 4th Edition, Wiley & Sons, 2003.

MET3XX ELECTIVE-1 CLT (4 3 1)

Course No.: MET 356 ADDITIVE MANUFACTURING PROCESSES C L T (4 3 1)

COURSE OUTCOMES: At the end of this course, the students shall be able to:

1. Understand the basics of additive manufacturing (AM) and working principles of different AM processes.
2. Explore the applications of different AM processes in various fields.
3. Analyze various AM processes to understand their relative merits and demerits.
4. Design and develop functional models using different AM techniques.

Unit-I

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, AM vs traditional manufacturing, advantages and limitations of AM over conventional manufacturing, nomenclature of AM machines, prototyping, tooling and manufacturing. Classification of AM processes, common AM processes, generalized AM process chain and steps in AM, types of materials for AM.

Unit-II

Vat Photo polymerization AM Processes: Introduction, materials for AM processes utilizing Vat Photo polymerization, Stereo-lithography (SL), photo polymerization process, process modeling, variants and classification of VAT photo polymerization process, Advantages and drawbacks of vat photo polymerization processes.

Powder Bed Fusion (PBF) AM Technique: Introduction to PBF, materials, powder fusion mechanism, process parameters and modeling, powder handling, powder fusion techniques, PBF process variants, Advantages and drawbacks of PBF.

Extrusion Based AM Processes: Introduction, basic principles of extrusion-based processes, Fused Deposition Modeling (FDM), materials, Bio extrusion, Contour Crafting, Non-Planar systems, RepRap FDM systems, process benefits and drawbacks.

Unit-III

Material Jetting (MJ) and Binder Jetting (BJ) AM Processes: Introduction to MJ and BJ, materials, process description to MJ and BJ, variants of MJ and BJ, comparison between MJ and BJ, benefits and drawbacks.

Sheet Lamination AM Processes: Introduction, Variants of sheet lamination, Laminated Objected Manufacturing (LOM), Ultrasonic additive manufacturing (UAM), benefits and drawbacks of UAM.

Directed Energy Deposition (DED) AM Processes: Introduction to DED, process description, classification of DED techniques, benefits and drawbacks of DED.

Recommended Texts:

1. Manu Srivastava, Sandeep Rathee, Sachin Maheshwari, TK Kundra**,** “Additive Manufacturing: Fundamentals and Advancements”, Ist ed.2019, Boca Raton: CRC Press, Taylor & Francis group.

2. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, 2nd Edition, Springer, 2015.

Recommended References:

1. Sandeep Rathee, Manu Srivastava, Sachin Maheshwari, TK Kundra, Arshad Noor Siddiquee, “Friction Based Additive Manufacturing Technologies: Principles for Building in Solid State, Benefits, Limitations, and Applications”, Ist ed.2018, Boca Raton: CRC Press, Taylor & Francis group.

2. Chua Chee Kai, Leong Kah Fai, “3D Printing and Additive Manufacturing: Principles & Applications”, 4th Edition, World Scientific, 2015.

3. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.

4. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

MET3XX ELECTIVE-1 CLT (4 3 1)

Course No.: MET 357 Advanced Thermodynamics C L T (4 3 1)

<table>
<tr><td rowspan="3">Subject:
Advanced Thermodynamics
(Code: MET3XX)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech
Mechanical Engineering
3rd Year &6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

After the completion of course, students will be able,

CO1	To extend the in-depth knowledge in the application of the laws of thermodynamics
CO2	To apply concepts of entropy generation and exergy to practical applications/systems
CO3	To have a coherent knowledge about the evaluation of the thermodynamic properties
CO4	To identify, formulate and solve a wide range of real world problems involving energy transfer

Unit 1

Scope and methods of thermodynamics, Review of Thermodynamics, Mathematical background, Macroscopic and Microscopic approaches in thermodynamics, Energy and first law of thermodynamics, First law for closed and open systems, Broadening understanding of energy transfer by work and heat, Structured presentation of First law of Thermodynamics.

Unit 2

Second law of thermodynamics, Traditional formulation of Second law of thermodynamics, logical relation between alternative statements of the second law, Mathematical formulation of second law of thermodynamics, Entropy maximum and Energy Minimum principle, Born-Caratheodory formulation of second law.

Unit 3

Entropy Generation, Concept of Exergy of system, Exergy balance of closed and open systems, Second Law efficiency (of heat engines, heat pumps, refrigerators, work producing and consuming devices, heat exchangers), Thermoeconomics, Exergy account of a vapour power plant (Case study), Thermodynamics of a Biological System.

Unit 4

Thermodynamic properties of pure fluid, ideal gas properties, State relationships for real gases and liquids, Two-constant and Multiconstant Equation of state, Virial Equations, Vander Waals Equation of State, Redlich-Kwong Equation of state, Compressibility charts, Generalized Equation of state, Maxwell's relations, Generalized relations, Evaluation of Thermodynamic properties, p-v-t relations for gas mixtures, Multicomponent systems, Chemical potential (Fugacity).

Textbooks:

3. Bejan, A., "Advanced Thermodynamics" John Wiley & Sons, 2006.
4. Moran, M.J., Shapiro, H.N., Boettner, D.D., Bailey, M.B., "Principles of Engineering Thermodynamics", Wiley India, 2017.

Reference Books:

3. Kestin, J., "A Course in Thermodynamics", McGraw Hill, 1979.
4. Wark, K., "Advanced Thermodynamics", McGraw Hill, 1995.

MEL361	APPLIED THERMODYNAMICS LAB	0-0-2	Credits: 1

Prerequisites: Thermodynamics, Fluid Mechanics, Applied Thermodynamics, Hierodulic machines

Course Outcomes: At the end of the course, the student should be able to:

CO1: To investigate the performance and emission testing of SI Engine.

CO2: To investigate the performance and emission testing of CI Engine.

CO3: To acquire knowledge of working principle of compressors.

CO4: To gain knowledge of Turbines,

List of Experiments:

9. Study of different internal combustion engine models.
10. Experimental study of characteristic performance curves & emission of spark ignition engine using gasoline as fuel.
11. Experimental study of characteristic performance curves & emission of compression ignition engine using diesel as fuel.
12. Study of working of compressors using different compressor models.
13. Experimental study of characteristic performance curves of single cylinder reciprocating compressors.
14. To study the constructional details of hermetically sealed reciprocating compressor.
15. Study of the Pelton wheel Turbine.
16. Study of the Francis Turbine.

MEL 362 INDUSTRIAL ENGINEERING-I LAB C P (1 2)

COURSE OUTCOMES:

5. **Demonstrate human factors/ergonomic principles (HF/E) that influence the design, performance and safety of work systems.**
6. **Apply HF/E guidelines and use standard HF/E in the design of work systems.**
7. **Model work systems using standard techniques, such as flow diagrams, process charts, operation charts, activity charts, block diagrams, and process maps, for purposes of work system documentation, analysis, and design.**
8. **Determine the time required to do a job using standard data, occurrence sampling, time study, and predetermined time systems.**

1. Ergonomic design study (Present/proposed/new) of a product, equipment or work environment (human-machine interface) – (This involves about four to five laboratory classes / sessions)
2. To assembly a product (electrical holder, etc.), record the cycle time and draw learning curve of the operator performing the assembly.
3. Draw Out line process chart and two hand flow process charts for the assembly performed in experiment no. 2, and analyse the present method and also suggest improved method/s.
4. Study and draw of flow process charts (some suitable assembly operation)
5. Study and draw multi activity chart of a suitable method and propose better method/s.(Man and machine)
6. Study suitable movements/travel of man, material or equipment, and draw string diagram, travel chart and flow diagrams.
7. To calculate the standard time of a suitable job, using predetermined time standard techniques.

MES 363 SEMINAR CP (2 4)

CO1	Review literature on a given advanced topic related to the specific stream.
CO2	Summarise the concept of the chosen topic systematically after considerable study of the content from primary as well as secondary sources
CO3	Learn and present the structure and format of technical reports as per specified norms
CO4	Interpret graphs of various kinds and discuss the concept & conclusion in an open seminar.

MEI 364 INDUSTRIAL TRAINNING C (2)

CO1	To study the concept of Facility, Location & Layout & implement in their Industrial training Project work.
CO2	An understanding of the impact of engineering solutions and industrial safety in a global and social context.
CO3	Develop the ability to work as an individual and in group with the capacity to be a leader or manager as well as an effective team member.
CO4	Demonstrate competence in mechanical engineering fields through problem identification, formulation and solution.

Course Code: MET 401 **Mechatronics and Measurement Systems** **C L T (4 3 1)**

Mechatronics and Measurement Systems

COURSE OUTCOMES:

CO5 Identify and develop operational research models from the verbal description of the real system.
CO6 Understand the mathematical tools that are needed to solve optimisation problems.
CO7 Use mathematical software to solve the proposed models.
CO8 Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

UNIT I

Measurement and Instrumentation; definitions, significance, Fundamental methods, generalized measurement system, Functional elements, Types of input quantities, standards, calibration, uncertainty, Errors, Classification of instruments, Input-output configuration, Interfering and modifying inputs, methods of correction, Generalized performance characteristics, static characteristics, static calibration, Dynamic characteristics, zero and first order instruments, time constant, Second-order instruments, transient response characteristics. Relative and absolute motion devices, relative displacement, Resistive potentiometers, bridge circuit, LVDT, Variable inductance and variable capacitance pick-ups, Piezoelectric transducers, fibre optic displacement transducer, Resistance strain gage, Relative velocity-translational and rotational, Mechanical revolution counters and timers, stroboscopic method, Moving coil and moving magnet pickups, DC and AC tachometers, Eddy current drag-cup tachometer, acceleration measurement.

UNIT II

Hydraulic and pneumatic load cells, flapper nozzle principle, Force transducers with elastic members, Proving ring transducer, cantilever beam transducer, electromagnetic balance, Dynamometers – Absorption, driving and transmission type, reaction forces in shaft bearings, prony brake, eddy current brake dynamometer, Instruments for high, mid and low pressure measurement, dead weight and null type, Elastic element gages, Differential pressure cell, high pressure measurement, Low pressure measurement –, Pirani gages & McLeod pressure gauge.

UNIT III

Orifice meters, Venturimeter, Pitot tube, Flow nozzle, Variable area meters, rotameter, design and accuracy, Positive displacement flow meter, turbine flow meter, Electromagnetic flow meter, ultrasonic flow meters, Temperature sensing techniques, liquid-in-glass and bimetallic thermometers, Pressure thermometers, electrical resistance thermometers, Thermistors, Thermocouples, thermopiles, Radiation pyrometers, Optical pyrometer.

Text Book:

1. Beckwith, B., “Mechanical Measurements”, 6th edition, *Pearson Education Int. ,2008*.

Reference Book:

3. Nakra B.C. “Instrumentation, Measurements & Analysis”, 2nd edition, *Tata McGrawHill, N.Delhi, 2008.*

4. Doeblin, E.O., “Measurement systems”,5th edition, *McGraw Hill, New Delhi, 2004.*

Course No.: MET402 INDUSTRIAL ENGINEERING – II **C L T (4 3 1)**

INDUSTRIAL ENGINEERING – II

COURSE OUTCOMES:

5. Grasp the concept of organizational design with emphasis on organization principles & work design.
6. Analyse & design facility location and layout using various techniques and softwares.
7. Demonstrate the ability to use the methods of statistical quality control and process control for effective designing of Industrial Quality Monitoring Systems.
8. Demonstrate the ability to apply the techniques of material management and inventory control for effective designing and systematic implementation of various MM methods and inventory systems in manufacturing set-up.

UNIT I

Factory organization**:** Introduction to Plant organization, Principles of Organizational structure, Organization charts, Types of Organizations, Developing an organization structure, Results of good organization,, Informal organization, advantages and disadvantages.

Location and Layout analysis: Introduction to Facility location problems, Factors affecting the plant location. Break even analyses and their application, Subjective, qualitative and semi- Quantitative techniques of facility location, Single facility Location problem, Minimax Location problem, Gravity problem and their applications. Line balancing, Introduction to facility layout and their objectives, Classification of Layouts, with advantages and disadvantages of each, Layout design procedures(CRAFT,CORELAP,ALDEP), Material handling systems, Make or Buy decisions, Planning and control of Batch Production,. Characteristics of Batch Production, Determination of Batch size, Minimum Cost batch Size, Maximum Profit Batch size, Sequencing and scheduling for Batch Production, Line of Balance technique.

UNIT II

Inspection and quality control**:** Concept and Definition of Quality, Concepts of Inspection and quality control, Objectives of inspection, Function of Inspection and their types, Concept of statictical quality control (SQC), Process variation, Sampling inspection. Concepts and types of Control charts, Acceptance sampling, application of control charts and sampling plans.

UNIT III

Materials management and inventory control**:** Integrated materials management and their components, Functions and objectives of material management, Introduction and concepts of Inventory management, Purchase model with instantaneous replenishment and without shortage, Manufacturing model without shortages, Purchase model with shortages, Manufacturing model with shortages, Probabilistic inventory concepts with lead time., Selective inventory management- ABC , FSN, VED analyses.

Text Book:

1. Everett, E.A., Ronald J.E, "Production and Operations Management" *Prentice Hall of India, 5th edition, New Delhi, 2001.*

Reference Books:

6. Claude, S.G., "Management for Business & Industry" *Prentice Hall of India*, New Delhi, 2000.

7. Everett, E.A., Ronald J.E, "Production and Operations Management", *Prentice Hall of India, 5th Edition, New Delhi, 2001.*

8. Grant, E.L; Leavenworth R.S, "Statistical Quality Control", *Tata Mcgraw Hill, 7th Edition*, New Delhi, 1996.

9. Apple, J.M, "Plant Layout & Material Handling", *John Wiley & Sons, New York.*

10. Maynard, Industrial Engineering Hand Book, *McGraw Hill, New York.*

Course No.: MET403 MACHINE DESIGN **C L T (4 3 1)**

MACHINE DESIGN

COURSE OUTCOME:

5. Analyse the stress and strain of mechanical components.
6. Demonstrate knowledge of basic machine elements used in machine design.
7. Design machine elements to perform functions in order to obtain desired objectives under various operating conditions.
8. Conduct a failure analysis for the design of mechanical components to select the suitable materials and manufacturing considerations.

UNIT I

Design of friction elements, various types of brakes, design equations for various types of brakes, design analysis of all types of brakes, e.g., band brake, long shoe brake, etc. design analysis of all types of clutches, design of couplings and keys for shafts, etc, design and analysis of flat and V-belt, equations for power, slip, etc, design of chain drive.

UNIT II

Introduction to gear design, design of spur gear, equation for σ_b and σ_c for spur gear, design analysis for bending, force analysis for Helical gear, design analysis for helical gear, design of bevel gear, determination of bearing forces, horizontal and vertical shafts, design analysis for bevel gear , design analysis for worm gear.

UNIT III

Introduction to Plain bearings, Bearing surface at Micro level, Derivation of Energy equation and PV factor , PV graph, Values of PV , Derivation of Wear coefficient equation, Step-by-step procedure for Plain bearing design, Self lubricating bearings and use of clearance for life of bearing, Design of Hydrodynamic bearings, Derivation of Reynolds equation for three dimensional case, Journal bearing geometry,Variation of viscosity with pressure and temperature, Viscosity index, Sommerfeld number, Analysis of ho, h_{min}, Q_{in}, Q_{loss}, T_{in} , T_{out}, Introduction to Rolling element bearings, Design of AFB (??) , Equations for L_{10} life, Static loading and dynamic loading ,Use of

AFB catalogue, Determination of Load based on radial and thrust load for ball bearings, Derivation of Load equation for Tapered AF bearings, Design analysis on the basis of loads and selection of AFB from a catalogue.

Text Books:

3. Mot, R.L., "Machine Elements in Mechanical Design", *Maxwell Macmillan Intl. edition N.York , USA, 1992.*

4. Shigley, J.E., "Machine Engineering Design*", McGraw Hill, higher education,2004.*

Reference Books:

Shigley, J.E., Mischke, C. Brown T., "Standard Hand book of Machine Design" *McGraw Hill.*

Elective II: Design

Course No.: MET404 ADVANCED MECHANICS OF SOLIDS **C L T (4 3 1)**

Course Title: ADVANCED MECHANICS OF SOLIDS

Pre-requisite(s): Strength of Materials

Course Outcomes:

At the end of the course, a student should be able to:

CO1 Understand the concept of tensor.

CO2 Analyse advanced concept of stress and strain in structural problems.

CO3 Apply the concept of different elastic functions to solve complex problems.

CO4 Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.

UNIT 1

Mathematical Preliminaries: Introduction to tensor algebra: symmetric and skew-symmetric tensor, summation convention, eigenvalue and eigenvector of tensor, spectral theorem, polar decomposition theorem, product of tensor, principal invariants of tensor, coordinate transformation of tensor, Tensor calculus: gradient, divergence, curl, differentiation of scalar function of a tensor. (8 L)

UNIT 2

Analysis of Stress and Strain: Definition and notation of stress, Cauchy stress tensor, equations of equilibrium, principal stresses and stress invariants, stress deviator tensor, octahedral stress components, General deformations, small deformation theory, strain transformation, principal strains, spherical and deviatoric strains, Strain-displacement relations, strain compatibility, stress and strain in curvilinear, cylindrical, and spherical coordinates, fundamental equations of plasticity. (8 L)

UNIT 3

Problem formulation and solution strategies: Field equations, boundary conditions, stress and displacement formulation, Beltrami-Michell compatibility equations, Lame-Navier's equations, principle of superposition, uniqueness theorem, Saint-Venant's principle, Brief descriptions about general solution strategies - direct, inverse, semi-inverse, analytical, approximate, and numerical methods. (8 L)

UNIT 4

Two-dimensional problems: Plane stress and plane strain problems, generalized plane stress, Antiplane strain, Airy stress function, polar coordinate formulation and solutions, Cartesian coordinate solutions using polynomials and Fourier series method. (8 L)

Text Books:

1. Elasticity, Theory, Applications, and Numerics by Martin H. Sadd

2. Theory of Elasticity by Stephen Timoshenko and , J. N. Goodier

3. Advanced Mechanics of Solids, Otto T. Bruhns, Springer publications.

Reference Books:

1. Continuum Mechanics, A.J.M Spencer, Dover Publications, INC

2. Advanced Mechanics of Materials by H. Ford and J. M. Alexander 3. The Linearized Theory of Elasticity, W. S. Slaughter, Springer Science + Business Media, LLC

Elective II: Thermal

Course No.: MET 405 **Refrigeration and Air Conditioning** **C L T (4 3 1)**

Course Outcomes:

5. To Identify the need and importance of various refrigeration and air conditioning cycles, the typical and some advanced and innovative schematic designs, and the goals of R&AC systems.
6. To design the VCRS and VARS with improving performance parameters.
7. To describe the working of different types of air conditioning systems.
8. To evaluate the actual applications of R&AC.

UNIT-I

Introduction

Basics of refrigerator and heat pump, Carnot refrigeration and heat pump, units of refrigeration, COP of refrigerator and heat pump, Carnot COP, Ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, vapor refrigeration system, steam jet refrigeration, thermo- electric cooling, adiabatic demagnetization

Basic Principle of operation of air refrigeration system, Bell Coleman air refrigerator, advantages of using air refrigeration in air craft, disadvantage of air refrigeration in comparison to other cold producing methods, simple air refrigeration in air craft, simple evaporative type, air refrigeration in air craft, necessity of cooling the air craft.

UNIT-II

Vapor Compression refrigeration system

Simple vapour compression cycle, Methods of improving COP, flash chamber, flash inter cooler, optimum inter stage pressure for two stage refrigeration system, single expansion and multi expansion cases, basic introduction of single load and multi load systems, cascade systems, Nomenclature of refrigerants.

Vapor absorption refrigeration system and special topics

Basic absorption system, COP and maximum COP of the absorption system. Actual NH_3 absorption system, function of various components, Li-Br absorption system, Selection of refrigerant and absorbent pair in vapor absorption system, Electro-Lux refrigerator, comparison of compression and absorption refrigeration system, , desirable properties of refrigerants, cold storage and Ice Plants.

UNIT-III

AIR CONDITIONING

Psychrometric properties of moist air, By- pass factor of coil, sensible heat factor, ADP of cooling coil, Air washer. Air conditioning systems: Classification, factors affecting air conditioning systems, comfort air conditioning system, winter air conditioning system, summer Air Conditioning system, year-round air-conditioning system, unitary air conditioning system, central air conditioning system, Room sensible heat factor, Grand sensible heat factor, effective room sensible heat factor, Industrial application of Air conditioning.

Text Books:

3. Refrigeration and Air Conditioning - C.P. Arora, Tata McGraw-Hill
4. Refrigeration and Air- Condition by W. Stoecker Mc Graw Hill

Reference Books:

1. Basic Refrigeration and Air Conditioning- Ananthana and Rayanan, McGraw-Hill
2. Refrigeration and Air Conditioning- Arora and Domkundwar, Dhanpat Rai.

Elective II: Production

Course No.: MET406 **Material Testing, Inspection and Characterization** **C L T (4 3 1)**

COURSE OUTCOMES:

By successful completion of this course, the student will be able to

1. Understand various destructive and non destructive methods of testing materials.

2. Explain the principles of metallurgical microscope, X-ray Diffractrometer (XRD), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Thermal analysis and dilatometer.

3. Describe the various sample/specimen preparation techniques for XRD, SEM, TEM and thermal analysis and quantitative metallography.

4. Apply knowledge to select appropriate tool to characterize the material by knowing its merits and demerits.

UNIT I

Purpose and importance of destructive tests – Concepts, and method of Tensile, hardness, bend, torsion, fatigue and creep testing.

UNIT II

Purpose and limitations of NDT, Concepts, operating principles, liquid penetrant test, magnetic particle testing, eddy current testing, ultrasonic testing radiography, acoustic emission, thermal imaging method. Comparison of NDT methods and selection of NDT methods.

UNIT III

Tools of characterisation - Light microscopy, basic principles and special techniques. X-ray diffraction and its applications in materials characterization.

Electron microscopy, Construction, operation and applications of scanning electron microscope (SEM), transmission electron microscope (TEM)

UNIT IV

Thermal analysis: Thermo gravimetric analysis, differential thermal analysis, differential scanning calorimetry &dilatrometry.

TEXT BOOKS:

1. Non-destructive testing, B.Hull And V.John, Macmillan, 1988.

2. Modern Physical Metallurgy and Materials Engineering, R. E. Smallman, R. J. Bishop, sixth edition, Butterworth-Heinemann, 1999.

3. Materials Characterisation, P.C.Angelo, Elsevier (India) Pvt. Ltd, Haryana, 2013,

Elective III: Design :-

Course No.: MET407 **BASIC FRACTURE MECHANICS** **C L T (4 3 1)**

COURSE OUTCOMES:

5. Identify and describe different failure mechanisms in materials and engineering structures.
6. E
xplain how a crack affect an engineering structure and describe the state of stress and strain that may arise in the vicinity of the crack front in different materials
7. Evaluate fracture toughness for structures with cracks using LEFM and EPFM techniques.
8. Analyze the crack growth in materials subjected to fatigue loads.

UNIT I

Mechanisms of fracture and crack growth, cleavage fracture, ductile fracture, fatigue cracking, Summary of basic problems and concepts in fracture, a crack in a structure, theoretical strength of a material, Inglis's solution, crack tip stresses, the Griffith criterion, Modified Griffith's theory

UNIT II

The elastic crack-tip stress field, Stress Intensity factor, the effect of finite size, Some special cases, elliptic cracks the energy principles, the concept of energy release rate, the criterion for crack growth, the crack resistance, the concept of J-integral, crack opening displacement criterion, K_{IC} and G_{IC} test methods

UNIT III

Crack-tip plastic zone, Irwin's plastic zone correction, The Dugdale approach, Plane stress versus plane strain, plastic constraint factor, the thickness effect, application of von Mises and Tresca yield criteria to obtain plasticity effected regions, Fatigue failure, S-N curve, Crack initiation and propagation, effect of overload, crack closure, Environmental assisted cracking, service failure analysis

Text Book:

1. Anderson T.L., "Fracture Mechanics Fundamentals and applications", *CRC, Taylor & Francis, 2005.*

Reference Book:

Janssen, M. J., Zuidema, J., Wanhill R.J.H., "Fracture Mechanics", *Spon Press, 2004*.

2. Prashant Kumar, "Elements of Fracture Mechanics", *McGraw Hill Education, 2017*

Elective Thermal

Course No.: MET408 **Design of Fluid Thermal Systems** **C L T (4 3 1)**

COURSE OUTCOMES:

After the completion of course, students will be able,

CO1	To understand thermal system engineering design process
CO2	To learn the characteristics of the components of the thermal system and their effects on overall system performance
CO3	To simulate a thermal system and solve for a workable solution
CO4	To identify, formulate and solve a wide range of real world thermal related problems

UNIT 1

Introduction, Design versus Analysis, Synthesis versus Design, Optimal and Nearly Optimal designs, Life Cycle Design, Thermal design aspects, Concept, creation and assessment, Thermal system (Basic Characteristics, Analysis), some typical examples, formulation of the design problem, Steps in design process, Material selection.

UNIT 2

Modelling of thermal systems, types of models, Mathematical modeling, General procedure (Transient/steady state, spatial dimensions, lumped mass approximation, simplification of boundary conditions, negligible effects, idealizations, material properties, conservation laws, simplification of governing equations), final model and validation, physical modeling and dimensional analysis, curve-fitting, Numerical modeling and simulation, Solution procedures, methods for numerical simulation,

UNIT 3

Formulation of problem for optimization, optimized design, objective function, constraints, operating conditions versus hardware, optimization methods (Calculus methods, Search methods, etc.), Optimization of thermal systems, Considerations of Second law of Thermodynamics, Economic analysis, Estimation of total capital cost, principles of economic evaluation,Thermoeconomic analysis and evaluation.

UNIT 4

Applications with Thermodynamics, Heat and Fluid flow, Cogeneration system Exergy analysis, Thermal insulation, Fins, Electronic packages, Refrigeration, Power Generation, Energy Storage by Sensible heating.

Textbooks:

3. Bejan, A., Tsatsaronius, G., Moran, M., “Thermal Design and Optimization”, John Wiley, 2013.
4. Stoecker, W.F., “Design of Thermal Systems”, McGraw Hill, 2017.

Elective Production

Course No.: MET409 ADVANCED MANUFACTURING TECHNOLOGY **C L T (4 3 1)**

ADVANCED MANUFACTURING TECHNOLOGY

Course Outcomes:

CO1	Identify the use of advanced manufacturing processes in industries and explain the process of micro machining.
CO2	Identify the need of super finishing processes and understand the process of super finishing.
CO3	Understand the process of non-conventional forming.
CO4	Apply knowledge to select appropriate surface processing technique to get the desired surface properties.

UNIT I

Introduction to Advanced manufacturing processes, Advantages of advanced manufacturing processes. Advances in Machining: High speed machining, hard turning. Micro machining: Introduction and need of micro machining, Diamond Micro- grinding/turning, Abrasive Micro machining, Ultrasonic Micromachining, Electric-discharge Micro-machining, Laser Micro-machining, Electrochemical Micro-machining.

UNIT II

Super finishing processes:Introduction to finishing processes, Need and application of superfinishing processes, Abrasive flow finishing, Magnetic Abrasive flow finishing, Magneto rheological abrasive flow finishing.

UNIT-III

Advances in forming: Introduction and application of non-conventional forming, need of non-conventional forming, Electro Magnetic forming, Hydro forming, explosive forming. Advantages of non-conventional forming.

UNIT IV

Surface processing: Introduction and need of surface processing, surface properties, cladding, chemical vapour deposition, physical vapour deposition, shot peening, surface modification by severe plastic deformation. Strategies for improving surface properties.

	• Rao, P.N., Manufacturing Technology, Volume 2, McGraw-Hill Education, New Delhi. • Serop K. Steven, "Manufacturing Processes for Engineering Materials", Prentice Hallof India,2004

Elective Production

Course No.: MET410 | Conduction Heat Transfer | **C L T (4 3 1)**

CONDUCTION HEAT TRANSFER

COURSE OUTCOME

CO1 To formulate and solve one dimensional steady state heat conduction problems

CO2 To formulate and solve two-dimensional steady state and transient heat conduction problems

CO3 To solve heat conduction problems involving phase change

CO4 To identify, formulate and solve real world problems related to heat conduction

UNIT I

Introduction, Fourier's law of heat conduction, thermal conductivity, Differential formulation of heat conduction in rectangular, cylindrical and spherical coordinates, General boundary conditions and initial condition, non-dimensional analysis of the heat conduction equation, heat conduction for anisotropic medium, one-dimensional steady state heat conduction, Extended surfaces, Constant area fins, Variable area fins, moving fins, Bessel differential equations and Bessel functions.

UNIT II

Two-dimensional steady state heat conduction, Separation of variable method, Homogeneous differential equations and boundary conditions, Sturm-Liouville boundary valve problems, Non-homogeneous differential equations, Non-homogeneous boundary conditions, Method of superposition, Solution to problems in Cartesian and cylindrical coordinates, Unsteady heat conduction, lumped heat capacity system, Non homogeneous equations and boundary conditions, Transient conduction in plates, Transient conduction in cylinders, Transient conduction in spheres, Duhamel's Superposition Integral, Conduction in Semi-infinite regions.

UNIT III

Heat conduction involving phase change, Moving interface boundary condition, non-linearity of the interface energy equation, Simplified model (Quasi-Steady approximation), Exact solutions, Stefan's solution, Solidification of semi-infinite region, Melting of semi-infinite region.

UNIT IV

Heat Transfer in living tissue, Mathematical modeling of vessel-Tissue heat transfer, Microscale heat conduction, physics of energy carriers, Limitations of Fourier's law, Hyperbolic heat conduction, Solutions and approximations for the microscale heat transfer, Inverse heat transfer, parameter estimation, applications to heat transfer, method of sensitivity coefficients, Least squares approach, linear and non-linear inverse problems.

Textbooks:

3. Jiji, L.M., "Heat Conduction", Springer, 2009.
4. Kakac, S., Yener, Y., Naveira-Cotta, C.P., "Heat Conduction", CRC Press, 2018.

Reference Books:

4. Ozisik, M.N., Hahn, D.W., "Heat Conduction", John Wiley, 2012.
5. Muralidhar, K., Banerjee, J., "Conduction and Radiation", Naraosa Publishing House, 2010.
6. Poulikakos, D., "Conduction Heat Transfer", Prentice Hall, 1993.

Course No.: MEL411 **MECHATRONICS LAB.** **C L T (1 2)**

MECHATRONICS LAB.

COURSE OUTCOME:

5. Identify and use basic modern tools for measurement of electrical and electronic signals.
6. Identify and use different types of sensors and actuators for designing a mechatronic product.
7. Design basic circuits utilizing modern electrical and electronic components including operational amplifiers and integrated circuits.
8. Write basic microcontroller programs for controlling a mechatronic product.

LIST OF EXPERIMENTS

10. Sensor/Actuator - Interfacing, calibration, frequency domain characterization, MATLAB serial interface, and serial LCD display
11. Design of electropneumatic circuits for L (??) and square cyles using PLC's.
12. Sorting of components on an intelligent a conveyor system.
13. Modelling of DC Motor System.
14. DC Motor position tracking.
15. DC Motor position set-point control via PID controller, using relay automatic tuning technique7.
16. Disection of an existing system.
17. Demonstration of recent projects on Mechatronics.
18. Mini Project on Independent modeling, analysis, and design of a mechatronic control system (Select one “mechatronic plant” from the Quanser, rotary family).

Course No.: MEL412 INDUSTRIAL ENGINEERING-II LAB **C L T (1 2)**

INDUSTRIAL ENGINEERING-II LAB.

COURSE OUTCOMES:

5. Present a numerical and graphical characterization of quantitative data assuming the quantitative data are observations from a normal distribution to compute the Probability of specific numerical outcomes. Construct and interpret normal Probability plots of quantitative data.

6. Construct, implement and interpret X-bar and R control charts for variables from Standards and from data; and demonstrate how to use the corresponding OC curves.

7. Construct, implement and interpret p, c, and u control charts for attributes from Standards or data; and demonstrate how to use the corresponding OC curves.

8. Demonstrate and simulate layouts to determine optimum material flow rate and cycle time of a job using witness software.

List if experiments:

8. To study the layout of a shop in an organization and draw existing and proposed layouts.

9. To measure the variable characteristics (diameter of pins, with micrometer) and prepare a frequency histogram. Calculate values of X bar and sigma.

10. Verify that when random samples are taken from a lot with a certain percentage of defective, same %age lands to appear in random sampling by using Shewart's kit.

11. Simulate an inspection situation with the help of a Schewhart's bowl and plot X bar, and R charts using computed data.

12. To conduct Process capability study of a machine tool and to specify the tolerances for a job.

13. To verify the theorem "the standard deviation of the sum of any number of independent variables is the square root of the sum of the squares of the S.Ds of the independent variable. Determine statistically, the permissible tolerance of mating components, when the tolerance of the assembly is given.

14. To draw control chart for percent defectives after inspecting a sample and sorting out

the defective units.

Course No.: MEP413 **MAJOR PROJECT – Stage 1** **C L T (3 0 0)**

CO1 Identify a topic in advanced areas of Mechanical Engineering.

CO2 Review literature to identify gaps and define objectives & scope of the work.

CO3 Generate and implement innovative ideas for social benefit.

CO4 Develop prototypes/models, experimental set-up and software systems necessary to meet the objectives.

Course No.: MET 451 | Operation Research | **C L T (4 3 1)**

OPERATION RESEARCH

COURSE OUTCOMES:

5. Illustrate knowledge of fundamental concepts about operation research.
6. Compare and categorize the knowledge of different approaches to operational performance improvement.
7. Appraise the ability to work effectively in a team and in group and use of business tools.
8. Outline the various Japanese techniques for justify the knowledge and performance improvement in industrial cost control.

UNIT I

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Simplex Method, Graphical solution of LPP., Artificial variables, big-M method, two-phase method, degeneracy and unbound solutions.

UNIT II

Transportation Problem. Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.

UNIT III

Assignment model. Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem. Sequencing models. Solution of Sequencing Problem – Processing and Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machines.

UNIT IV

Inventory models. Inventory costs. Models with deterministic demand – model (a) demand rate uniform and production rate infinite, model (b) demand rate non-uniform and production rate infinite, model (c) demand rate uniform and production rate finite.

Replacement Models. Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fail suddenly: individual replacement policy, group replacement policy.

TEXT BOOKS:

1. P. Sankara Iyer, ”Operations Research”, Tata McGraw-Hill, 2008.

2. A.M. Natarajan, P. Balasubramani, A. Tamilarasi, “Operations Research”, Pearson Education, 2005.

REFERENCE BOOKS:

1. J K Sharma., “Operations Research Theory & Applications , 3e”, Macmillan India Ltd, 2007.

2. P. K. Gupta and D. S. Hira, “Operations Research”, S. Chand & co., 2007.

3. J K Sharma., “Operations Research, Problems and Solutions, 3e”, Macmillan India Ltd.

4. N.V.S. Raju, “Operations Research”, HI-TECH, 2002.

Elective IV: Design

Course No.: MET 452 **Theory of Thin Plates and Shells** **C L T (4 3 1)**

THEORY OF THIN PLATES AND SHELLS

Course Outcomes:

At the end of the course, students will be able to

1. Use analytical methods for the solution of thin plates and shells.

2. Use analytical methods for the solution of shells.

3. Apply the numerical techniques and tools for the complex problems in thin plates.

4. Apply the numerical techniques and tools for the complex problems in shells.

UNIT I

Introduction: Space Curves, Surfaces, Shell Co-ordinates, Strain Displacement Relations, Assumptions in Shell Theory, Displacement Field Approximations, Stress Resultants, Equation of Equilibrium using Principle ofVirtual Work, Boundary Conditions.

UNIT II

Static Analysis of Plates: Governing Equation for a Rectangular Plate, Navier Solution for Simply-Supported Rectangular Plate under Various Loadings, Levy solution for Rectangular Plate with other Boundary Conditions.

UNIT III

Circular Plates: Analysis under Axi- Symmetric Loading, Governing Differential Equation in Polar Co-ordinates. Approximate Methods of Analysis- Rayleigh-Ritz approach for Simple Cases in Rectangular Plates.

UNIT IV

Static Analysis of Shells: Membrane Theory of Shells- Cylindrical, Conical and Spherical Shells, Shells of Revolution with Bending Resistance - Cylindrical and Conical Shells, Application to Pipes and Pressure Vessels. Thermal Stresses in Plate/ Shell

Text books:

• Theory of Plates and Shells, Timoshenko S. and KriegerW., McGraw Hill.

• Stresses in Plates and Shells, UguralAnsel C., McGraw Hill.

References:

• Thin Elastic Shells, KrausH., John Wiley and Sons.

• Theory of Plates, ChandrashekharaK., Universities Press.

• Design and Construction of Concrete Shells, Ramaswamy G.S.

Elective IV: Thermal-

Course No.: MET 453 Power Plant Engineering **C L T (4 3 1)**

POWER PLANT ENGINEERING

Course Outcomes:

5. Identify the different types of power plants and understand the layout of steam power plant.

6. Understanding of Hydroelectic Power plant and Coordination of different types of power plants.

7. Able to descibe the working operations of Nuclear, Diesel, Gas and Steam power plants.

8. To apply & analyses the economics of power plant and able to decides the tariffs for different power plants.

UNIT I

Introduction:- Energy source for generation of electric power. Principle types of power plants, their special features and applications, major power plants in India.
Steam Power Plants :- Selection of site, general layout of the power plant, special features of the modern steam boilers, circulation principle, steam separation and purification, economizers and air pre-heater types and estimation of performance, super-heater and superheat control, feed water heaters, cooling tower , temperature and pressure control. Introduction to hydro electric power plant, types of hydro-electric plant in combination with steam plant, Runoff river plant in combination with steam plant, storage plant in combination with steam or nuclear plant, Coordination of hydro-electric and gas turbine stations, coordination of different types of power plants.

UNIT II

Nuclear Power Plants :- Nuclear fuel, nuclear energy by fission, main components of nuclear reactors, pressurized water, boiling water, liquid metal and gas nuclear reactors.

Diesel Power Plants :- Plant layout , two and four stroke cycle diesel engines, fuel injection, lubrication and cooling systems, supercharging and starting systems. Gas and Steam Turbine combined Cycles:- Simple gas and steam combined cycle power generation.

UNIT III

Economic Analysis of Power Plants and Tariffs :- The cost of electrical energy , selection of types of generating equipment , performance and operating characteristics of power plant , load division among generators , Tariff methods of electrical energy .Combined operation of different power plants :- Advantages of combined working , Load division among power stations , Storage

Text Book:

2. Rajput R.K., "A text book of power plant engineering", *Laxmi Publication, Pvt. Ltd., New Delhi, 2007.*

Reference Books:

7. Thermal Engineering by Ballaney, Khanna Publisher
8. Thermal Engineering by Domkundar& Arora, Dhanpat Rai
9. Steam Turbine Theory & Practice by Kearton, W.J. Pitman.
10. Power Plant Engineering by Morse
11. Power Plant Engineering by Domkundwar
12. Power Plant Technology by El-Wakil

Elective IV: Production-

Course No.: MET 454 **ENTREPREUNERSHIP DEVELOPMENT AND RISK MANAGEMENT** **C L T (4 3 1)**

ENTREPREUNERSHIP DEVELOPMENT AND RISK MANAGEMENT

COURSE OUTCOME:

On completion of the course, the students will be able to:

5. Understanding the dynamic role of entrepreneurship and small businesses
6. Organize and Manage a Small Business
7. Understand Financial Planning, Control and Strategic Marketing Planning
8. Explain New Product or Service Development and Business Plan Creation

UNIT-1

Introduction to Entrepreneurship: Meaning, Role of Entrepreneur, Entrepreneur Process: different approaches, Motivation for becoming an Entrepreneur. SME Concept, its role, status, prospects and policies for promotion of SMEs. Importance of Entrepreneurship: innovations, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Issues & Problems Entrepreneurial Practices, 11 Contribution of Entrepreneurs: Towards R&D, creates Wealth of Nation & Self prospect with Challenge, Entrepreneur Carrier: Different Stages, Entrepreneur Development Programmers (EDPs).

UNIT-II

Characteristics of Entrepreneurship: Risk taker, Perceptive, Curious, Imaginative, Persistent, Goal setting, Hardworking, Research & Management Skill, Soft skills and Feasibility, Women Entrepreneurship: Opportunities, promotion Hurdles and Prospects of women Entrepreneurs.Factors & Models of Entrepreneurial Development, Social Entrepreneurial Initiative: Solving social Problems, Business plan, Strategic Plan vs Business Plan, Technical and Financial Feasibility study and analysis of projects under self employment scheme including small entrepreneur. The World of Opportunity, Idea versus Opportunity, sources of ideas and idea generation techniques, sources of opportunities, identification and selection of opportunities, the Business Plan, Components of a business plan, How to develop a good business plan?, Role of Entrepreneurial Institutions in Entrepreneurship Development, Various Schemes and Incentives.

UNIT-III

Farm based enterprises for production and post production of Agri-produce: Crops: Cereals, Legumes, Oilseeds; Horticulture crops : Fruits and vegetables; Livestock production : Poultry, Fishery, Medicinal and Aromatic plants. Handlooms & Sericulture; Handicraft, coir, jute & leather Agro-Eco Tourism, Micro entrepreneurial skills development and good production practices, Role of Ministry of MSME, Registration Process of MSME, Emerging Technologies & Business Opportunities in India.

UNIT-IV

Risk Management: Risk Factor, Sensitivity Analysis, Vulnerability Analysis, External Risk, Internal Risk, Environmental Risk. Financial planning . Forecasting inputs and outputs, Components of the financial plan, Bootstrapping ,Venture and Growth Capital, Managing a Micro Enterprise, Human resource development for enterprise growth; delegation, motivation and leadership in microenterprises.

REFERENCE BOOKS

8. Byrd Megginson, Small Business Management An Entrepreneur's Guidebook 7th ed, McGraw-Hill, Irwin
9. N. V. R. Naidu, Naidu I. K, Management and Entrepreneurship. International Pvt Ltd, 01-Jan-2008
10. Frank Martin and Marcus Thompson Palgrave, Social Enterprise Developing Sustainable Businesses Macmillan
11. David R. Stokes, Nicholas Wilson Cengage, Small Business Management and Entrepreneurship Learning EMEA, 2006 - Business & Economics
12. Donald F. Kuratko Cengage, Learning Entrepreneurship: Theory, Process, Practice Business & Economics 14-Nov-2008
13. Timmons, Jerry A., and Spinelli, Stephen, 2009. New Venture Creation: Entrepreneurship for the 21st Century, 8th Edition, Boston, MA: Irwin McGraw-Hill
14. Carree, M.A., and A.R. Thurik „Impact of Economic Growth,'Hand Book of Entrepreneurship Research, New York:Springer

Elective V: Design –

Course No.: MET 455 Theory of Elasticity **C L T (4 3 1)**

THEORY OF ELASTICITY

Course Outcomes:

5. Explain the fundamental concept of stress & strain followed by an analytical expression relating the stress & strain in 3-D systems.

6. Apply the compatibility equations & boundary conditions to solve the problems of T.O.E in practices.

7. Analyze the structural members subjected to pure bending using the fundamental concept of stress,strain & elastic behaviours of materials.

8. Apply analytical techniques to predict the ffects of stress concentration in simple solids & structural components.

UNIT I

Introduction: Elasticity, stress components of stress and strain, Hooks law. Equations in polar coordinates, Plane stress and plane strain: Strain at a point, Mohr circle for strain rosette, differential equation of equilibrium, boundary conditions, compatibility equations, overview of Airys stress functions.

UNIT II

Two dimensional problems in rectangular coordinates: solution by polynomials, St Venants principles, determination of displacement, bending of beams, solution by Fourier series. Two dimensional problems in polar coordinates: Equations in polar coordinates, equation about 1- axis, and pure bending in curved bars.

UNIT III

Determination of strains and displacement, effect of circular hole on stress distribution in plate concentrated and vertical loading of a straight boundary, circular disc, general solution and its applications, Analysis of stress and strain in thee dimensions: stress at a point, principal stress, stress ellipsoid and stress director surface, homogenous deformation, strain at a point, principle strain rotation.

Text Books:

1. Timoshanko, S.P. and Goodier, J.N., “Theory of Elasticity,” *Mc-Graw Hill Book Company, N.Y. , USA, 1970.*

Reference Books:

1. Love, A.E.H., “The Mathematical Theory of Elasticity,” *Dover Publications, NewYork, USA, 1944.*

Elective V: Thermal –

Course No.: MET 456 Renewable Energy Systems **C L T (4 3 1)**

RENEWABLE ENERGY SYSTEMS

COURSE OUTCOMES:

5. To compare aware about different renewable energy resources.
6. To know the conversion of energy from one form to other.
7. To know the importance the solar radiation and its utilization.
8. To analyze of different energy conversion energy systems.

COURSE CONTENT:-

UNIT-I

Introduction

Introduction to energy, Relevance of energy in the development of country, conventional, non-conventional and renewable sources of energy. Status of conventional sources of energy and their conservation, Exploring renewable sources of energy.

UNIT-II

Solar Radiation and Applications of Solar Heat

Extraterrestrial solar radiation, components of radiation, geometry of earth and sun, geometry of collector and the solar beam, effects of earth's atmosphere, measurements of solar radiation, type of water heaters, selective surfaces, space heating, space cooling, water desalination, solar ponds, solar concentrators, thermos- electric power system, problems.

Photovoltaic Generation

Introduction, the silicon p-n junction, photon absorption solar radiation input, photovoltaic circuit properties and loads, limits to cell efficiency, solar cell construction, other types of photoelectric and thermo-electric generation.

UNIT-III

Hydro and Wind Powers

Principle of hydro power conversion, impulse turbine, reaction turbines, wind turbine types, linear momentum and basic theory, dynamic matching, characteristics of the wind, power extraction by a turbine, electricity generation, mechanical power, problems.

Bio-Fuels

Introduction, Bio fuels, classification, bio-mass production for energy farming, direct combustion for heat, pyrolysis (destructive distillation), alcoholic fermentation, anaerobic digestion for bio-gas, agrochemical fuel extractions.

UNIT-IV

Wave Energy and Tidal Power

Introduction, wave motion, wave energy and power, wave patterns, devices, the causes of tides, enhancement of tides flow power, tidal range, power, world tidal power sites.

OTEC and Geothermal Energy

Principles of Ocean Thermal Energy Conversion (OTEC), Claude cycle, Andersan cycle, Introduction to geothermal energy, dry rock and hot aquifer analysis, harnessing geothermal resources

Text Books:

1. Solar Energy by S P Sukhatme, Publisher Tata Mc Graw- Hill New Delhi

Reference Books:

1. Renewable Energy Rsources by john W. Twidell and Anthony D. Weir, published by E.& F. N. SponLtd,Lndon.

2. Renewable energy by Bent Sorensen by Academic press

4. Non-conventional Energy Sources by G D Rai by Khanna Publishers Delhi

Elective V: Production

Course No.: MET 457 Advanced Welding and Allied Processes **C L T (4 3 1)**

ADVANCED WELDING AND ALLIED PROCESSES

Course Outcomes:

CO1	Identify the use of welding processes in manufacturing industries.
CO2	Apply knowledge to select appropriate welding process based on the application.
CO3	Explain welding of plastics and underwater welding.
CO4	Understand the process of thermal spraying and thermal cutting.

UNIT I

Introduction to welding

Welding Principle, Application of welding in industries, Weld ability of Material, Arc welding consumables, Shielding gases and association mixtures. Weld bead geometry and shape factors. Weld dilution,weld joint configurations, liquation cracking, hot cracking.Automation in welding.

UNIT II

Fusion and Solid state welding

Fusion Welding Processes:Classification of fusion welding processes, Submerged Arc Welding, Electroslag welding, Plasma arc welding.

Solid state welding: Introduction, Advantages of solid state welding over fusion welding processes, Explosive welding, Ultrasonic welding, Friction welding, Friction stir welding, Welding zones in FSW.

UNIT III

Welding of Plastics and Underwater welding

Plastics, Types of plastics,Welding of Plastic: Introduction, Classification of plastic welding, Hot plate welding, Hot gas welding, Ultrasonic welding, Friction welding, Applications of plastic welding.

Underwater Welding: Need and application of underwater welding, Dry underwater welding, wet underwater welding. Advantages and Limitations of dry and wet underwater welding.

UNIT IV

Thermal Spraying and Thermal Cutting

Thermal spraying: Introduction,Thermal spray processes, Application of thermal spraying, Thermal Cutting of Metals: Introduction, Methods and applications.Oxy-Fuel Gas Cutting, cutting torch, Oxygen-Lance Cutting, Plasma Arc cutting.

- Rao, P.N., Manufacturing Technology, Volume 2, McGraw-Hill Education, New Delhi.
- Lindberg, R.A., Processes and Materials of Manufacturing, Allyn and Bacon, Boston
- Khan N. Z, Siddiquee A. N. and Khan Z. A., Friction stir welding of dissimilar Aluminium alloys, CRC Press, Boca Raton, 2017.

Elective VI: Design

Course No.: MET 458 **MECHANICS OF COMPOSITE MATERIALS** **C L T (4 3 1)**

MECHANICS OF COMPOSITE MATERIALS

COURSE OUTCOMES

On completion of this subject students will be able to:

1. To identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.

2. To predict the failure strength of a laminated composite plate

3. Understand the linear elasticity with emphasis on the difference between isotropic and anisotropic material behaviour.

4. Acquire the knowledge for the analysis, design, optimization and test simulation of advanced composite structures and Components.

UNIT -1

Definition and classification of composite materials: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, CarbonComposites. Reinforcements and Matrix Materials. Manufacturing Techniques of Composites: Fiber Reinforced Plastic (FRP) Processing: Layup and curing, fabricating process, open and closed mould process, Hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding. Fabrication Process for Metal Matrix Composites (MMC's): Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

UNIT -2

Density, Mechanical Properties; Prediction of Elastic Constants, Micromechanical Approach, Halpin-Tsai Equations, Transverse Stresses.Thermal Properties; Expression for Thermal Expansion Coefficients of Composites, Expression for Thermal Conductivity of Composites, Hygral and Thermal Stresses.Mechanics of Load Transfer 15 from Matrix to Fiber; Fiber elastic-Matrix Elastic, Fiber Elastic-Matrix Plastic. Load transfer in Particulate Composites. Numerical Problems.

UNIT -3

Elastic Constants of an Isotropic Material, Elastic Constants of a Lamina, Relationship between Engineering Constants and Reduced Stiffnesses and Compliances, Variation of Lamina Properties with Orientation, Analysis of Laminated Composites, Stresses and Strains in Laminate Composites, Inter-laminar Stresses and Edge Effects. Numerical Problems.

UNIT -4

Tensile and Compressive strength of Unidirectional Fiber Composites. Fracture Modes in Composites; Single and Multiple Fracture, Debonding, FiberPullout and Delamination Fracture. Strength of an Orthotropic Lamina; Maximum Stress Theory, Maximum Strain Criterion, Tsai-Hill Criterion, Quadratic Interaction Criterion, Comparison of Failure Theories.Fatigue; S-N Curves, Fatigue Crack Propagation Tests, Damage Mechanics of Fatigue, Thermal Fatigue. Creep behavior of Composites.

UNIT -5

Symmetric Laminates, Cross-ply laminates, Angle ply Laminates, Antisymmetric Laminates, Balanced Laminate. Failure Criterion for a Laminate.Design of a Laminated Composite.Numerical Problems.

TEXT BOOKS:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Taylor & Francis, 2nd Ed, 2005

2. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012 3. Robert M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1999.

REFERENCE BOOKS:

1.MadhijitMukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004

2. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009

3. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993 4. Hand Book of Composites, P.C. Mallik, Marcel Decker, 1993

Elective VI: Thermal

Course No.: MET 459 **Advanced Fluid Mechanics** **C L T (4 3 1)**

After the completion of course, students will be able,

CO1	To have a good knowledge of the methods and techniques in viscous flows theory and be in a position tointerpret viscous flow phenomena
CO2	To writeNavier-Stokes equations (conservation laws for mass, momentum, and energy) for simple fluids
CO3	To solve for velocity and pressure fields in a viscous flow subjected to steady and transient conditions and formulate boundary layer approximations
CO4	To identify, formulate and solve flow problems by applying knowledge of fluid mechanics and mathematics

UNIT I

Introduction, Concept of a fluid, Concept of Viscosity, Concept of Continuum, Properties of a fluid, Historical outline, Flow analysis Techniques, Eulerian and Langrangian flow description, Classification of fluid flows, Velocity and acceleration field, Material derivative, Control Volume and differential element approach, Reynolds Transport Theorem, Conservation of mass, Linear Momentum Equation, Energy Equation, Fluid Element kinematics, Linear motion and deformation, Angular motion and deformation.

UNIT II

Vectors and Tensors, Representation of second order tensor, Addition, subtraction and multiplication of tensors, Transpose of a tensor, Symmetric and Unsymmetric tensor, Unit tensor, Dyadic product, Divergence, Curl, Gradient of a vector and tensor, Significance of Gradient of velocity vector, Deformation, rotation, Divergence Theorem, Constitutive Equations for fluids, Stress Tensor for a simple flow, Stoke's Principle, Navier-Stokes Equation.

UNIT III

Exact Solutions of the Navier-Stokes Equations, Flow between through a straight stationary channel, Couette Flow, Hagen-Poiseulle flow, Flow between two concentric rotating cylinders, Axially moving concentric cylinders, Unsteady parallel flow (Stoke's first problem), Flow near an oscillating flat plate (Stoke's second problem), start-up of Couette flow, Transient axisymmetric Poiseulle flow, Flow of two immiscible fluids in a channel, Fully developed flow of a power law fluid, Superposition of Poiseuille and Couette flows.

UNIT IV

Laminar Boundary layers, Boundary-layer equations, Flow over a Flat plate, Blasius flow, Momentum-Integral Equation for the Boundary layer, Approximate methods for Boundary layer equations, Karman-Pohlhausen Method for Flow over a Flat Plate, Turbulent boundary layers, Characteristics of Turbulent flow, Laminar-Turbulent Transition, Engineering implications of turbulence, Correlation functions, Reynolds decomposition, Governing Equations for Turbulent flow, Measurement of Turbulence quantities, Shear-stress models, Prandtl's Mixing Length Hypothesis.

Textbooks:

3. White, F.M., "Viscous Fluid Flow", McGraw Hill, 2013.
4. Schlicting, H., "Boundary Layer Theory", McGraw Hill, 1979.

Reference Books:

5. Muralidhar, K., Biswas, B., "Advanced Engineering Fluid Mechanics", Narosa Publishing House, 2015.
6. Graebel, W.P., "Advanced Fluid Mechanics", Academic Press, 2009.
7. Aris, R., "Vectors, Tensors and Basic Equations of Fluid Mechanics", Dover Publications, 1962.
8. Munson, B.R., Young, D.F., Okiishi, T.H., Fundamentals of Fluid Mechanics, Wiley, 2017.

Elective VI: Production

Course No.: MET 460 Value Engineering **C L T (4 3 1)**

VALUE ENGINEERING

UNIT I:

Introduction to value engineering (VE) & value analysis (VA), Life Cycle of a product, Methodology of VE, Reasons for the existence of unnecessary costs. Quantitative definition of Value, use Value and Prestige value, Estimation of product Quality/Performance, Types of functions, Relationship between use functions and Esteem Functions in product design, Functional cost and functional worth, Effect of value improvement on profitability, Tests for poor value, Aims of VE systematic approach.

UNIT II

Elementary introduction to VE, Job plan functional approach to value improvement, Various phases and techniques of the job plan, Factors governing project selection, Types of projects, Life cycle costing for managing the total value, concepts in LCC, Present value concept, Annuity concept, net present value, Pay Back period, internal rate of return on investment (1RR), Examples and Illustrations. Creative thinking and creative judgement, positive or constructive discontent, Tangible and intangible costs of implementation, False material, Labour and overhead saving, VE/VA yardsticks, Relationship between savings and probability of success, Reliability Estimation, system Reliability, Reliability elements in series and parallel.

UNIT III

PHASES AND TECHNIQUES OF VE JOB PLAN:

General Phase, Information phase, Function phase, Creativity/Speculation Phase, Evaluation Phase, Investigation Phase and Recommendation Phase***:*** Value improvement recommendation theory, determination of cut-off point (cop), road blocks in implementation. Decision Matrix/Evaluation Matrix, Quantitative comparison of Alternatives, Estimation of weights factors and efficiencies, Utility transformation functions, Bench marking, Perturbation of weight factors (sensitivity analysis), and Examples.

FAST Diagramming: Critical path of functions, HOW, WHY & WHEN Logic, Supporting and all time functions.

Reference Books:

5. Arthur E. Mudge, "Value Engineering- A Systematic Approach",*McGraw Hill Book Co.* 1971.

6. Miles L.D., "Techniques of value Analysis and Engineering", *McGraw Hill Book Co., New York, 1970.*

7. ASTME-American society for Tool and Manufacturing Engineers," Value engineering in Manufacturing", *Prentice Hall Inc. USA, 1967.*

Course No.: MEP463	**MAJOR PROJECT – Stage II**	**C L T (9 0 0)**

CO1 Identify methods and materials to carry out experiments/develop code.

CO2 Reorganize the procedures with a concern for society, environment and ethics.

CO3 Analyze and discuss the results to draw valid conclusions.

CO4 Prepare a report as per recommended format and defend the work.

CO5 Explore the possibility of publishing papers in peer-reviewed journals/conference proceedings.

S.No.	Course Code	Course Title	L-T-P	Credits	Contact Hours
1	MMT 301	Corrosion Engineering	2-1-0	3	3
2	MMT 302	Iron Making	3-1-0	4	4
3	MMT 303	Foundry Technology	2-1-0	3	3
4	MMT 304	Mechanical Working of Materials	2-1-0	3	3
5	MAT 305	Quantitative Aptitude and Analytical Reasoning	2-1-0	3	3
6	MMT 001 MAT 002 HST 003	**Elective- I** Fuel, Furnace and Refractories/ Operation Research/ Principle of Management	2-1-0	3	3
7	ITT 004 CST 005	**Elective- II** Simulation using MATLAB and Python Data Structures	2-0-2	3	4
8	MML 306	Laboratory Practice in Corrosion Engineering	0-0-2	1	2
9	MML 307	Laboratory Practice in Foundry Technology	0-0-2	1	2
10	MML 308	Laboratory Practice in Mechanical working of Materials	0-0-2	1	2
Total				**25**	**29**

Recommendations of DUGC, Metallurgical and Materials Engineering

Proposed Scheme/ Curriculum Outline for 3rd Year B. Tech. Metallurgical and Materials engineering programme

'August 2021 Onwards'

Semester- 5th

***(i) Student should select one course each from Elective I & II.**

(ii) Student can opt online courses from Elective I & II if available.

(iii) If student opt online course, then they should follow all the terms & condition of said courses including examination procedures.

Semester- 6th

S.No.	Course Code	Course Title	L-T-P	Credits	Contact Hours
1	MMT 351	Ceramic Technology	2-1-0	3	3
2	MMT 352	Materials Characterization	2-1-0	3	3
3	MMT 353	Transport Phenomena in Materials Engineering	2-1-0	3	3
4	MMT 354	Steel Making	3-1-0	4	4
5	MMT 355	Joining of Materials	3-1-0	4	4
6	MMT 006 HST 007 ITT 008 CST 009	**Elective** Failure Analysis/ Entrepreneurship for Engineers/ Object Oriented Programming with Java/ Design & Analysis Algorithm	3-1-0/ 3-0-2	4	4
7	MML 356	Laboratory Practice in Ceramic Technology	0-0-2	1	2
8	MML 357	Laboratory Practice in Materials Characterization	0-0-2	1	2
9	MML 358	Laboratory Practice in Joining of Materials	0-0-2	1	2
10	MMS 359	Tour Training and Professional Interview	0-0-2	1	2
Total				**25**	**29**

Semester 7th

S.No.	Course Code	Course Title	L-T-P	Credits	Contact Hours
1	MMT 401	Non-Destructive Testing and Evaluation	2-1-0	3	3
2	MMT 402	Polymer Technology	2-1-0	3	3
3	MMT 403	Physical Metallurgy of Light Metals and Alloys	2-1-0	3	3
4	MMT 404	Pollution and Environmental Science	2-1-0	3	3
5	MMT 010 MMT 011 MMT 012	**Elective- I** Secondary Steel Making/ Plasma Processing of Materials/ Advance Manufacturing Processes	3-1-0	4	4
6	MMT 013 MMT 014 ITT 015	**Elective-II** Alternate Methods of Iron Making/ Thin Films/ Big Data	3-1-0/ 3-1-0/ 3-0-2	4	4/5
7	HSL 405	Personal Interview (Audit)	1-0-0	0	1
8	MML 406	Laboratory Practice in Non-Destructive Testing	0-0-2	1	2
9	MML 407	Laboratory Practice in Polymer Technology	0-0-2	1	2
10	MMP 408	Project Preliminary work & Seminar	0-0-3	3	3
Total				**25**	**28/29**

Semester- 8th

S.No.	Course Code	Course Title	L-T-P	Credits	Contact Hours
1	MMT 451	Tribology of Engineering Materials	2-1-0	3	3
2	MMT 452	Composite Materials	2-1-0	3	3
3	MMT 453	High Temperature Materials	3-1-0	4	4
4	MMT 016 MMT 017 HST 018 ITT 019	**ELECTIVE** Bio-Materials/ Nano-materials/ Marketing Management/ Block Chain	3-1-0/ 3-0-2	4	4/5
5	MMP 454	Major Project	0-0-15	10	15
6	MML 455	Laboratory Practice in Composite Materials	0-0-2	1	2
Total				**25**	**31/32**

SEMESTER WISE COURSE STRUCTURE
AND
SUBJECT WISE COURSE CONTENT

5TH SEMESTER

METALLURGICAL AND MATERIALS ENGINEERING DEPARTMENT

<table>
<tr><td rowspan="3">Subject: Corrosion Engineering
(Code: MMT 301)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3th Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

C01: Study the forms of corrosion
C02: To apply corrosion prevention methods
C03: To Understanding the kinetics, mechanism the High temperature oxidation and hot corrosion of metals and alloys

Module 1
Corrosion Principles - Electrochemical aspects, Importance and cost of corrosion. Computation of corrosion rates, Thermodynamics of corrosion, Passivation, Mixed potential theory of corrosion and its application.

Module 2:
Different Forms of Corrosion and Their Controls - Uniform Corrosion, Selective Corrosion Including Pitting Corrosion, Crevice Corrosion, Intergranular Corrosion, Filiform Corrosion, Stress Corrosion Cracking, Corrosion Fatigue, Fretting Corrosion, Cavitation Corrosion, Leaching, Erosion-Corrosion.

Module 3
Principle behind Protection of Materials against Corrosion: Cathodic and anodic protection, inhibitors, coatings and design. Decorative coatings by electroplating. Corrosion Testing Methods. IS specification

Module 4
High Temperature Corrosion & Oxidation of Metals And Alloys: Rate Laws, Kinetics and Mechanics. Wagner's parabolic law of Oxidation. Hot Corrosion, Corrosion in Mixed Gaseous Environment. High temperature materials.

Text books

1. Corrosion Engineering, Greene, N.D.,M.G. Fontana ,Tata McGraw Hill,2005
2. Corrosion–For science and engineering, Kenneth R Trethewey and John Chamberlain, Longman Inc,1996
3. Metallic corrosion and prevention, Raj Narayan, Oxford Publications,1988
4. An introduction to Electro-metallurgy , Sharan & Narain, Standard Publisher,1999

References

1. Corrosion and corrosion control – An introduction to corrosion science and engineering, Herbert H. Uhlig and R. Winston Revie, John Wiley & Sons,1985
2. ASM hand book – Vol 13: Corrosion, ASM International,2001
3. Principles and prevention of corrosion, Denny A. Jones, Prentice Hall Inc.,1996
4. Corrosion and corrosion protection handbook , Philip A. Schweitzer, ASM,1983

<table>
<tr><td rowspan="3">Subject: Iron Making
(Code: MMT302)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

CO 1: Understand the construction and design of iron making blast furnace and its accessories
CO 2: Perform the heat and material balance of a blast furnace
CO 3: Calculate the carbon rate depending on the percentage of direct and indirect reduction in the blast furnace, raceway adiabatic flame temperature and tuyere gas composition depending on the moisture content, oxygen content, and temperature of the blast

CO 4: Understand the alternative routes of iron making.

Course Details:

Module 1
Raw materials and their preparation (Sintering and pelletizing). Blast furnace design, construction and instrumentation. Blast furnace stoves and blast preheating. Thermal and material balance sheets.

Module 2
Burden calculations. Blast Furnace slags and their behavior, slag-metal reactions. Irregularities in the Blast Furnace.

Module 3
Modifications in blast furnace: high top pressure, humidification, Oxygen-enriched blasts, solid, liquid and gaseous injection through hot blast.

Module 4
Alternative methods of iron production such as: HYL, Midrex, Rotary kiln, Shaft furnaces, and Corex process.

Text books

1. Production of Iron and Steel Vol. I, G.R. Bashforth, Chapman & Hall, 1965.
2. Iron Making, A.K Biswas, SBA Publications, 2005.
3. Iron making, R.H. Tupkary, Khanna Publishers, 2008.
4. Sponge Iron production by direct reduction of iron oxide, Amit Chaterjee, PHI, 2010.
5. High Metal Production by Smelting Reduction of Iron Oxide, Amit Chaterjee, PHI, 2010.
6. Physical chemistry of Iron & Steel making, Ward R.G, ELBS, 1999.
7. Physical chemistry of Iron & Steel making, Bodsworth C., ELBS/Edward Arnold Pub., 1988.

<table>
<tr><td rowspan="2">Subject: Foundry Technology (Code: MMT303)</td><td colspan="2" rowspan="2">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L
2</td><td>T
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<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcome:

CO1: Ability to identify the advantages and applications of foundry practices as compared to other processes.
CO2: Knowledge of the materials used for moulding process.
CO3: Understanding the design of riser and gating system for efficient casting process.
CO4: Understanding the working principle of melting furnaces and procedures for melting different metals and alloys.
CO5: Ability to inspect and identify different casting defects with remedial measures.

Course Details:

Module 1:
Introduction: Introduction to metal casting processes- advantages, disadvantages and applications; classification of foundries.

Module 2:
Moulding materials and mould making: Sources of molding sands in India, classification and characteristics of different types of sand, grain size, shape and size distributions. Ingredients of molding sand and their effect on properties; binders and additives; testing of moulding sand; machines for sand mixing and preparation of moulds; classification of moulding methods- sand moulding process and its types, CO_2 process, shell moulding, machine moulding, floor and pit moulding, ceramic moulding, etc.

Module 3:
Core and core materials: Types of cores, core sands, preparation of cores, core baking and finishing.
Module 4:
Foundry tooling and methoding:
Pattern making- functions of patterns and its types, Pattern allowances and materials.
Core making- Core allowances and core print design.
Gating and feeding: Functions of gating system and its various components, types of gates; functions of risers, overview of pouring and solidification, concept of shrinkage, Chvorinov's rule, types of riser, methods of designing proper gating and risering system for ferrous and non-ferrous casting; directional solidification and methods to achieve directional solidification.

Module 5:
Melting furnaces and melting practice: Various types of melting furnaces used in foundry; melting practice for steels, cast iron and its types, aluminium alloys, copper alloys and magnesium alloys.

Module 6:
Casting and fettling
Classification of casting methods and equipments- sand casting, die casting, permanent mould casting, centrifugal casting, plaster mould casting, investment casting, continuous casting, squeeze casting, full mould process, strip casting, Rheo and thixocasting; shot blasting, grinding and fettling.

Module 7:
Casting defects and salvaging
Common casting defects - classifications, causes and remedies; salvaging and heat treatment of castings**.**

Text Books

1. Principles of Metal Casting, Heine R W., Loper, C.R. Rosenthal, Tata-McGraw Hill Publishing Co Ltd., 1995.
2. Principles of Foundry Technology, Jain P.L, Tata McGraw Hill, 1995
3. Metal Casting : Principles and Practice, Ramana Rao T V., New Age International Publishing, 1996
4. Fundamentals of metal casting technology, Mukherjee P.C.,Oxford and IBH Publishing House, 1996
5. Manufacturing technology, Rao P N, Tata-McGraw Hill Publishing Co Ltd., 1998

References

1. ASM Metals hand Book, Vol 15, Casting, ASM International, 2001
2. Foundry Technology, Beeley P R., Butterworths, London, 1982
3. Foundry Engineering, Srinivasan N K., Khanna Tech Publications,1994

<table>
<tr><td rowspan="3">Subject: Mechanical Working of Materials
(Code: MMT304)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

CO1: Analysis of the thermal, metallurgical and mechanical factors involved in forming metals into useful shapes (conventional and non-conventional).

CO2: Classification of various metalworking processes.

CO3: Familiarization with the general methods, mechanical equipments required and defects created in various metal forming operations.

CO4: To evaluate the mechanics of various metalworking operation.

Course Details:

Module-I
Introduction to Mechanical Working:

Manufacturing Processes, Classification of metal working/forming processes, General mechanics of metal working operations, Flow Stress, Effect of temperature, strain rate and metallurgical structure in metal working operations, Friction and lubrication, Residual stresses.

Module-II
Bulk Deformation Processes in Metal working:

a) Rolling, Classification of rolling processes, Mechanics involved in rolling operations, Rolling mills, Defects in rolled products.
b) Forging**,** Classification of forging processes, Forging equipments, Mechanics involved in forging, Forging defects.

c) Extrusion, Classification of extrusion processes, Extrusion equipment, Analysis of extrusion process, Defects in extruded products.
d) Drawing of rods, wires and tubes, Rod, wire and tube drawing processes, Drawing equipments, Analysis of drawing operation, Defects in rods wires and tubes.

Module III
Sheet Metalworking:

Cutting Operations - shearing, blanking, punching, Analysis of sheet metal cutting, Bending operations, Analysis of bending, Stretch forming, Deep drawing, Mechanics of drawing, Operations performed with metal tooling, Equipments for metal forming, Defects in formed parts.

Module IV

Non-conventional Forming Methods: Explosive Forming, Magnetic Forming, Electric discharge forming, Laser Forming.

Text Books:

1. Mechanical Metallurgy, Dieter G. E., Mc Graw Hill, 1988.
2. Fundamentals of Modern Manufacturing: Materials, Processes and Systems,Mikell P. Groover, John Wiley & Sons, Inc., 2010.
3. Metals Handbook, Vol.14, Forming and Forging, Metals Park Ohio, USA, 2001.
4. Handbook of Metal Forming, Kurt Lange, Society of Manufacturing Engineers, Michigan, 1988.

Reference Books:

1. Metal Forming Fundamentals and Applications
2. Tylan Altan, Soo Oh, Harold Gegel, ASM, Metals Park, Ohio, USA, 1983.
3. Mechanical Treatment of Steel, Vol.4 Bashforth G R Chapman & Hall, 1968.

<table>
<tr><td rowspan="3">Subject: Quantitative Aptitude and Analytical reasoning
(Code: MAT305)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
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<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives

C01: To enhance analytical and problem-solving skills

C02: To improve the basic mathematical skills

C03: To study information and apply logic to find patterns or make inferences.

Course Details:

Module I:

LCM and HCF, Percentages, Profit and Loss, Interest (Simple and Compound), Speed, Time and Distance, Time and Work, Averages, Ratio and Proportion, Algebra

Module II:

Linear Equations; Quadratic Equations, Complex Numbers, Logarithm; Progressions, Surds and Indices, Permutation and Combination

Module III:

Clocks, Calendars, Blood Relations (Family Tree), Logical Sequence, Direction sense and Decision Making

Module IV:

Quantitative Reasoning, Puzzles, Logical Reasoning based on Rankings, Critical Reasoning

References:

1. Quantitative Aptitude, R.S.Agarwal, S Chand Publishing, 2002
2. Magical Book on Quicker Maths, M. Tyra, BSC Publishing, 2018
3. Quantitative Aptitude, Arun Sharma, McGraw Hill, 8th ed., 2019
4. Verbal and Non-Verbal Reasoning by Dr. RS Aggarwal
5. Analytical Reasoning by M.K Pandey.

<table>
<tr><td rowspan="3">Subject: Fuels, Furnaces and Refractories
(Code: MMT 001)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
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<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

C01: To understand the difference between solid, liquid and gaseous fuels and their manufacturing process and uses.

C02: Describe the fundamentals about refractories and metallurgical furnaces.

C03: Outline construction and working principles of different types of furnaces and refractories.

Module-I

Fuels: Their classifications and resources in India, Composition and Constitution of Coals, Metallurgical Coke and its properties and production, Gaseous and liquid fuels: Coal Gasification, Petroleum and its Refining, Coke Oven and Petroleum by-products, Combustion of fuels, Regenerators, Recuperators and their efficiencies, Newer sources of energy, testing of solids, liquids and gaseous fuels.

Module-II

Furnaces: Their classification. Elements of furnace construction, Batch type and continuous furnaces, fuel economy, heating and heat saving methods, Furnace design, Furnace temperatures and Furnace atmospheres and their control,

Module-III

Refractories: Their classifications, compositions, structures, properties and applications, Manufacture of Acid, Basic and Neutral Refractories, Special Refractories like Graphite, Zirconia, Thoria, etc., Testing and Quality control of Refractories.

Text Books

1. Coal, Francis Penguin, 1967
2. Fuels, Brame and King, ASTM, Philadelphia, 1967
3. Refractories, Norton F.H, Tata Mc Graw Hill, 1984
4. Refractories- production, properties and applications, Chesti A.R , PHI, 1986
5. Industrial furnaces, Trinks W., John Wiley and Sons, 2004
6. Handbook of Refractories, D.N Nandi, Tata Mc Graw Hill, 1987
7. Elements of Fuels Furnaces and Refractories, O.P.Gupta, Khanna Publications, 1993
8. Refractories Production and Properties, Chester, IOM, 1973

Subject: Operation Research (Code: MAT 002)	**Year & Semester: B. Tech Metallurgical and Materials Engineering 3rd Year & 5th Semester**		**Total Course Credit: 3**		
			L	T	P
			2	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes:

C01: To solve complex problems under uncertainty

C02: To analyze the method of problem-solving and decision-making that is useful in the management of organizations

Course Details:

Module 1
Nature and Development of Operations Research, Problem formulation, Linear Programming Problem, Graphical Method, Simplex Method, Two-phase, Simplex Method. Big M method

Module 2
Transportation and Assignment Models. Replacement Models - Simple Problems. Gam Theory: Two person Zero-Sum Game. Sequencing Models-Processing n-jobs through two Machines, Processing n-jobs through three machines. Queuing Theory: Single- Channel Poisson Arrivals with Exponential Service (M/M/I) Model.

Textbooks:

1. Linear Programming, G. Hadlay, 1962
2. Operations Research: An introduction, Hamdy a. Taha, 2011
3. Optimization Techniques in Operation and Researh, Sivazham and Stenfel
4. Quantitative Methods for Managerial Decisions, C.M.Paik, Tata Mc Graw Hill, 1973
5. Fundamentals of Operation Research for Management, S.K. Gupta, and J.M. Cozzolino, 1976
6. Fundamentals of Operations Research, Ackoff Sasieni

Subject: Principle of Management (Code: HST 003)	**Year & Semester: B. Tech Metallurgical and Materials Engineering 3rd Year & 5th Semester**		**Total Course Credit: 3**		
			L	T	P
			2	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: Upon successful completion of this course, the learner will be able:

C01: To Practice the process of management's four functions: planning, organizing, leading, and controlling.

C02: To Identify and properly use vocabularies within the field of management to articulate one's own position on a specific management issue and communicate effectively with varied audiences.

C03: To evaluate leadership styles to anticipate the consequences of each leadership style.

C04: To gather and analyze both qualitative and quantitative information to isolate issues and formulate best control methods

Module	Topic(s)	Learning Outcomes
1	**Introduction to management and organizations**	1. DefineManagement and outline the evolution of management thought. 2. Differentiate between Manager Vs Entrepreneur 3. Discuss different types of managers along with their managerial roles 4. Describe the various types of Business organization 5. Explain Organization culture and Environment – 6. Discuss Current trends and issues in Management.
2	**Planning**	1. Discuss the Nature and purpose of planning 2. Discuss planning process and identify types of planning 3. Define objectives and outline the process of setting objectives 4. Explain decision making steps and process.
3	**Organising**	1. Discuss Nature and purpose of organizing 2. Differentiate between Formal and informal organization 3. Explain organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design 4. Describe Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.
4	**Directing**	1. Discuss the Foundations of individual and group behavior 2. Explain motivation – motivation theories – motivational techniques 3. Explain leadership – types and theories of leadership 4. Outline process of communication – barrier in communication – effective communication – communication and IT.
5	**Controlling**	1. Explain System and process of controlling – budgetary and non-budgetary control techniques 2. Discuss the use of computers and IT in Management control 3. Identify Productivity problems and management – control and performance – direct and preventive control – reporting.

Suggested Readings:

1. Stephen A. Robbins & David A. Decenzo& Mary Coulter, “Fundamentals of Management”, Pearson Education.
2. Robert Kreitner&MamataMohapatra, “Management”, Biztantra.
3. Harold Koontz & Heinz Weihrich “Essentials of management” Tata McGraw Hill.
4. Tripathy PC & Reddy PN, “Principles of Management”, Tata McGraw Hill.

<table>
<tr><td rowspan="3">Subject: Simulation using MATLAB and Python (Code: ITT 004)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
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<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives: To get introduced about MATLAB platform and its modalities.

1. Scope of MATLAB in Metallurgy and its applications.
2. To get introduced about Python and its libraries.
3. Use cases of Python and its packages.

Unit I: Introduction to MATLAB
Introduction to the basic environment, data types, Numbers, Arithmetic Operations and Special Characters, Vectors and Matrices, colon notation, strings and arrays.

Unit II: Conditionals and functions
Decision, conditionals, loops, scripts and functions, solving non-linear problems, Data import and output.

Unit III: Advanced functionalities
Plotting, graphics, algebra, calculus, Integration, differential, polynomials and transforms.

Unit IV: Introduction to Python
Why Python? Basic syntax, variable types, basic operations, conditional statements, looping, control statements.

Unit V: Data Manipulation and functions
String manipulation, List, Tuple, Dictionary, Functions, searching and sorting, Modules.

Unit VI: Files and Exception Handling
Opening and closing files, reading and writing files, functions specific to files, Exceptions, Exception handling, User-defined exceptions.

References:

1. MATLAB: Easy Way of Learning by S. Swapna Kumar
2. Learning MATLAB: A Problem Solving Approach by Walter Gander
3. Learning Python by Mark Lutz, David Ascher
4. Beginning Python by M. L. Hetland

<table>
<tr><td rowspan="3">Subject: Data Structures
(Code: CST 005)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives

- Understand the concept of ADTs(Abstract Data Types)
- Identify data structures suitable to solve problems
- Develop and analyze algorithms for stacks, queues along with their applications
- Develop algorithms for binary trees and graphs along with their applications
- Implement sorting and searching algorithms
- Implement symbol table using hashing techniques

Learning Outcomes

By the end of the course, the students will be able to :

- Design and analyze programming problem statements.
- Choose appropriate data structures and algorithms and use it to design algorithms for a specific problem.
- Understand the necessary mathematical abstraction to solve problems.

Course Synopsis

The course seeks to empower students with advanced programming concepts to enable them to become efficient programmers.

Course Outline / Content

Unit	Topics	Week
1.	**Introduction:** Basic concept of data, structures and pointers. **Strings:** Representation, String operations, Implementing String.h library functions.	1
2.	**Arrays:** Representation, implementation, polynomial representation. Limitations.	1
3.	**Linear Data Structures: Linked Lists** Linked List and its comparison with array implementation. Types of Linked lists, Applications of Linked lists. Implementing Linked Lists using structures. Insertion, Deletion, Search, Print.	4
4.	**Stacks: Static and Dynamic** Implementation. Applications of Stacks. Prefix Postfix and Infix Expressions. Infix to postfix conversion, Expression evaluation, and expression trees.	3

5.	**Queues: Static and Dynamic** Implementation. Applications of Queues, Types of Queues, Array Implementation of Circular Queues, Search and Update Operations on Varieties of Linked Lists, Linked List Implementation of Stacks and Queues	3
6.	**Recursion**: Recursion, Recursion and Stacks. Expression evaluation using stacks.	
7.	**Non-Linear Data Structures:** Introduction to Trees, Implementation of Trees, Binary Trees, Tree Traversals with an Application, Binary Search Trees (BSTs), Query and Update Operations on BSTs, static and dynamic implementation. Tree operations, insert, delete, and search. **Heaps:** Definition and Implementation of Max and Min Heap. Priority Queue ADT, Binary Heap Implementation and Applications of Priority Queues	4
8.	**Hashing:** Implementation of Dictionaries, Hash Function, Collisions in Hashing, Separate Chaining, Open Addressing.	2
9.	**Sorting Algorithms:** Stability and In Place Properties, Insertion Sort, Merge Sort, Quick Sort, Heap Sort, Lower Bound for Comparison Based Sorting Algorithms, **Linear Sorting Algorithms:** Counting Sort, Radix Sort, Bucket Sort	3
10.	**Graph Algorithms:** Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Minimum Spanning Trees (MST), Prim's and Kruskal's algorithms for MST, Connected Components, Dijkstra's Algorithm for Single Source Shortest Paths. Tree Traversals.	3
11.	**Storage Management:** Memory Management techniques, garbage collection.	1
	Text Books	
1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, PHI, 2009.	
2.	Ellis Horowitz, SartajSahni and SanguthevarRajasekaran, Fundamentals of Computer Algorithms, Second Edition, Universities Press, 2011.	
3.	Data Structures by Rajni Jindal	
4.	Data Structures - Schaum's Series	
	References	
1.	Data Structures by Knuth	
2.	Data Structures by Farouzan	
3.	Data Structures using C and C++ by Langsam, Augestern, Tanenbaum.	

<table>
<tr><td rowspan="3">Subject: Laboratory Practice in Corrosion Engineering
(Code: MML 306)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3th Year & 5th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term/Class Assessment
(40 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Outcomes:

C01: To study the microstructure of a corroded sample.
C02: To study the galvanic corrosion of metals by weight loss method
C03: To study the effect of cathodic protection on given couple of metallic samples
C04: To study the influence of various inhibitors on corrosion protection
C05: To understand the working principle of potentiostat. Aqueous corrosion.
C06: To study the High temperature oxidation of metals/alloys.

List of Experiments

1. To study the microstructure of a corroded sample.
2. To understand the working principle of pH meter.
3. To study the galvanic corrosion of metals by weight loss method.
4. To study the effect of cathodic protection on given couple of metallic samples.
5. To study the influence of various inhibitors on corrosion protection.
6. To understand the working principle of potentiostat. Aqueous corrosion.
7. To study the High temperature oxidation of metals/alloys.

<table>
<tr><td rowspan="3">Subject: Laboratory Practice in Foundry Technology
(Code: MML 307)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term/Class Assessment
(40 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Outcome:

CO1. Identify the sand morphology and understand the effect of sand particle size distribution on the sand mold properties.
CO2. Illustrate different sand testing methods available for sand mold preparations.
CO3. Ability to prepare molds for casting process.
CO4. Knowledge about furnaces used for melting purpose.
CO5. Ability to perform casting of different alloys.

List of Experiments:

1. To find the distribution of sand grains using a set of sieves and to find the average grain fineness number.
2. To determine the percentage of clay present in base sand.
3. To find the effect of water content, clay content on green permeability of foundry sand.
4. To find the green compression strength of the given specimen at different percentage of clay and moisture
5. To determine the green shear strength of the given specimen for different percentages of clay and moisture.
6. To determine the tensile strength of sand using two types of binders Viz. core oil binder and sodium silicate binder.
7. To determine the hardness of sand core and sand mould by using steel ball tester.
8. Preparation of green sand mould.
9. To determine the flowability of moulding sand.
10. Demonstration of foundry melting practice of ferrous and non-ferrous alloys

<table>
<tr><td rowspan="3">Subject: Laboratory Practice in Mechanical Working of Materials (Code: MML 308)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 5th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term/Class Assessment
(40 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Objectives:

CO-1. To test a metal specimen subjected to dynamic loading.

CO-2. To examine and analyze different bulk metal forming operations.

CO-3. To assess the shearing and bending operations.

List of Experiments:

1. To perform fatigue test on a ferrous sample and plot the S-N curve.
2. To perform rolling of materials and co-relate the percentage cold-working with hardness and microstructure.
3. To perform wire drawing of ferrous and non-ferrous materials.
4. To perform forging by forging hammer.
5. To perform V-bending of the rod.
6. To perform shearing operation on the metallic rod.

METALLURGICAL AND MATERIALS ENGINEERING DEPARTMENT

<table>
<tr><td rowspan="3">Subject: Ceramic Technology (Code: MMT351)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

C01: To understand the structural characteristics & structural imperfections of ceramic materials.

C02: To understand the phase equilibria, microstructures & high temperature reactions of ceramic systems.

C03: To understand the microstructural characteristics, sintering and methods of forming and mechanical properties of ceramic products.

Details of the Course:

Module 1:
Introduction to ceramics, Structural characteristics of ceramics and glasses, structural imperfections, surfaces, interfaces and grain boundaries.

Module 2:
Atom mobility, ceramic phase equilibrium diagrams, phase transformation, glass formation and glass ceramics, reactions with and between solids.

Module 3:

Grain growth, sintering and vitrification, microstructure of ceramics, fabrication processes mechanical properties.

Suggested Books:

S. No.	Name of the Books	Author(s)	Publisher	Year of Publication
1.	Fundamentals of Ceramics	Michael Barsoum	Mc Graw Hill Publishing Co.	1997
2.	Foundations of Materials Science and Engineering	William F.Smith	McGraw-Hill Inc, New York	1993
3.	Introduction to Fine Ceramics	NobukaIchinose	John Wiley	1987
4.	Composite Materials: Engineering & Science	Mathews and Rawlings	Chapman & Hall, London,	1994
5.	Ceramic Matrix Composites	Chawla K K	Chapman and Hall, UK	1993
6.	Modern Composite Materials	Broutmanand Krock, VanVlack K H	Addison Wesley Co.	1967
7.	Physical Ceramics for Engineers		Addison Wesley Co.	1964
	Introduction to Ceramics	Kingery, W D		
	Modern Ceramic Engineering-properties, processing and use in design.		John Wiley, USA	
	Introduction to the principles of ceramic processing.			

<table>
<tr><td rowspan="3">Subject: Materials Characterization (Code: MMT352)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcome:

CO1: Understanding the working principles of the optical microscopy, XRD and electron microscopy
CO2: Describe the various sample preparation techniques for structural and microstructural characterization techniques
CO3: Ability to analyze the materials, grain size, crystal structure, composition and phases by using XRD and microscopy techniques
CO4: Ability to analyze materials by SEM and TEM in different modes
CO5: Understand the operation and application of different spectroscopic and thermal analysis techniques

Module 1:
Optical microscopy: Introduction, Image formation, concept of resolution, numerical aperture, empty magnification, depth of field and depth of focus, lens aberrations, components of microscope- illumination system, objective lens and eyepiece, etc.; specimen preparation for optical microscopy; Imaging mode- bright-field and dark-field, principles and application of polarized, phase contrast and interference microscopy; quantitative microscopy- estimation of grain size, volume fraction and grain boundary area.

Module 2:
X-ray diffraction (XRD): Brief review of crystal structure; Production and properties of X-ray, Bragg's law and X-ray diffraction, diffraction intensities, factors affecting intensity, structure factor calculations- SC, BCC, FCC. NaCl structure, etc., Working principles and components of an X-ray diffractometer; application of X-ray diffraction – Indexing of XRD patterns for crystal structure determination, determination of crystallite size and lattice strain, residual stress measurement, elemental analysis by X-ray fluorescence (XRF) spectrometry.

Module 3:
Electron Microscopy
Scanning electron microscopy (SEM): Introduction to electron microscopy, interaction of electrons with the specimen; principle, construction and operation of SEM; sample preparation; different detectors, modes of operation, image formation of plane and fractured surfaces, elemental analysis by EDS.

Transmission electron microscopy (TEM): Construction and working principles of TEM; specimen preparation technique for TEM; principles of electron diffraction in TEM, bright and dark field imaging, selected area diffraction, indexing of diffraction patterns.

Module 4:

Introduction to additional characterization techniques: working principle and application of- Atomic force micrososcopy, Auger Spectroscopy, Electron probe microanalyis (EPMA), dilatometry, Thermogravimetric analysis (TGA) & Differntial Scanning calorimetry (DSC), emission spectroscopy, raman spectroscopy, Fourier-transform infrared spectroscopy (FTIR), four probe resistivity measurement and magnetic measurements, X-ray photoelectron spectroscopy (XPS).

Text Books

1. Metallography, principle and practice ,Vander Voort, Mc Graw Hill,1984
2. Elements of X-ray Diffraction, B.D. Cullity, Addison–Wesley Publishing Company, 2001
3. Electron Microscopy and Analysis, P.J Goodhew J. Humphreys R Beanland, Taylor and Francis, 2001.
4. 'Fundamentals of light microscopy and electronic imaging, Douglas B. Murphy, Wiley-Liss, Inc. USA, 2001.
5. Scanning Electron Microscopy and X-Ray Microanalysis: Joseph Goldstein and Dale E. Newbury, Springer, 2011
6. X-ray diffraction, C. Suryanarayana, M. G. Norton, Springer US, 1998
7. Materials characterization, Yang Leng, JohnWiley & Son, 2008

References:

1. David B. Williams, C. Barry Carter, " Transmission Electron Microscopy: A Textbook for Materials Science" ,Springer, pub. 2009.
2. ASM Handbook, Volume 10, Materials Characterisation, Whan R E (Ed), ASM international,1986

<table>
<tr><td rowspan="3">Subject: Transport Phenomena in Materials Engineering
(Code: MMT353)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

CO1: Explain the basics and scientific aspects of mass transfer, heat flow, fluid flow and mass transfer

CO2: Apply the transport concepts and equations of mass transfer, heat transfer and fluid flow for modelling of metallurgical processes

CO3: Obtain the ability to convert actual (descriptive) processes into appropriate equations and then attempt to solve the same

CO4: Solving different numericals pertaining to heat transfer, mass transfer and fluid flow

Module-I

Mass Transfer: Mass transfer processes and Metallurgical Kinetics-Rate controlling step, Diffusion- Laws of diffusion; steady state one dimensional; Pseudo-steady state diffusion; unsteady state diffusion. Diffusion in gases, liquid and solid. Convection and Mass Transfer in Fluids under Laminar and Turbulent flow, Mass transfer between a fluid and a solid. Boundary Layer – Mass Transfer Coefficient, Fluid flow viscosity, Differential mass and momentum balances,

Module-II

Variables K-influencing Dimensionless groups in Mass Transfer – Analytical, Solution of Mass Transfer co-relations. Mass Transformer between two fluids – film and Boundary Layer Theories, Surface renewed theory of Mass transformer. Theory of reaction rates. Mass transfer processes, convective mass transfer, concept of mass transfer coefficient.

Module-III

Gas-solid and gas liquid interfacial reaction – Adsorption – Slow surface reactions in high temp. metallurgy. Thermodynamics activity of absorbed atomic species. Reaction kinetics, Basic definition and concepts, reaction rate theories, Slag Metal Reaction –Electrochemical Kinetics at High Temp. Nucleation and growth – Homogeneous and Heterogeneous Nucleation – Nucleation of CO Bubbles in molten iron and in de-oxidation of steel.

Module-IV

Diffusivity and mechanism of diffusion.

Some special topics- Diffusion of gases through porous solid. Role of Merangoni Effect in Fluid Mass Transfer, Heat Transfer and Reaction Rates. Heat conduction equations and their applications. Convective heat transfer and radiative heat transfer.

Text Books

1. Rate Processes in Metallurgy, Mohanty AK, PHI, 2000
2. Basic Fluid Mechanics, Kothandaraman C.P. and Rudramoorthy, R., New Age International, 1998
3. Fundamentals of Engineering Heat and Mass Transfer, Sachdeva, R C, New Age International, 1996
4. Fundamentals of heat and Mass Transfer, Kothandaraman C P., New Age International,1997
5. Transport Phenomena, Bird R.B, Stewart E.S and Light foot, John Wiley & Sons, 2002
6. Transport Phenomena in Metallurgy, Geiger GH and Poirier DR, Addison Wesley, 1973

<table>
<tr><td rowspan="3">Subject: Steel Making (Code: MMT354)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:
CO1: Understand the basics of Physical Chemistry applied to Steel Making Processes
CO2: Classify different kinds of furnaces and their ancillary equipments used for Steel making
CO3: Analyze various factors influencing quality of the steel produced in steel making
CO4: Compare the traditional steelmaking to modern day manufacturing routes for the improvement of quality
CO5: Differentiate between various steel making processes like Bessemer, LD, Kaldo, etc.

Module-I
Basics: Brief history and earlier methods of steel making. Mixers and their merits. Desiliconization and desulphurization of B.F iron.
Module-II
Steel Making Processes: Steel making by Bessemer and side blown converters. O.H and Duplex/Triplex methods, Electric-Arc and Induction processes. Basic oxygen processes -L.D KALDO, ROTOR, LDAC, and top and bottom blown practices.
Module-III
Principles: Physico-Chemical principles of each of the above practices. Inclusions in steel. Deoxidation and vacuum treatment of steels. Electroslag refining.
Module-IV
Casting: Ingot mould and base plate preparation for casting. Steel casting practice. Ingot defects and their control. Continuous casting practice of steel and its merits.

Module-V
Different Steels: Recent trends in plain and alloy steel technology. Principles and production of alloy steels - HSLA, Tool and die, stainless, spring, magnetic and silicon steels etc.Instrumentation in steel works. Indian Steel plants and practices.

Text Books
1. Iron Making and Steel Making – Theory and practice, Ahindra Ghosh and Amit Chatterjee,, PHI, 2008
2. Introduction to Modern Steel Making Tupkary, R.H. Khanna Publications, New Delhi, 1994
3. The Making, Shaping and Treating of Steel, Richard J Fruchal, AISE Steel Foundation, 1998
4. Manufacture of Iron and Steel, Vol 2 Bashforth, GR Chapman & Hall, London, 1965
5. Introduction to Steel making, R.H.Tupkari, Khanna Publishers, 2004
6. Physical Chemistry of Iron and Steel Making, C.Bodswarth. Edward Arnold Publications, 1988

<table>
<tr><td rowspan="3">Subject: Joining of Materials (Code: MMT355)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

CO 1: identify, formulate, and solve engineering problems related to welding

CO 2: select and design welding materials, processes and inspection techniques based on application, fabrication and service conditions.

CO 3: identify the defects in welded joints and recommend remedial actions to prevent such defects in a professional manner

CO 4: design welding techniques for materials with poor weldability.

Module 1

Principles and classification of joining methods. Welding equipments.

Module 2

Conventional and special/recent welding practices including submerged, Laser, Plasma, MIG, TIG, Electron beam welding, solid-state welding processes, etc. Brazing and Soldering.

Module 3

Transformations in parent metal, design of weldments, slag-metal equilibria, gas pick up by welds and its influence. Weld cracking and its prevention. Preheating of base metals. Preheating temperature etc. Heat treatment of welds. Testing and quality control of welds-Macro and micro examinations etc.

Module 4

Metallurgical aspects of welding. Structure of welds and fusion zones. Weld defects and testing. Weldability of carbon, stainless steel and other alloy steels, cast irons, Cu, Al, Ti and their alloys, etc.

Text books

1. Modern Welding Technology, Howard B Cary, Helzar, Pearson Prentice Hall, 2005.
2. Manufacturing Engineering And Technology, S. Kalpakjian R.S. Steven, Prentice Hall, 2001.
3. Welding Engineering And Technology, R.S.Parmar, Khanna Publishers, 2002.
4. Welding Technology, Gower A. Kennedy, Macmillan Publishing Company, 1974.
5. Welding – Principles And Application, Larry Jeffus, Delmar Thomson Learning, 1999.
6. Principles Of Welding, R W Messler, John Wiley Sons, 1999.

<table>
<tr><td rowspan="3">Subject: Failure Analysis
(Code: MMT 006)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

C01: Discuss different sources of failure and the techniques and stages of failure analysis
C02: Understand the fundamentals of fracture mechanics
C03: Analyze elevated temperature and environmentally induced failures.Predict the reasons behind failures of various engineering components like shaft, bearing.

Module-I

Fundamental sources of failures.

Module-II:

General practice in failure analysis.

Module-III:

High and low temperature failures, Mechanisms of and the influence of structural, Environmental parameters on failure, Identification of types of failure.

Module-IV:

Service failures of cold formed parts, forgings, castings, weldments.

Module-V: Case studies - failures in power plants, etc

Text Books

1. Metallurgy of Failure Analysis, A.K.Das, Tata Mc Graw Hill Publishing Company Ltd New Delhi
2. Understanding How Components fail, by Donal J. Wulpi, second Edition.
3. Metas Hand book , 8th edition vol .10. Americal Society For Metals
4. Testing of Metallic Materials, Suryanarayana AVK, PHI,1

<table>
<tr><td rowspan="3">Subject: Entrepreneurship for Engineers
(Code: HST 007)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives:
Upon successful completion of this course, the learner will be able:
- To develop and strengthen entrepreneurial quality and motivation.
- To understand and develop entrepreneurial skills and understanding to run a business efficiently and effectively.
- To identify the various sources of financial and non financial support for entrepreneurs.

Module	Topic(s)	Learning Outcomes
1	**Introduction to Entrepreneurship**	1. Define Entrepreneur, Entrepreneurship and Entrepreneurial Traits 2. Differentiate between Entrepreneur, Innovator and Manager 3. Explain the Entrepreneurial decision process 4. Identify the Role of Entrepreneurship in Economic Development 5. Explain Ethics and Social responsibility of Entrepreneurs. 6. Outline Opportunities for Entrepreneurs in India and abroad 7. Describe Woman as Entrepreneur
2	**Creating and Starting the Venture**	1. Identify Sources of new Ideas 2. Discuss methods of generating ideas, problem solving, product planning and development process
3	**The Business Plan**	1. Explain the Nature and scope of Business plan 2. Write Business Plan 3. Evaluate Business plans 4. Use and implement business plans 5. Prepare Marketing plan, financial plan and the organizational plan, Launching formalities
4	**Financing and Managing the new venture**	1. Identify Sources of capital, 2. Prepare and Keep Accounting Records 3. Discuss recruitment, motivation and leadership 4. Discus Marketing and sales controls. 5. Describe E-commerce and Internet advertising
5	**New venture Expansion**	1. Identify features and evaluation of joint ventures, acquisitions, merges, franchising.

	Strategies and Issues	2. Explain Public issues, rights issues, bonus issues and stock splits
6	**Institutional support to Entrepreneurship**	1. Identify the role of following institutions in supporting and financing entrepreneurial growth in India: Directorate of Industries, District Industries, Centers (DICs), Industrial Development Corporation (IDC), State Financial corporation (SFCs), Commercial banks Small Scale Industries Development Corporations (SSIDCs), Khadi and village Industries Commission (KVIC), National Small Industries Corporation (NSIC), Small Industries Development Bank of India (SIDBI)

Suggested Readings:

1. Zimmerer T.H, Scarborough N.M, Winson D, **Essentials of Entrepreneurship and Small Business Management**, PHI Learning, New Delhi
2. Mary Coulter, **Entrepreneurship in Action,** PHI Learning Pvt. Ltd, N. Delhi
3. Barringer Bruce R & Ireland R Duane, **Entrepreneurship –Successfully Launching New Ventures**, Pearson Education
4. Charantimath P.M, **Entrepreneurship Development and Small Business Management**, Pearson Education, New Delhi
5. TanejaSatish, **Entrepreneurship Development**, Himalaya Publishing House, Mumbai

<table>
<tr><td rowspan="3">Subject: Object Oriented Programming with Java (Code: ITT 008)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
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<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives:

- **C01:** To study the background and history of java.
- **C02:** To understand the fundamentals of object-oriented programming in Java, including defining classes, objects, invoking methods etc.
- **C03:** To study the various exceptions and string handling mechanisms with examples.
- **C04:** To understand different approaches to concurrent programming and file handling mechanisms.
- **C05:** To understand the structure various GUI components with examples.

UNIT I - Introduction:

Programming language Types and Paradigms, Computer Programming Hierarchy, How Computer Architecture Affects a Language? , Why Java? Role of Java Programmer in industry, Features of Java Language, JVM –The heart of Java, Java's Magic Bytecode.
The Java Environment: Installing Java, Java Program Development , Java Source File Structure, Compilation, Executions.

UNIT II - Object-Oriented Programming Concepts:

Basic Language Elements: Lexical Tokens, Identifiers, Keywords, Literals, Comments, Primitive Data types, Operators Assignments. Object-Oriented Programming: Class Fundamentals , Object & Object reference , Object Lifetime & Garbage Collection, Creating and Operating Objects , Constructor & initialization code block, Access Control, Modifiers, methods Nested , Abstract Class & Interfaces, Defining Methods, Argument Passing Mechanism, Method Overloading, Recursion, Dealing with Static Members, Finalize() Method, Native Method.

UNIT III - Extending Classes and Inheritance

Use and Benefits of Inheritance in OOP, Types of Inheritance in Java, Inheriting Data members and Methods, Role of Constructors in inheritance, Overriding Super Class Methods ,Use of "super" , Polymorphism in inheritance.

UNIT IV - Exception Handling

The Idea behind Exception ,Exceptions & Errors ,Types of Exception,Control Flow In Exceptions, JVM reaction to Exceptions ,Use of try, catch, finally, throw, throws in Exception Handling ,In-built and User Defined Exceptions.

UNIT V - Array & String

Defining an Array, Initializing & Accessing Array, Multi –Dimensional, Array, Operation on String, Mutable & Immutable String.

UNIT VI - GUI Programming
Introduction to Applets and Interfaces, Designing Graphical User Interfaces in Java, Components and Containers

List of experiments:

1. Write a Hello World Program in Java.
2. Basic program to understand use of decision making i.e. use of for loop, if-else, while, do-while.
3. Write a Java program that works as a simple calculator. Use a grid layout to arrange buttons for the digits and for the +, -,*, % operations. Add a text field to display the result. Handle any possible exceptions like divide by zero.
4. Write a Java Program to define a class, describe its constructor, overload the Constructors and instantiate its object.
5. Write a Java Program to define a class, define instance methods and overload them and use them for dynamic method invocation.
6. Write a Java Program to demonstrate use of nested class.
7. Write a Java Program to implement inheritance and demonstrate use of method overriding.
8. Write a program using Applet to display a message in the Applet.
9. Develop an Applet that receives an integer in one text field & compute its factorial value & returns it in another text filed when the button "Compute" is clicked.

Text Books:

1. Java for Programmers, P.J. Dietel, H. M. Dietel, Pearson Education.
2. Java SE 6, Joel Murach, A. Steelman, SPD Pvt. Ltd.
3. Head first java, Kathy Sierra, Bert Bates, Oreilly.
4. Core Java, Cay Horstman and Gary Cornell, Prentice Hall

<table>
<tr><td rowspan="3">Subject: Design & Analysis Algorithm
(Code: CST 009)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives

- To understand asymptotic notations to analyze the performance of algorithms.
- To understand and apply various problem solving techniques such as divide and conquer, greedy algorithm, dynamic programming, etc.
- To solve given problem by selecting the appropriate algorithm design technique and justify the selection.
- To know the concepts of P, NP, NP-hard and NP-complete problems.

Learning Outcomes

This is a first course in algorithm design. Students will:

- Learn good principles of algorithm design;
- Learn how to analyze algorithms and estimate their worst-case and average-case behavior (in easy cases);
- Analyze the asymptotic performance of algorithms.
- Write rigorous correctness proofs for algorithms
- Become familiar with fundamental data structures and with the manner in which these data structures can best be implemented; become accustomed to the description of algorithms in both functional and procedural styles;
- Learn how to apply their theoretical knowledge in practice (via the practical component of the course).

Course Synopsis

Basic strategies of algorithm design: top-down design, divide and conquer, average and worst-case criteria, asymptotic costs. Simple recurrence relations for asymptotic costs. Choice of appropriate data structures: arrays, lists, stacks, queues, trees, heaps, priority queues, graphs, hash tables. Applications to sorting and searching, matrix algorithms, shortest-path and spanning tree problems. Introduction to discrete optimisation algorithms: dynamic programming, greedy algorithms. Graph algorithms: depth first and breadth first search.

Course Outline / Content

Unit	Topics	Week
1.	**Analysis of Algorithms:** Algorithm Design paradigms, motivation. Review of algorithmic strategies, asymptotic analysis: upper and lower complexity bounds. Identifying differences among best, average and worst Case Behaviours. Big O, little O, omega and theta notations, Standard complexity classes. Empirical measurements of performance. Time and	3

	space trade-offs in algorithms. Analysing recursive algorithms using recurrence relations.	
2.	**Divide & Conquer:** Structure of divide and conquer algorithms: examples, Binary search, Quick sort, analysis of divide and conquer run time recurrence relations. **Greedy Algorithms:** Overview of the greedy paradigm, examples of exact optimization solution (minimum cost spanning tree), approximate solution (Knapsack problem), single source shortest paths.	2
3.	**Dynamic Programming**: Overview, difference between dynamic programming and divide and conquer, applications: shortest path in graph, matrix multiplication, travelling salesperson problem, longest common sequence.	3
4.	**Graph Algorithms:** Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Minimum Spanning Trees (MST), Prim's and Kruskal's algorithms for MST, Connected Components, Dijkstra's Algorithm for Single Source Shortest Paths, Floyd's Algorithm for All-Pairs Shortest Paths Problem.	3
5.	**Back Tracking:** Overview, 8-Queens problem and Knapsack problem. **Branch & Bound:** LC searching, bounding, FIFO branch and bound, Applications: 0/1 Knapsack problem, Travelling salesperson problem.	2
6.	**Computational complexity:** Complexity measures, Polynomial vs non-polynomial time complexity; NP hard and NP complete classes, Examples.	1
	Text Books	
1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", PHI.	
2.	Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Third Edition, Pearson Education, 2006	
3.	Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Second Edition, Universities Press, 2011	
4.	Anany Levitin. "Introduction to the Design and Analysis of algorithms", Pearson.	
	References	
1.	Steven S Skiena, "The Algorithm Design Manual" – Springer Publications	
2.	Knuth, " The Art of Programming", Addison Wesley Vol I and II	
3.	Michael T Goodrich, "Algorithm Design" WILEY Publications.	

<table>
<tr><td rowspan="3">Subject: Laboratory Practice in Ceramic Technology
(Code: MML 356)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
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<tr><td>Evaluation Policy</td><td>Mid-Term/Class Assessment
(40 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Outcome: The student(s) shall be able:

C01: To understand the method of making and testing refractory products
C02: To understand the method of making and characterizing ceramic powders

List of Experiments:

1. Powder Preparation – Crushing of fireclay grog, Size distribution of grog
2. Determination of Packing Density of refractory raw materials
3. Fabrication of refractory bodies using best packed refractory raw materials.
4. Firing of refractory bodies at different temperatures
5. Study of effect of Composition, Forming pressure & Firing temperature on some properties of refractory bodies.
6. Testing of various important properties of refractories as per IS.
7. Spalling Resistance Test (Thermal Shock Resistance) of refractory bodies.
8. Refractory corrosion test
9. Outline of general Method of preparation of Ceramic powder materials
    a. Sol Gel Method (b) Precipitation and Co-Precipitation technique.
10. Some Ceramic powder preparation:
    (a) Micron alumina (b) Silica Gel and precipitated Silica (c) $MgAl_2O_4$ Spinel
    (d) Mullite (e) Ferrite
11. Characterization of Ceramic powder:
    (a) Tap density (b) DTA / TGA / DTGA (c) Raman Spectroscopy (d) Particle Size Analysis

<table>
<tr><td rowspan="3">Subject: Laboratory Practice in Materials Characterization (Code: MML 357)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term/Class Assessment
(40 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Outcome:

CO1: Ability to prepare the specimens for microstructural analysis
CO2: Knowledge about the operation of the XRD, optical and electron microscopy
CO3: Analyze the microstructural features of different alloys by using optical and electron microscopes
CO4: Understand and interpret the grain size of the specimens by using different techniques

List of Experiments

1. Determination of chemical composition of metallic sample by emission spectroscopy.
2. To prepare the metallic sample for metallographic examination.
3. Determination of cubic crystal structure using powder XRD.
4. Precise lattice parameter determination using XRD.
5. Estimation of crystallite size using Scherrer formula.
6. Ductile and brittle fracture surface study using scanning electron microscope
7. Chemical analysis using energy dispersive spectroscopy (EDS) analysis in SEM.
8. To demonstrate the TEM sample preparation and TEM analysis.
9. DSC/DTA analysis.
10. Dilatometry analysis.

<table>
<tr><td rowspan="3">Subject: Laboratory Practice in Joining of Materials
(Code: MML 358)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term/Class Assessment
(40 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Outcomes: At the end of course students will be able to:

1. Design and conduct experiments, as well as to analyze and interpret data related to material joining process
2. Select and design welding materials and processes based on application, fabrication and service conditions
3. Differentiate the microstructure and strength in fusion zone, HAZ, and base metal
4. Design suitable heat treatment for the welded components.

List of Experiments:

- Preparation and joining of two surfaces by soldering and brazing.
- Welding of cast irons, Aluminum, Copper and their alloys.
- Arc Welding of steel parts/welding to fill a hole in a steel trough.
- Gas welding of a given sample.
- Macro and Micro- examination of a welded joint.
- Determination of the strength properties of a welded joint and weld defects.
- Heat-treatment of a weld.
- Welding by other modern techniques for which facilities may be available.
- Welding of dissimilar metals i.e. Steel, cast iron, Stainless Steel, Mild steel, etc.

<table>
<tr><td rowspan="3">Subject: Seminar
(Code: MMS 359)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td></td><td colspan="3"></td></tr>
</table>

Course outcomes:

The student should be able:

C01: To improve their oral communication skills

C02: To become aware of recent advancement in the field of Metallurgical and Materials Engineering

Details:

1. A co-curricular activity based on seminar talks. This will involve a detailed study of a topic of interest and production in the candidates own style. Each student will be required to give a seminar talk on the subject of his/her interest. The handouts of the talks will be submitted by the student before the talk is delivered. These seminar talks will prepare the students for a proper survey of literature, compilation of information so gathered and presentation of the same to the audience. The handouts submitted by the students will be in accordance with the standard of technical papers.
2. The award of sessional will be based upon the preparation and presentation of seminar talks and performance in the group.

<table>
<tr><td rowspan="3">Subject: Tour Training and Professional Interview (Code: MMI 360)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
3rd Year & 6th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td colspan="4"></td></tr>
</table>

Course Outcomes:

C01: The students should be able to develop an understanding of the actual working environment.

C02: To enhance their knowledge and skill from what they have learned in the college and its implementation in different industries.

C03: To imbibe the good qualities of integrity, responsibility and self-confidence required in industries

Details

1. Each student will be required to undertake practical training during the winter vacations for a minimum period of 6 weeks in metallurgical/manufacturing industries. Each student will submit a training report in the department and give details of the jobs he was assigned during the practical training at the industry where he has taken such practical training. Separate report for the training taken at different industries will be required to be submitted by each candidate.
2. The students will also be required to go for a long industrial/educational tour to visit various industries and educational Organisations of Metallurgical concern. Each student will submit a tour report on completion of the tours.
3. The tour and training report as submitted by each student will be assessed by the staff members and evaluated for sessional awards.
4. A viva-voce examination will be conducted by an Examiner for assessment of Tour and Training undertaken by each student and for his/her professional achievements, Group discussing during the 6th semester course work.

SEMESTER WISE COURSE STRUCTURE
AND
SUBJECT WISE COURSE CONTENT

7TH SEMESTER

METALLURGICAL AND MATERIALS ENGINEERING DEPARTMENT

<table>
<tr><td rowspan="3">Subject: Non- Destructive Testing and Evaluation (Code: MMT 401)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

C01: Recognize the importance of NDT Techniques in quality control department of various manufacturing units and basics of NDT
C02: Understand about the principles, procedure and equipments for various methods of NDT
C03: Justify the advantages, disadvantages and limitations of each NDT Methods
C04: Classify the applications of each NDT Techniques in different industry and manufacturing units
C05: Differentiate and compare between all NDT methods based on their reliability, accuracy and cost for the selection of suitable method
C06: Apply these NDT Techniques on test materials in laboratory and analysis the data for the prediction of defect.

Module 1
Introduction to NDT, Comparison between destructive and Non Destructive Testing, Importance of NDT testing in the quality control of materials/product, Scope and limitations of NDT, Career prospects in NDT, Introduction to different NDT Methods, Visual examination methods.

Module 2
Liquid Penetrant Testing – Principle of Liquid penetrant testing, Solid Liquid interaction (contact angle), Capillary action, types and properties of liquid penetrants. Sample preparation/cleaning, Dwell time, removal of excess penetrants, Developer application, Selection of penetrant method – solvent removable, water washable, post emulsifiable, Inspection (Normal visible dye, Flurosence dye), Advantages, disadvantages and application of LPT.
Magnetic Particle Inspection (MPI)- Principles of MPI, basic physics of magnetism, permeability, flux density, cohesive force, magnetizing force, resistivity, residual magnetism, Methods of magnetization, magnetization using products using yokes, direct and indirect method of magnetization, continuous testing of MPI, residual technique of MPI, system sensitivity, checking devices in MPI, Advantages, disadvantages and Applications
Ultrasonic Testing (UT): Types of waves, frequency, velocity, wavelength, reflection, divergence, attenuation, Couplants, Piezoelectric materials, Transducer, basic principle of Ultrasonic testing, Contact and Non-contact methods, EMAT (Electromagnetic Acoustic

Transducer), Procedure for defect inspection, ultrasonic testing techniques resonance testing, through transmission technique, pulse echo testing technique, instruments used UT, accessories such as transducers, types, frequencies, and sizes commonly used, Advantages, disadvantages and Applications.

Module 3

Acoustic Emission Testing (AET): Basic principle of Acoustic emission testing, Sources of Acoustic emission, Characteristics of A.E Signals, Relationship between crack size and stress, Kaiser and Felicity effect, Signal parameters (Counts, Peak amplitude, Duration, Rise time, MARSE),Acoustic Emission testing system, System Calibration, Source location technique for defect identification. Advantages, disadvantages and Applications

Radiography Testing (RT):

Nature of X-Ray, Generation of X-ray, Scattering phenomena, Techniques and procedure, Image formation, Radiography film, Film density, Film processing technique, Radiographic evaluation, Advantages, disadvantages and applications.

Eddy Current Testing (ECT):

Basic principle of working, Farady's Law and Lenz's Law, Resistance, Inductance and Impedance, Lift of curve, Effect of thermal conductivity, Types of Eddy current probes, Balance Bridge, Standard depth of penetration, Effect of sample thickness, frequency, thermal conductivity on lift of curve, Calibration, Material thinning, , Advantages, disadvantages and Applications.

Module 4

Thermography and Holography:

Basic principle of thermography, Infrared radiation, Law of radiation, Active and Passive Infrared radiation technique, Principle of holography, Interference and diffraction, Recording of hologram and Reconstruction of image, Defect analysis, Advantages, disadvantages and application of thermography and holography.

In-situ Metallographic Examination:

Sample preparation steps for test material, Different damage mechanisms detected through microstructure, Analysis of defect present on material surface by optical microscopy, Advantages, Limitation and applications.

Comparison and selection of NDT methods

Text Books

1. Non-Destructive Evaluation and Quality Control, ASM Metals Handbook, American Society of Metals, Metals Park, Ohio, 2001
2. Non-Destructive Testing, MC, Gonnagle, W T, McGraw Hill Book Co, 1988
3. Non-Destructive Testing, Louis Cartz, ASM International, Metals Park Ohio, 1995
4. Non-Destructive Testing, Barry Hull and Vernon John, ELBS / Macmillan, 1989

<table>
<tr><td rowspan="3">Subject: Polymer Technology (Code: MMT402)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: After completing the course, the student should be able-

C01: To understand the chemistry, size, kinetics and structure of polymers

C02: To understand Tg, crystallinity, copolymerization and degradation of polymers

C03: To understand the reactions, solutions, types and processing of polymers

Course Detail:

Module 1
Genesis, Chemistry of polymerization, Molecular weight and size, Kinetics of polymerization, chemical and geometrical structure,

Module 2
Glass transition temperature, crystallinity in polymers, copolymerization, individual polymers, polymer degradation,

Module 3
Polymer reactions, polymer solutions, elastomeric, fiber forming and plastic materials, polymer processing

S. No.	Name of the Books	Author(s)	Publisher	Year of Publication
1.	Polymer Science	Gowariker, Viswnathan, JayadevSreedhar	New Age International Ltd.	2005
2.	Foundations of Materials Science and Engineering	William F.Smith	McGraw-Hill Inc, New York	1997
3.	Plastics: Materials and processing	Brent Strong A	Prentice-Hall, New Jersey	2000
4.	Polymer Processing	Morton-Jones D.H	Chapman and Hall, New York	1989
	Plastic Materials			

<table>
<tr><td rowspan="3">Subject: Physical Metallurgy of Light Metals and Alloys (Code: MMT 403)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:
After completing the course,the student should be able-

- **C01:** To understand the physical metallurgy of cast and wrought Aluminum alloys
- **C02:** To understand the physical metallurgy of Magnesium and Titanium alloys
- **C03:** To understand the physical metallurgy of composites and foams

Details of Course:

Module 1:
Introduction: Definition of light metals, cast and wrought alloys, characteristics of light metals and alloys, trends in applications

Module 2:
Physical metallurgy of aluminum alloys: Work hardening and annealing, forming limit curves, textures, principles of age hardening, micro-alloying effects, hardening mechanisms, aging processes, mechanical behavior, corrosion behaviour.

Wrought aluminum alloys: Designation and tempers, heat treatable and non-heat treatable alloys, Li containing alloys, joining, special products- aircraft alloys, automotive alloys, packaging alloys, electrical conductor alloys

Cast aluminum alloys: Designations, tempers and characteristics, alloys based on Al-Si, Al-Cu, Al-Mg, Al-Zn-Mg systems, modification in Al-Si alloys, joining

Module 3:
Magnesium alloys: Introduction to alloying behavior, alloy designations, Zr-free and Zr-containing alloys, wrought magnesium alloys, extrusion alloys, forging alloys, trends in applications of Mg alloys, electrochemical aspects

Titanium alloys: Introduction and classification, basic principles of heat treatment, alpha alloys, α/β alloys, beta alloys, wrought and cast commercial titanium alloys, texture effects, surface treatments, engineering performance- tensile, creep, and fatigue behaviour, applications- general applications, aerospace, power generation, automotive, marine, biomaterials

Module 4:

Novel Materials: Light metal matrix composites, metallic foams, nanophase alloys

Suggested Books:

Sl. No.	Name of Authors/ Books/ Publisher	Year of Publication/ Reprint
1	Polmear I.J., Light Alloys, 4th Ed., Elsevier	2004
2	Brandes E.A. and Brook G.B., Smithells Light Metals Handbook, Elsevier	1998
3	Totten G.E. and Mackenzie D.S., Handbook of Aluminum Vol. 1: Physical Metallurgy and Processes, CRC Press	2003
4	Friedrich H.E., Mordike B.L. and Friedrich H., Magnesium Technology, 1st Ed., Springer	2004
5	Ber L.B., Kolobnev N. and Kablov E.N., Heat Treatment of Aluminum Alloys: Advances in Metallic Alloys, CRC Press	2010
6	Lütjering G., Williams J.C., Titanium, 2nd edition, Springer	2007

<table>
<tr><td rowspan="3">Subject: Pollution and Environmental Science (Code: MMT 404)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4^{th} Year & 7^{th} Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

C01: Providing teaching and learning to make students acquainting with advanced science and technology in Environmental Science so as to skill them in pollution control in various metallurgical industries

C02: Be skilled both to control and maintenance in Environmental pollution, waste water treatment and other related activities in Environmental Engineering.

C03: Substantially prepared to take up prospective research assignments.

Module I:

Environment: Concepts of Environment, Environmental gradients, Tolerance levels of environmentfactor, EU, US and Indian Environmental Law. Chemistry in Environmental Engineering: Chemistry of the atmosphere, combustion related air pollution, global environmental problems - ozone depletion, greenhouse effect, acid rain etc.

Ecological Concepts: Biotic and Abiotic components, Ecosystem Process: Energy transfer, FoodChain and Food Web, Water cycle, Oxygen cycle, Carbon cycle, Nitrogen cycle etc., Soil chemistry,

Soil composition, properties, identification and classification, Noise pollution Effect of noise on people, rating systems, community noise sources and criteria, traffic noise predicti on, noise control, Noise standards, measurement and control.

Module 2:

Waste Water Treatment: Water Treatment: water quality standards and parameters, Ground water.Water treatment processes, Pre-treatment of water, Conventional process, advanced water treatment process. DO and BOD of Waste water treatment process, primary and secondary treatment of waste water, Activated sludge treatment: Anaerobic digestion, Reactor configurations and methane production.Water resources, characteristics of water, water pollutants, oxygen demanding wastes, sur face water quality, groundwater quality, water treatment systems, biomedical wastes treatment technologies and disposal options.

Module 3:

Solid waste, Definition and characteristics of industrial and hazardous wastes, Hazardous waste management, Solid Waste Management, Source classification and composition of MSW: Separation, storage and transportation, Reuse and recycling, Waste Minimization Techniques, Hazardous waste and their generation, Transportation and treatment: Incinerators, Inorganic waste treatment. E.I.A., Environmentalauditing,Hazardous substances and risk analysis: Hazardous substance legislation, risk assessment, hazard deification, potential carcinogens, toxicity testing in animals, human exposure assessment.

Module 4:
Air quality standards, emission standards,emission standards, criteria pollutants, air pollution and me teorology, atmospheric dispersion, emission controls, Air pollution and pollutants, criteria pollutants, Acid deposition, Global climate change –greenhouse gases, non-criteria pollutants, air pollution meteorology, Atmospheric dispersion, Industrial Air Emission Control, Flue gas desulphurization, NOx removal, Fugitive emissions.

Text Books
1. G. Kiely, “Environmental Engineering” Irwin/ McGraw Hill International Edition, 1997, ,
2. Arcadio P. Sincero&Gergoria A. Sincero, “Environmental Engineering” Prentice Hall India
3. M. L. Davis and S. J. Masen, “Principles of Environmental Engineering and Science”, McGraw Hill, International Edition, 2004
4. Curringham&Saigo, “Environmental Science”, TMH,
5. Gilbert M. Masters & Wendell P. Ela, “An Introduction to Environmental Engineering and Science”, PHI Publication.
6. Gilbert M Masters, “ Introduction to Environmental Engineering and Science” Prentice Hall
7. M.L. Davis and D.A. cornwell “Introduction to Environmental Engineering” McGraw-Hill
8. J. G. Hen“Environmental Science and Engineering” Benjamin/Cummings Publishers ry and G. W Heinke Education

Subject: Secondary Steel Making (Code: MMT 010)	Year & Semester: B. Tech Metallurgical and Materials Engineering 4th Year & 7th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes:

CO 1: Understand the concept of clean steels – their characteristics and importance
CO 2: Understand the fundamentals and practices of secondary steel making processes
CO 3: perform thermodynamic and kinetic calculations
CO 4: appreciate the science and technology of stainless steel making

Module 1

The concept of cleanliness of steels, non-metallic inclusions, dissolved gases, tramp and residual elements in steels and their effects on steel properties.

Module 2

Thermodynamic and kinetic considerations of deoxidation, desulphurization, decarburization and degassing of steel melts.

Module 3

Limitations of primary steel making, unit operations and unit processes in ladle metallurgy, slag free tapping.

Module 4

Ladle furnace designs and operation, injection metallurgy.

Module 5

Operations of degassing reactors viz. DH, RH, tank degassers etc. Re-melting refining technologies, special steel making processes viz. AOD, VOD, continuous steel making etc.

Text/Reference books

1. Principles of secondary processing & casting of liquid steels: AhindraGhosh, Oxford & IBH.
2. Secondary steel making, principles and applications: AhindraGhosh, CRC press.

<table>
<tr><td rowspan="3">Subject: Plasma Processing of Materials
(Code: MMT 011)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:
1. Relate the main collisional processes to plasma composition and chemistry.
2.Distinguish the various types of interaction between plasma species and surfaces.
3. Discuss plasma film growth and deposition techniques.
4. Contrast plasma etch mechanisms with traditional chemical etch methods.
5. Solve applied problems, identifying the key parameters involved and performing relevant numerical calcuations.

Module-I
CHARACTERISTICS OF PLASMA CHEMISTRY: Introduction to plasma chemistry, **v**arious plasma generation methods for chemistry and various applications of plasma technology to chemistry, Plasma generation methods include thermal equilibrium plasma; non equilibrium plasma;

Module-II
Plasma Types: arc plasma, RF plasma, microwave plasma, glow plasma, microwave plasma, DBD plasma, and atmospheric pressure non-equilibrium plasma, Plasma-surface interactions,

Module-III
Applications: Application of high temperature heat source, organic and non organic synthesis, decomposition technology of various materials, separation technology et al. thermal plasmas, non-thermal plasmas, thermal plasma processing-material synthesis, thermal plasma processing-sparation, thermal plasma processing-material synthesis-chemical synthesis, thermal plasma processing-waste treatment.

Module-IV
Heat and Mass Transfer: Basics of heat transfer, Heat transfer by thermal plasma and non-thermal plasma, high temperature heat transfer, various mechanisms, Mass transfer in plasma processes, various mechanisms associated with mass transfer in thermal and non-thermal plasmas.

Text Books

1. Text Book Of Plasma Physics, Suresh Chandra, CBS Publishers, 2010
2. Plasma Chemistry, Fridman, A. Cambridge: Cambridge University Press, 2008

3. Nonequilibrium Phenomena in Plasmas, A. Surjalal Sharma and Predhiman Kaw, eds., Springer, 2005.
4. Plasma Chemistry, L. S. Polak and Yu A. Lebedev, eds., Cambridge, 1999.
5. Plasma Physics and Engineering, A. Fridman and L. Kennedy, Taylor and Francis, 2004.
6. Industrial Plasma Engineering, J. Reece Roth, Vol. 2 - Applications, IOP, 2001.
7. Thermal Plasmas and New Materials Technology, vol 1&2, M. Zukov and O. Solonenko, eds., Cambridge, 1999.
8. Principles of Plasma Discharges and Materials Processing, Michael Lieberman and Allan Lichtenberg, Wiley & Sons, 1994.
9. Plasma Spraying: Theory and Applications, ed. R. Suryanarayanan, World Scientific, 1993.
10. Plasma Technology: Fundamentals and Applications, eds. M. Capitelli and C. Gorse, Plenum Press, 1992.
11. Plasma Polymerization and Plasma Interactions with Polymeric Materials, ed. H. Yasuda, Wiley & Sons, 1990.
12. Plasma Etching, eds. D. Manos and D. Flamm, Academic Press, 1989.
13. Fundamentals of Plasma Physics, J. A. Bittencourt, Pergamon, 1986

<table>
<tr><td rowspan="2">Subject: Advance Manufacturing Processes (Code: MMT 012)</td><td colspan="2" rowspan="2">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L
3</td><td>T
1</td><td>P
0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:
CO1:To familiarize students with the latest technologies involved in manufacturing industries.
CO2: To understand additive manufacturing and the role of material science in AM.
CO3: Understanding about the near net shape casting, forging and forming processes.

Module I: Additive Manufacturing (AM)
Introduction to AM, evolution of AM, Steps in AM, Types of AM processes like Vat Photo polymerization AM Process, Material Jetting AM Process, Binder Jetting AM Process and Extrusion-Based AM Process etc. Advantages of AM and Types of materials used in AM.
Materials Science for AM: Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship.
Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation of Pattern, Property Enhancements using Non-thermal and Thermal Techniques. Criteria for selection of AM process and its applications.

Module 2: Advanced Metal Forming Processes
Metal forming processes: High energy rate forming, Electro Magnetic Forming, Electro Hydraulic forming Stretch Forming and Contour roll forming. Plastic deformation processes; Flashless forging, Cold forging. Super plastic forming, powder metal forging, liquid forging, rheo-forging and isothermal forging processes.

Module 3: Advanced Casting and Machining Processes
Precision castings processes, Economical and technological factors involved in near net shape processing of materials. Machining processing like Abrasive Jet machining (AJM), Water Jet machining (WJM), Ultrasonic machining (USM), Electric discharge machining (EDM), Laser Beem machining (LBM) and Electron Beem machining EBM.

Text Books
1. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.
2. Patri K. Venuvinod and Weiyin Ma, "Rapid Prototyping: Laser-based and Other Technologies", Springer, 2004.
3. RafiqNoorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

4. Principle of Metal Casting- Heine, R.W. Loper ,C. Philip and C.R.Rosenthal, McGraw Hill.2.
5. Principle of Metal Casting- P.L.Jain,TMH3.
6. Manufacturing Technology- P.N.Rao, TMH
7. ASM Metal Hanbook, Metal forming and forging, Vol 14.
8. Panday P.C and Shan H.S, “Modern machining Processes” Tata McDraw-Hill, New Delhi

<table>
<tr><td rowspan="3">Subject: Alternate Methods of Iron Making
(Code: MMT 013)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:

CO 1: Understand the need for alternative routes of iron making and the current scenario in India and World.
CO 2: Understand the thermodynamics and kinetic aspects of iron oxide reduction in solid and liquid state.
CO 3: Design processes for the direct reduction of iron oxide.
CO 4: Suggest remedial actions for the problems encountered during the storage and handling of DRI.

Module 1

Introduction: Need for the development of alternative routes, approaches towards new techniques. Classification of processes.

Module 2

Principles: Thermodynamic and kinetic aspects of iron ore reduction in solid and liquid state using solid/gaseous reductants.

Module 3

Methods: Sponge iron production using shaft, kiln, retort and rotary hearth reactors. Raw materials preparation.Selection of reductants.Heat and mass transfer.Energy consumption and operating problems. Storage, transportation and utilization of sponge iron in India.

Module 4

Pre-Reduced Pellets and Powders: Pre-reduced iron ore pellets for blast furnace applications, concept of composite pellets and its feasibility. Iron powder and iron carbide preparation from fluidised bed reactor and other processes. Operating/storage problems.

Module 5

Smelting-Reduction Processes: Principles, classification, merits and limitations. COREX process and electric smelting processes.

Text books

1. L.VonBogdandy and H.J. Engell: Reduction of Iron Ores, Springer.
2. R.R. Rogers (ed.): Proc. of Symp. Iron Ore Reduction, Pergamon.
3. A Chatterjee: Sponge iron production by direct reduction of iron oxide,PHI,New Delhi,2010.
4. A Chatterjee:hot metal production by smelting reduction of iron oxide, PHI,New

Delhi,2010.
5. RH Tupkary : Modern iron making,Khanna publishers, New delhi

Reference books

1. Proc. of Int. Conf. on Alternative Routes to Iron & Steel under Indian Conditions, IIM Jamshedpur 1988.
2. A. Chatterjee, R. Singh and B. Pandey: Metallics for Steelmaking- Production and Use, Allied Publisher.

<table>
<tr><td rowspan="3">Subject: Thin Films
(Code: MMT 014)</td><td rowspan="3" colspan="2">Year & Semester: B. Tech Metallurgical and Materials Engineering
4^{th} Year & 7^{th} Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: After completing the course,the student should be able-

- **C01:** To understand the scientific principles of processing of thin films
- **C02:** To understand the science of epitaxy and technique of CVD
- **C03:** To characterize the film and know its applications

Module 1:

Introduction: Applications of thin films, processing techniques

Gas kinetics: Maxwell-Boltzmann distribution, molecular impingement flux, Knudsen equation, mean free path, transport properties.

Evaporation: thermodynamics of evaporation, evaporation rate, alloys, compounds, sources, deposition monitoring techniques.

Deposition: adsorption, surface diffusion, nucleation, structure development, interfaces, stress, adhesion.

Module 2:

Epitaxy: symmetry, applications, disruption, growth monitoring, composition control, lattice mismatch, surface morphology.

Chemical Vapor Deposition: Gas supply and convection, reaction equilibrium and surface processes, diffusion limited deposition and reactor models.

Module 3:

Film characterization: structure, thickness, topography, inhomogeneity, crystallography, bonding, point defects, composition, stress and optical, electrical and mechanical behavior of thin films.

Applications: Technology of polysilicon thin-film transistors, thin film transistors in active-matrix liquid crystal displays, organic based thin film transistors, vacuum deposited organic thin film transistors based on small molecules.

Text Books:

Sl. No.	Authors/Name of Books/ Publisher	Year of Publications/ Reprint
1	Ohring, M., "Materials Science of Thin Films", 2nd Ed., Academic Press.	2001
2	Smith D.L., "Thin-Film Deposition: Principles and Practice", McGraw-Hill Professional.	1995
3	Kagan, C.R., Andry, P., "Thin Film Transistors", Marcel Dekker.	2003
4	Eishabini-Riad, A., Barlow, F. D., "Thin Film Technology Handbook", 1st Ed., McGraw-Hill Professional.	1997
5	Siddal, G. (Ed.), "Thin Films Science and Technology", Elsevier.	1984

<table>
<tr><td rowspan="3">Subject: Big Data
(Code: IIT 015)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives:

- **C01:** Introduction to Big Data: The 3 V's, their challenges and application domains.
- **C02:** Collection of Big Data: Eventual Consistency and NoSQL systems, Google BigTable
- **C03:** Large-Scale Data Analytics Systems: MapReduce, Hive, and Parallel Databases
- **C04:** Basic Statistical Analysis using different Mathematical algorithms

Unit I
Introduction:
Big Data Overview, Introduction to the Big Data problem.Current challenges, trends, and applications, Algorithms for Big Data analysis. Data sets, Mining and learning algorithms that deal with large datasets Technologies for Big Data management. Big Data technology and tools, special consideration made to the Map-Reduce paradigm and the Hadoop ecosystem.
What is data sciences, The rising and importance of data sciences, Big data analytics in industry verticals, Data Analytics Lifecycle and methodology, Data Understanding, Data Preparation.

Unit II
Modeling:
Evaluation, Communicating results, Deployment, Data exploration &preprocessing.

Unit III
Measures and Evaluation:
Data Analytics: Theory & Methods, Supervised learning, Linear/Logistic regression, Decision trees, Naïve Bayes, Unsupervised learning, K-means clustering, Association rules

Unit IV
Unstructured Data Analytics:
Technologies & tools, Text mining, Web mining, operationalizing an Analytics project, Data Visualization Techniques, Creating final deliverables Term project: Using Amazon AWS, BlueMix, Cognos, Biginsights.

List of experiments:

(i) Perform setting up and Installing Hadoop in its three operating modes: Standalone and Distributed.
(ii) Use web-based tools to monitor your Hadoop setup.
(iii) Implement the following file management tasks in Hadoop: Adding files and directories, Retrieving files, Deleting files
Hint: A typical Hadoop workflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command line utilities.
(iv) Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
(v) Write a Map-Reduce program that mines data from any dataset or real-time data from any source
(vi) Implement Matrix Multiplication with Hadoop Map Reduce
(vii) Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data.
(viii) Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes

Text Books:

1. Big Data: A Revolution That Will Transform How We Live, Work, and Think by Viktor Mayer-Schönberger, Kenneth Cukier.
2. Hadoop: The Definitive Guide by Tom White, Doug Cutting.
3. Real-Time Big Data Analytics: Emerging Architecture by Mike Barlow.

<table>
<tr><td rowspan="2">Subject: Personal Interview
(Code: HSL 405)
Audit</td><td rowspan="2">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year &7th Semester</td><td colspan="3">Total Course Credit: 0</td></tr>
<tr><td>L
1</td><td>T
0</td><td>P
0</td></tr>
<tr><td>Evaluation Policy</td><td></td><td colspan="3"></td></tr>
</table>

Course Objectives:

The course aims to:

1. Acquaint students with the various types of interviews
2. Familiarize students with the employer's expectations during an interview
3. Apprise students with the do's and don'ts of personal interviews
4. Prepare students for a successful personal interview
5. Facilitate effective platforms for mock interviews

Syllabus Components:

1. Types of interviews and format of employment interviews
2. Types of interview questions and ways to answer them
3. Employer's expectations
4. Elements of a good and a poor interview
5. Successful preparation for the job interviews
6. Answering questions during the interview
7. Successful follow-up after the interview

Course Outcomes:

After successful completion of this course, the student will be able to:

C01: Prepare for personal interviews efficiently

C02: Anticipate key questions from the employer/interviewer

C03: Answer questions fluently, confidently, and clearly

Suggested Readings:

1. *Developing Communication Skills*. 2nd Edition. By Krishna Mohan and MeenaBanerji. Published by Macmillan, 1990, 2009.
2. *Effective Business Communication*. 7th Edition-Special Indian Edition. By HertaA Murphy, Herbert W Hildebrandt, Jane P Thomas. Published by McGraw Hill Education. 1997, 2018.

<table>
<tr><td rowspan="3">Subject: Laboratory Practice in Non- Destructive Testing (Code: MML 406)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>10 Marks</td><td colspan="3">90 Marks</td></tr>
</table>

Course Outcomes:

C01: To gain experience with and understanding of the types, advantages and applications of various NDT methods.

C02: To be able to choose the best NDT method for a given part.

Details

1. To identify Macroscopic flaws by Visual inspection
2. To detect surface and near surface defects of conductive material using eddy current.
3. To identify/detect discontinues on given sample using Ultrasonic Inspection.
4. To detect flaws in magnetic materials using Magnetic Particle Inspection
5. To inspect flaws that breaks the surface of the sample by liquid penetration.

<table>
<tr><td rowspan="3">Subject: Laboratory Practice in Polymer Technology (Code: MML 407)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 7th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term/Class Assessment
(40 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

Course Outcomes: The student(s) shall be able**:**

CO1: To synthesize polymers

CO2: To characterize polymers

List of Experiments:

1. Determination of molecular mass of styrene by viscosity measurements.
2. Study the effect of temperature on the viscosity of polymer solutions.
3. Determination of glass transition temperature by DSC method.
4. Synthesis of Nylon 66 by interfacial polymerization and confirm the synthesis by IR spectroscopy.
5. Synthesis and kinetic investigation of radical polymerisation of styrene to polystyrene.
6. Synthesis of Melamine-Formaldehyde resin.
7. Synthesis of a conducting polymer poly-aniline/polystyrene and determine its conductivity.
8. To determine Iodine value in the polymer sample.

<table>
<tr><td rowspan="3">Subject: Project Literature Survey
(Code: MMP 408)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year &7th Semester</td><td colspan="3">Total Course Credit: 2</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Evaluation Policy</td><td>Mid-Term/Class Assessment
(40 Marks)</td><td colspan="3">Final-Term
(60 Marks)</td></tr>
</table>

The student should be able to

C01: To collect research papers of journals & conferences on the topic.

C02: To identify inconstancies: gaps in research, conflicts in previous studies, open questions left from other research

C03: To understand the research problem being studied and to identify new ways to interpret prior research

Details:

1. Each student will undertake a project work, involving complete literature survey, design and fabrication of some working process models, and /or a laboratory experimentation, and presentation of results, under the supervision of a faculty member to be fixed in a meeting of the faculty members of the department keeping in view the students choice of project topic, their aptitude, facilities available and the availability of staff.
2. The project will be assigned before the conclusion of the 6th semester examination and students will start working on literature survey etc., when 7th semester classes commence. A write-up and a complete list of consumables and non-consumable items to be needed by each student to complete the project work will be submitted to the teacher concerned in a fairly typed form for assessment and for arranging the materials from the market, if necessary, so that the practical work is started just at the commencement of the 8th semester classes. Each student will submit a complete literature survey of the project work assigned to the concerned supervisor for assessment.

SEMESTER WISE COURSE STRUCTURE
AND
SUBJECT WISE COURSE CONTENT

8TH SEMESTER

METALLURGICAL AND MATERIALS ENGINEERING DEPARTMENT

<table>
<tr><td rowspan="3">Subject: Tribology of Engineering Materials (Code: MMT 451)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:
After completing the course,the student should be able-

- **C01:** To understand the concepts of surface roughness, friction, adhesion, & wear
- **C02:** To understand wear testing methods
- **C03:** To understand the tribological properties of solids
- **C04:** To understand the surface treatments used to minimize wear

Details of the Course:

Module 1
Surface properties and surfaces in contact: Nature of metallic surface, surface geometry, measurement of surface topography, quantifying surface roughness, contact between surfaces; Friction, the laws of friction, measurement of friction, origin of friction, theories of friction adhesion- theory, extension of the adhesion theory

Module 2
Wear: Types of wear, adhesive wear, Archard’s law, abrasive wear, erosion wear, factors affecting corrosive wear, wear map, various wear testing methods- pin on disc, pin on drum, slurry wear, air jet and water jet erosion as per ASTM standards

Module 3
Tribological properties of solid materials: Hardness, strength, ductility and work hardening rate, effect of crystal structure, effect of microstructure, mutual solubility of rubbing pairs and effect of temperature

Module 4
Surface treatments to reduce wear: Surface treatments with or without change of composition, surface coating- welding, flame, spraying, plasma spraying, electroplating and electroless coating, chemical vapour deposition (CVD) and physical vapour deposition (PVD), super hard coatings

Suggested Books:

Sl. No.	Name of Authors/ Books/ Publisher	Year of Publication/ Reprint
1	Hutchings I.M., Tribology – Friction and wear of engineering Materials, Edward Arnold	1992
2	Arnold R.D., Davies P.B., Halling J. and Whomes T.L., Tribology – Principles and Design Applications, Springer Verlag	1991
3	Bhushan B., Introduction to Tribology, John Wiley	2002
4	Bhushan B., Principles and Applications of Tribology, John Wiley	1999
5	Stachowiak G and Batchelor A.W., Engineering Tribology, 4th Ed. Elsevier Butterworth-Heinemann	2013

<table>
<tr><td rowspan="3">Subject: Composite Materials (Code: MMT452)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives:
After completing the course,the student should be able-

- **C01:** To understand the fabrication of reinforcements, role of matrix materials and the interfaces between them
- **C02:** To understand the various types of composites
- **C03:** To understand the mechanical properties, making and repairing of composite materials

Details of the Course:
Module 1:
Introduction, Reinforcements, Matrix materials, Interfaces

Module 2:
Polymer matrix composites, Metal matrix composites, Ceramic matrix composites, Carbon fiber/carbon matrix composites,Multifilamentary SuperconductingComposites

Module 3:
Mechanics, Strength and fracture, fatigue and creep, Design, non-conventional composites, repair and recycling of Composites

Suggested Books:

S. No.	Name of the Books	Author(s)	Publisher	Year of Publication
1.	Composite Materials	Chawla K K,	Springer Verlag, New York	1998
2.	Composite Materials: Engineering & Science	Mathews F L and Rawlings R D	Chapman & Hall , London	1994
3.	Ceramic Matrix Composites	Chawla K K	Chapman and Hall, UK	1993
4.	Modern Composite Material	Broutman L J, and Krock	Addison Wesley Publishing Company	1967
5.	Composite Materials: Science and Applications	Deborah Chung D	Springer International, USA	2004
6.	“Composites” Metals Hand Book Vol.21, 9th Edition		ASM	1989

<table>
<tr><td>Subject: High Temperature Materials
(Code: MMT 453)</td><td colspan="2">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credit: 4
<table><tr><td>L</td><td>T</td><td>P</td></tr><tr><td>3</td><td>1</td><td>0</td></tr></table></td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:
After completing the course, the student should be able-

- **C01:** To understand the types, properties, and requirements of high temperature materials
- **C02:** To understand the testing methods, equipment, and creep-fatigue interactions
- **C03:** To understand the available high temperature materials and coatings

Details of the Course:
Module 1:
Introduction: Need for high temperature materials, historical development of high temperature materials, and equipment for material testing at high temperatures, requirements of high temperature materials (mechanical properties and preferred microstructure, environmental resistance, erosion and wear).

Module 2:
Principles for high temperature strengthening: Metallic materials (solid solution strengthening, precipitation strengthening, dispersion strengthening grain size and grain boundary effects) Ceramic materials (phase control, defect tolerance, thermal shock resistance) composite materials.

Module 3:
Creep and stress rupture: Creep test, stress rupture test, structural changes during creep, mechanism of creep deformation, and fracture at elevated temperatures.

Module 4:
Creep-Fatigue interaction: Modes of high temperature fracture and fatigue fracture, creep-fatigue interaction (creep accelerated by fatigue), fatigue-creep interaction (fatigue accelerated by creep), micro-mechanism of damage, fracture criterion for creep fatigue, creep-fatigue failure mapping, creep-fatigue testing, influence of environment.

Module 5:
Materials for high temperature: Metals / alloys, superalloys, steels, titanium and its alloys, ceramics (Alumina, Zirconia, Silicon carbide, Silicon nitride, Glass ceramics) composites (Metal matrix composites, ceramic matrix composites) carbon – carbon composites.

Module 6:
Coatings for protection against high temperature corrosion and erosion: Corrosion / oxidation resistant coatings (metallic, ceramic, rare and reactive metal reinforced coatings), high temperature erosion and wear, thermal barrier coats.

Module 7:
Case studies: Applications in industry, aerospace, defense and nuclear industry.

Suggested Books:

Sl. No.	Authors/Name of Books/ Publisher	Year of Publications/ Reprint
1	Meetham, G. W., Van de Voorde, M. H., “Materials for High Temperature Engineering Applications (Engineering Materials)”, 1st Ed., Springer.	2000
2	Chan R. W., “High temperature structural materials”, Chapman & Hall.	1996
3	Reed R. C., “The Super-alloys: Fundamentals and Applications”, Cambridge University Press.	2008
4	Birks, N., Meier, G. H., and Pettit, F. S., “Introduction to the High Temperature Oxidation of Metals”, Cambridge University Press.	2009
5	Bose, S., “High Temperature Coatings”, Butterworth-Heinemann.	2007

<table>
<tr><td rowspan="3">Subject: Bio- Materials (Code: MMT 016)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:
After completing the course,the student should be able-

- **C01:** To understand different metallic, ceramic and polymeric bio materials
- **C02:** To understand dental, orthopedic, cardiovascular, & tissue regeneration materials
- **C03:** To understand tissue response to implants and degradation of biomaterials

Details of Course:

Module 1
Introduction: Historical background, construction materials, impact of biomaterials, strength of biological tissues, performance of implants, tissue response to implants, interfacial phenomena, safety and efficacy testing

Module 2
Metallic and Ceramic materials: Stainless steels, Co-Cr alloys, Ti-based alloys, Nitinol, biological tolerance of implant metals, ceramic implant materials, alumina, yittria stabilized zirconia, hydroxyapatite glass ceramics carbons, restorable ceramics, composites

Module 3
Polymeric implant materials: Polymers in biomedical use, polyethylene, polypropylene, acrylic polymer, hydrogels, polyurethane, polyamides, biogradable synthetic polymers, silicon rubber, micro-organisms in polymeric implants, polymer sterilization

Module 4
Dental Materials: Tooth composition and mechanical properties, impression materials, bones, liners, and varnishes for cavities, filling and restorative materials, oral implants, use of collagen in dentistry

Module 5
Cardiovascular and Orthopaedic implants: Artificial heart, aorta and valves, geometry of circulation, vascular implants, cardiac pace makers, bone composition and properties, fracture healing, joint replacement, knee joint repair, bone regeneration with restorable materials

Module 6
Tissue Engineering Materials and Regeneration: Substrate scaffolds materials, cellular aspects, viability, stem cells, bladder regeneration, cartilage regeneration, skin regeneration, regeneration in cardiovascular system

Module 7
Tissue response to implants: Normal wound healing process, body response to implants, blood compatibility, carcinogenicity

Module 8:
Degradation of Materials in the biological environment: Chemical and biochemical degradation of polymers, degradation effects on metals and ceramics, pathological classification of biomaterials

Module 9:
Case studies: Selection and design of biomaterials, implant and device failures

Suggested Books:

Sl. No.	Name of Authors/Books/Publisher	Year of Publication/ Reprint
1	Park J.B. and Bronzino J.D., Biomaterials: Principals and Applications, CRC Press	2003
2	Park J.B., Biomaterials Science and Engineering, Springer Press	1984
3	Rattner B.D., Hoffman A.S, Schoen F.J., Lemons J.E., Biomaterials Science: An Introduction to Materials in Medicine, Academic Press	2004
4	Park J.B. and Lakes R.S., Biomaterials: An Introduction, 3rd edition, Springer press	2007
5	Bhat, S.V., Biomaterials, 2nd edition, Narosa Publishing	2006

<table>
<tr><td rowspan="3">Subject: Nano- Materials (Code: MMT 017)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes:
After completing the course, the student should be able-

- **C01:** To understand the thermodynamics and kinetics of nanostructured materials
- **C02:** To understand the processing and characterization of nanostructured materials
- **C03:** To understand the deformation behaviour of nanomaterials

Details of Course:

Module 1:
Nanomaterials: Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials

Module 2:
Thermodynamics and kinetics of nanostructured materials: Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials

Module 3:
Processing: Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique

Module 4:
Structural characteristics: Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; Grain size, phase formation, texture, stress analysis

Module 5:
Deformation Behavior: Elastic and plastic deformation, mechanisms of plastic deformation-lattice dislocation motion, evolution of grain boundary defect structures, comparison between deformation mechanisms and effect of grain size distribution, grain boundary sliding and triple junction migration, triple junction diffusion, abnormal Hall-Petch effect dependence, localization of plastic flow and rotational plastic deformation in nanostructured materials. Nanoindentation techniques**-** principles and measurement of elastic and plastic properties of nanomaterials

Module 6:
Case studies: Design issues and applications of nanomaterials in various industries

Suggested Books:

Sl. No.	Name of Authors/ Books/ Publisher	Year of Publication/ Reprint
1	Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley	2003
2	Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers	2004
3	Koch C.C., Nanostructured Materials: Processing, Properties and Applications, William Andrew	2006
4	Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley	2008
5	Wang Z.L., Characterization of Nanophase Materials, Wiley	2000
6	Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer	2004
7	Fischer A.C., Nanoindentation, Springer	2002

<table>
<tr><td rowspan="3">Subject: Marketing Management
(Code: HST 018)</td><td rowspan="3" colspan="2">Year & Semester: B. Tech Metallurgical and Materials Engineering
4^{th} Year & 8^{th} Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

The course is an introduction to the language and issues of marketing with an emphasis on learning to develop responsive marketing strategies that meet customer needs. The course focuses on basic marketing concepts, the role of marketing in the organization, and the role of marketing in society. Topics include market segmentation, product development, promotion, distribution, and pricing. Further the course outlines marketing concepts related to external environment (which will focus on integrative topics with marketing, such as economics, politics, government, and nature), marketing research, international/global marketing with relevance to cultural diversity, ethics, the impact of technology on marketing, and careers inmarketing.

Course Objectives:

Upon successful completion of this course, the learner will be able:

- To analyze the role of marketing within the firm and society.
- To expose you to the two parts of a marketing strategy: the target market and themarketing mix.
- To study the four basic variables in the marketing mix: product, promotion, price, and distribution.
- To exercise analytical, communication, and presentation skills (through use of technological aids, such as

Module	Topic(s)	Learning Outcomes
1	**Marketing: Creating and Capturing Customer Value Company and** **Marketing Strategy: Partnering to Build Customer Relationships**	1. Define marketing and outline the steps in the marketing process. 2. Explain the importance of understanding customers and the marketplace, and identify the five core marketplace concepts. 3. Identify the key elements of a customer-drive marketing strategy and discuss the marketing management orientations that guide marketing strategy. 4. Discuss customer relationship management, and identify strategies for creating value for customers and capturing value from customers in return. 5. Describe the major trends and forces that are changing the marketing landscape in this age of relationships. 6. Explain companywide strategic planning and its four steps. 7. Describe the elements of a customer-driven marketing strategy and mix, and the forces that influence it. 8. List the marketing management functions, including the elements of a marketing plan, and discuss the importance of measuring and managing return on marketing.
2	**Analyzing the Marketing Environment** **Managing Marketing Information to Gain Customer Insight** **Consumer Markets and Consumer Buyer Behavior**	1. Describe the environmental forces that affect the company’s ability to serve its customers. 2. Explain how changes in the demographic and economic environments affect marketing decisions. 3. Identify the major trends in the firm’s natural and technological environments. 4. Explain the key changes in the political and cultural environments. 5. Discuss how companies can react to the marketing environment. 6. Outline the steps in the marketing research process 7. Explain how companies analyze and use marketing information 8. Discuss the special issues some marketing researchers face, including public policy and ethics issues. 9. Define the consumer market and construct a simple model of consumer buyer behavior.

		10. Name the four major factors that influence consumer buyer behavior.
3	**Customer Driven Marketing Strategy: Creating Value for Target Customers** **Products, Services, and Brands: Building Customer Value**	1. .Define the four major steps in designing a customer-driven marketing strategy: market segmentation, market targeting, differentiation, and positioning 1. List and discuss the major bases for segmenting consumer and business markets 2. Explain how companies identify attractive market segments and choose a market targeting strategy 3. Discuss how companies differentiate and position their products for maximum competitive advantage in the marketplace. 4. Discuss branding strategy—the decisions companies make in building and managing their brands 5. Identify the four characteristics that affect the marketing of a service and the additional marketing considerations that services require
4	**New Product Development and Product Life-cycle Strategies** **Pricing: Understanding and Capturing Customer Value**	1. Explain how companies find and develop new-product ideas. 2. List and define the steps in the new-product development process and the major considerations in managing this process. 3. Describe the stages of the product life cycle and how marketing strategies change during the product's lifecycle. 4. Answer the question "What is price?" and discuss the importance of pricing in today's fast changing environment. 5. Discuss the importance of understanding customer value perceptions when setting prices. 6. Discuss the importance of company and product costs in setting prices. 7. Identify and define the other important external and internal factors affecting a firm's pricing decisions.
5	**Price Strategies** **Marketing Channels: Delivering Customer Value**	1. Describe the major strategies for pricing imitative and new products. 2. Discuss the key issues related to initiating and responding to price changes.

	Retailing and Wholesaling	3. Explain why companies use marketing channels and discuss the functions these channels perform 4. Discuss how channel members interact and how they organize to perform the work of the channel alternatives open to a company 5. Explain how companies select, motivate, and evaluate channel members 6. Explain the role of retailers in the distribution channel and describe the major types of retailers. 7. Describe the major retailer marketing decisions.
6	**Communicating Customer Value: Integrated Marketing Communication s Strategy** **Advertising and Public Relations** **Personal Selling and Sales Promotion**	1. Define the five promotion mix tools for communicating customer value. 2. Outline the communications process and the steps in developing effective marketing communications. 3. Explain the methods for setting the promotion budget and factors that affect the design of the promotion mix. 4. Define the role of advertising in the promotion mix. 5. Describe the major decisions involved in developing an advertising program. 6. Define the role of public relations in the promotion mix. 7. Explain how companies use public relations to communicate with their publics. 8. Discuss the role of a company's salespeople in creating value for customers and building customer relationships 9. Discuss the personal selling process, distinguishing between transaction-oriented marketing and relationship marketing

Suggested Readings:

1. Kotler, P., Keller, K. L., Koshy, A., &Jha, M. **Marketing Management: A South Asian Perspective**. (14th Edition)
2. Govindarajan, M. **Marketing Management**. PHI Learning Pvt. Ltd.
3. PrachiGupta,AshitaAggarwal,H.Majra,I. Jacob,V. Jain,G.R. Krishna,R. Narang, S. Venkatesh,Suresh Paul A,S. Goswami. **Marketing Management: Indian Cases**. Pearson Publishing (1st Edition)
4. Karunakaran, K. (2008). **Marketing Management**. Himalaya Publishing Hou

<table>
<tr><td rowspan="3">Subject: Block Chain
(Code: ITT 019)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year & 8th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Objectives:

- **C01:** Understanding the need for distributed systems
- **C02:** Learning basic cryptographic algorithms used in distributed systems
- **C03:** Understanding the basics of blockchain technology
- **C04:** Studying and evaluating various consensus algorithms
- **C05:** Studying various applications of Blockchain

Unit I - Basics:
Distributed Database, Two General Problem, Byzantine General Problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete.

Unit II - Cryptography:
Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.

Unit III - Blockchain:
Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain.

Unit III - Distributed Consensus:
Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.

Unit IV - Cryptocurrency:
History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin • Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects - Cryptocurrency Exchange, Black Market and Global Economy.

Unit V - Blockchain Applications:
Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain.

References:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder,

Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
2. Wattenhofer, The Science of the Blockchain
3. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies
4. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System
5. DR. Gavin Wood, “ETHEREUM: A Secure Decentralized Transaction Ledger,”Yellow paper.2014.
6. Nicola Atzei, Massimo Bartoletti, and TizianaCimoli, A survey of attacks on Ethereum smart contracts

<table>
<tr><td rowspan="3">Subject: Major Project
(Code: MMP 454)</td><td rowspan="3">Year & Semester: B. Tech Metallurgical and Materials Engineering
4th Year &8th Semester</td><td colspan="3">Total Course Credit: 10</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>15</td></tr>
<tr><td>Evaluation Policy</td><td></td><td colspan="3"></td></tr>
</table>

Course Outcome:

The student should be able to perform an industrial **project** or applied research linked to the discipline of MME.

Details:

Final project report will be submitted by each student after making a presentation of his results/findings etc., before his/her supervisor and other faculty members. Final assessment of his/her project work will be done on the basis of a viva-voce examination by an external examiner.

Subject: Laboratory Practice in Composite Materials (Code: MML 455)	**Year & Semester: B. Tech Metallurgical and Materials Engineering 4th Year &8th Semester**	**Total Course Credit: 1**		
		L	T	P
		0	0	2
Evaluation Policy	Mid-Term/Class Assessment (40 Marks)	Final-Term (60 Marks)		

Course Outcomes: The student should be able:

C01: To be able to fabricate various composites
C02: To be able to characterize the composites

List of Experiments

8. Fabrication of metal matrix composites using stir casting method.
   a. in-situ (eg.: add iron oxide $MgAl_2O_4$, Al_2O_3andMgO in Al)
   b. ex-situ (Al matrix – add $SiC/SiO_2/Al_2O_3$, etc, particles)
   c. Characterization:
      i. hardness
      ii. wear behaviour
9. Fabrication of polymer matrix composites using hand lay-up method, etc.
   a. Effect of fiber loading (wt.%) on the mechanical properties of the composite
      i. Tensile strength
      ii. Impact
      iii. Hardness
      iv. Flexural strength