REVISED SCHEME OF COURSES
FOR 2-YEAR M.TECH.PROGRAMME
IN
WATER RESOURCE SENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR
(FOR 2021 BATCH ONWARDS)

REVISEDSCHEME

For

POST GRADUATE PROGRAMME

(MasterofTechnology)

IN

WATER RESOURCES ENGINEERING

(EFFECTIVE FROM: 2021 BATCH)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

HAZRATBAL, SRINAGAR, KASHMIR, J&K, INDIA-190006

DEPARTMENT OFCIVIL ENGINEERING
NATIONALINSTITUTE OFTECHNOLOGY SRINAGAR, J&K-190006

COURSESTRUCTUREAND SYLLABUSFOR

M.TECH.INWATERRESOURCESENGINEERING

SEMESTER –I:AUTUMN SESSION

S.NO.	Course No.	Subject	L	T	P	Credits
1	MTHM-101	Applied Statistics	3	1	0	3
2	CWE-101	Hydrologic Elements and Analysis	3	1	0	3
3	CWE-102	Advanced Fluid Mechanics	3	1	0	3
4	CWE-103	Lab-1	0	0	3	1
5	**Elective-I**		3	1	0	3
	CSE- 106	Construction Techniques and Management.				
	CWE-111	Programming in Hydrology				
	CWE-112	Water Management				
	CWE-113	Water Power Engineering				
	CWE-114	Hydrometeorology and Climate Change				
6	**Elective-II**		3	1	0	3
	CSE-103	Advanced Concrete Technology				
	MTHM-104	Numerical Methods				
	CWE-121	River Engineering				
	CWE-123	Urban Hydrology				
Total Credits						**16**

L–Lecture– Tutorial/Seminar, P – Practical/Studio work

SEMESTER –II:SPRINGSESSION

S.NO.	Course No.	Subject	L	T	P	Credits
1	CWE-201	Water Resources Systems	3	1	0	3
2	CWE-202	Open Channel Flow	3	1	0	3
3	CWE-203	Ground Water Hydrology	3	1	0	3
4	CWE-204	Lab-2	0	0	3	1
5	CWE-205	Seminar	0	0	4	1
6	**Elective-III**		3	1	0	3
	CWE-211	Embankment Dams				
	CWE-212	Contaminant Transport in Natural Systems				
	CWE-213	GIS & Remote Sensing Applications in Civil Engineering				
	CGE- 202	Advanced Foundation Engineering.				
	CWE-214	Flood Forecasting				
7	Elective-IV		3	1	0	3
	CWE-221	Computational Fluid Dynamics				
	CWE-222	Environmental Impact Assessment				
	CSE- 201	Finite Element Methods in Civil Engineering				
	CWE-223	Stochastic Hydrology				
	CWE-224	Rural Water Supply and Sanitation				
Total Credits						**17**

L–Lecture– Tutorial/Seminar, P – Practical/Studio work

SEMESTER –III: AUTUMN SESSION

S.NO.	Course No.	Subject	L	T	P	Credits
1	CWE-301	Water Quality and Environment	3	1	0	3
2	CWE-302	Hydraulic Structures	3	1	0	3
3	CWE-303	Dissertation(Stage I)	0	0	0	7
4	CWE-304	Field Visit and Data Collection	0	0	0	2
Total Credits						**15**

L–Lecture– Tutorial/Seminar, P – Practical/Studio work

SEMESTER –IV: SPRING SESSION

S.NO.	Course No.	Subject	L	T	P	Credits
1	CWE-401	Dissertation (Stage II)	0	0	0	12
Total Credits						**12**

Grand Total of Credits = 60

Evaluation:

Attendance & Class performance :

10%Midterm Examination : 30%

End term Examination : 60%

DISSERTATION

Thedissertationinvolvesadetailedstudyofa WaterResourcesrelated,problem(actualfield/Research)w hichastudenthastocarryoutunderthesupervisionofoneofthefaculty members of the Department.

FIELD VISIT AND DATA COLLECTION

The students shall have to visit an industrial / research based project in field and then submit a report and appear in a viva-voce examination / presentation in 3rdsemester. The student will be evaluated based on the quality of information and data that is collected during the visit. The aim is to acquaint the student with real life projects and develop professional skill set of the student. The evaluation shall be conducted by a departmental committee.

Part-time students will be eligible to take up the 3rdsemester regular in their 5th semester, only when they have successfully completed the first and 2nd semesters.

NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR
SYLLABUS FOR M.TECH IN WATER RESOURCES ENGINEERING

1ST SEMESTER

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **MTHM-101** Course Title: **Applied Statistics**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Autumn**
7. Pre-requisite : **Nil**
8. Objective: To impart understanding of various statistical and probabilistic techniques required in the water resources applications.
9. Details of Course:

S. No.	Contents	Contact Hours
1	Basic Concepts of Probability Theory: Probability, Random variables, Moments, Moment generating functions, Standard distributions, Two dimensional random variables ,Central limit theorem.	10
2	Estimation Theory	6
3	Principle of least squares – Regression and Correlation (Multiple and Partial),	6
4	Estimation of parameters – Maximum likelihood estimates – Method of moments.	4
5	Testing of Hypothesis	4
6	Sampling distributions – Tests based on normal. , chi-square and F-distributions , Analysis of variance – One way and two way classifications.	6
	Total	**36**

10. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Fruend, John, E., and Miller Irwin, Probability and Statistics for Engineers, Prentice Hall.	1980
2	Bhat U.N. Elements of Applied Stochastic Processes, Wiley Series in Probability and Mathematical Statistics, Second Edition.	1984
3	Anderson, O. D. and Perryman M.R. Time Series Analysis, North-Holland, Amesterdam.	1981
4	Anderson, O. D. Time Series Analysis, Theory and Practice I. North-Holland Amsterdam.	1982
5	Srinivasan, S. K. , and Mehata, K.M. Probability and Random Processes, Tata Mc Graw Hill.	1981
6	John, B. , Kennedy and Adam, M. Neville, Basic Statistical Methods ; Harper and Row Publishers, New York.	1986
7	Laplace Transform (Schaum Series) by Spiegel	

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-101** Course Title: **Hydrological Elements and Analysis**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Autumn**
7. Pre-requisite : **Nil**
8. Objective: To impart skills in fundamentals of hydrology, analysis and correlation of hydrological data and hence impart understanding of various principles and their applications in solving the real engineering problems encountered by water recourses planners and managers.

9. Details of Course:

S.No	Contents	Contact Hours
1.	INTRODUCTION: Historical background, hydrological cycle, hydrologic problems, water balance.	2
2.	Precipitation: Definition, types, forms, measurement – network design, Non-recording and recording (automatic) precipitation gauges. Analysis of data , Supplementing missing data, consistency of record, hyetograph, mass curve analysis, depth areas duration analysis. Rainfall frequency analysis, Station year method.	7
3.	Evapotranspiration: Evaporation, transpiration, evapotranspitation, Factors affecting, measurement, network design, estimation of evaporation and -evapotranspiration, Evaporation retardation..	3
4.	Infiltration: Infiltration capacity, rates and indices, factors affecting, measurement of infiltration, estimation of infiltration capacity from hydrograph analysis. Infiltration models.	5
5.	Hydrometry: Measurement of discharge, selection of site for stage and discharge measuring station non-recording and recording gauges, Accuracy and frequency of observed data, discharge measurement by area Velocity method and slope area method , Chemical methods.	3
6.	Runoff: Runoff, runoff cycle, components of runoff, factors affecting runoff, storage effects of runoff from snowmelt, Estimation of average monthly and annual runoff, rainfall - runoff relationships.	3
7.	Hydrograph and its components: Master recession curve, Base flow and its separation , Unit hydrograph theory and its application for isolated and complex storms , Synthetic unit hydrograph, S- curve, Unit hydrograph of varied durations, Instantaneous unit hydrograph, conceptual models.	7
8.	Computation of peak flow: Rational and Empirical relationships, Flood frequency analysis, Recurrence interval design flood.	3
9.	Flood routing: Routing through reservoirs.	3
Total		36

10. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Chow, Ven Te, 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 Ven Te," 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
8	Patra K.C. "Hydrology and water resources engineering" second edition Narosa Publishing House New Delhi	2008.

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-102** Course Title: **Advanced Fluid Mechanics**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Autumn**
7. Pre-requisite : **Nil**
8. Objective: To impart the knowledge of various aspects of fluid flow and applications.
9. Details of Course:

S. No.	Contents	Contact Hours
1	Equations of motion in general orthogonal coordinate systems: Derivation of Navier- Stoke's equations.	5

2	Dimensional analysis	5
3	Laminar Flow : Laminar flow between parallel plates- Plain-Poiseulle and Couette flow, Laminar flow through closed conduits, Lubrication mechanics.	6
4	Boundary layer theory – Laminar boundary layer, turbulent boundary layer; stability analysis of the boundary layer	6
5	Turbulence: Introduction, description by statistical methods, Phenomenological method, Measurement of Turbulence, scale and spectrum, Turbulence intensity RMS value, Laser-Doppler principle.	6
6	Diffusion	5
7	Fluid Machinery:	5
Total		**38**

10. Suggested Books:

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication**
1.	White, F.M. Fluid Mechanics. Mc Graw Hill	
2	Daiy and Harleman ; Fluid Dynamics , Edison Wesely , New York.	1973
3	R.A. Granger; Fluid Mechanics, Dover Publications, New York.	1995
4	Kundu, P.K.; Cohen I.M. Fluid Mechanics. ELSEVIER	2008
5	Graebel, W.P. Advanced Fluid Mechanics. ELSEVIER	2007
6	Fox R.W. and McDonald A.T. Introduction to Fluid Mechanics, John Wiley & Sons Inc.	2004

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-103** Course Title: **Lab-1**
2. Contact Hours **L : 0** **T: 0** **P : 3**
3. Examination Duration (Hrs.) : **Mid term** **1** **End term** **1**
4. Relative Weightage : **Mid Term** **50** **End Term** **50**
5. Credits : **1**

6. Semester : **Autumn**

7. Pre-requisite : **Nil**

8. Objective: To impart understanding of measurement of various fluid flow and weather parameters.

9. Details of Course:

S. No.	Contents	Contact Hours
1	To determine the infiltration rate of a particular plot of land using double ring infiltrometer, and construct infiltration capacity curves.	3
2	To study the variation of meteorological parameters, such as, air temperature, relative humidity, wind speed and wind direction using thermohygrometer and anemometer.	3
3	To study the variation of hydrological parameters, such as, water level and water temperature/ conductivity in a bore well., using water level recorder.	3
4	Free vortex experiment.	1.5
5	Forced vortex experiment.	1.5
6	Reynold's Experiment.	1.5
7	Flow visualization experiment.	1.5
8	Performance characteristics of turbines and Pumps.	3
Total		**18**

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CSE-106 (ELECTIVE)** Course Title: **Construction Techniques and --- Management**

2. Contact Hours **L : 2** **T: 1** **P : 0**

3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**

4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**

5. Credits : **3**

6. Semester : **Spring**

7. Pre-requisite : **Nil**

8. Objective: To impart understanding related to various techniques and management aspects of Civil Engineering constructions.

9. Details of course:

S.No	Contents	Contact Hours
1.	Construction planning-Construction facilities, Schedules, Layout of Plant utilities	6
2	Construction methods: Excavation and handling of Earth and Rock	8
3	Production and handling of Aggregartes and Concrete , cooling of concrete in dams	8
4	Drainage treatment of aquifers/sub-terrainean reservoirs	8
5	Construction control and management-CPM/PERT, Human Factors, Organisation.	6
Total		**36**

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	Peurifoy, R.L. and Ledbetter, W.B.; Construction Planning ,Equipment and Methods, McGraw Hill Singapore.	1986.
2	Robertwade Brown; Practical Foundation Engineering Handbook, McGraw Hill Publications.	1995
3.	Joy, P.K.; Total Project Management- The Indian Context, New Delhi, MacMillan India Ltd.	1992
4.	Uliman, John.E, et al; Handbook of Engineering Management, Wiley, New York.	1986
5.	Neville, A.M.; Properties of Concerte, Pitman Publishing Ltd.,London.	1978

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-111 (ELECTIVE)** Course Title: **Computer Applications**

2. Contact Hours **L : 2** **T: 1** **P : 0**

3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**

4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**

5. Credits : **3**

6. Semester : **Autumn**

7. Pre-requisite : **Nil**

8. Objective: To impart the understanding of a computer programming language and preparation of algorithms.

9. Details of Course:

S. No.	**Contents**	**Contact Hours**
1	Introduction: Digital Computer Systems, problem solving techniques, introduction to programming languages, computer language and C++, source programme, Compilation and debugging.	6
2	C++ Programming Basics: Using Turbo C++ , Basic program construction, preprocessor directive, #include, #define, Header and Library functions, Keywords, INPUT-OUTPUT Statements, comments, Constants, Variables, and operators, Formatting statements, ENDL and SETW manipulators.	6
3	Loops, Decision and Arrays: WHILE, DO-WHILE and FOR loops, general structure and control. IF, IF-ELSE statements, SWITCH, BREAK, CONTINUE statements, GOTO and labels, ARRAY fundamentals, types, use and manipulation of 2-D arrays as Matrices.	6
4	FUNCTIONS: Concept of modularization of structured programming. Basics of functions, their types declaration, definition and structure.	4
5	Object Oriented Programming Concept: General concepts of Object Oriented Programming , Objects and Classes, Member Functions , user defined data , Pointers ,etc.	6
6	File Processing: Streams , String I/O, Character I/O, Object I/O, input-output with Multiple objects, File Pointers, Disk I/O with Member Functions, Error Handing, Printer Output.	5
7	Practical Applications: Programming for mathematical models of Civil Engineering problems and Management information systems, use of general purpose programmes.	5
	Total	**36**

10. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Lafore, Robert . Object Oriented Programming with C++	
2	Panday, S.K. Object Oriented Programming with C++	

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-112 (ELECTIVE)** Course Title: **Water Management**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Autumn**
7. Pre-requisite : **Nil**
8. Objective: To impart understanding of various aspects related to supply and management of water for irrigating agricultural lands.
9. Details of Course:

S.No	Contents	Contact Hours
1.	Moisture –crop relationship	4
2.	Irrigation requirements, Irrigation efficiencies (Conveyance losses lined/unlined channels).	4
3.	Trickle, sprinkler and furrow irrigation. of arid lands. Drainage of irrigation land, Design aspects of these irrigation systems.	5
4.	Salinity of soil. Salinity control. Quality of irrigation water ; contaminants and their effect on various crop types.	6
5.	Operation of reservoirs	8
6.	Water management Policy during droughts. Predicting effect of water shortages on crops. Planning of water resources projects, Application of Nano-technology in Irrigation Engineering.	6
	Total	33

10. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Hansen, V.E. et al.; Irrigation Principles and Practice, John Willey and Sons, inc. New York.	1980
2	Michael A.M. Irrigation-Theory and Practice, Vikas Publishing House, New Delhi.	1990
3	Richard H. Cuenca; Irrigation System Design – An Engineering Approach, prentice hall Inc. New Jersy,.	1986
4	Zimmerman J.D.; Irrigation, John Wiley and Sons Inc. New York	1986
5	Asawa, G.L. ; Irrigation and Water Resources Engineering, New Age International (P) Ltd. Publishers.	2005

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-113 (ELECTIVE)** Course Title: **Water Power Engineering**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Autumn**
7. Pre-requisite : **Nil**
8. Objective: To impart the knowledge for understanding of various aspects of hydropower development. To familiarize the students with the various types of Civil Engineering structures used in hydropower development and design aspects of some of them.

9. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction: Hydropower development, power equation, assessment of potential, comparison of hydro thermal and nuclear power plants	2
2	Classification - High, Medium and Low Head schemes - Run off river plants - Storage power station - Tidal power plant - Recent experiences in wave power development - Underground power plants - Pumped storage schemes - Small and mini Hydropower systems - Power demand - Role of Hydropower in a grid.	3
3	WATER CONVEYANCE SYSTEM: Power Canals, Alignment, Design of Power canals, Flumes, Covered conduits and Tunnels. Penstocks- Alignment, types of penstocks, Economic Diameter of penstocks, Anchor blocks.; Water hammer, Surge Tanks.	6
4	DAMS: Selection of site, Preliminary Investigations, Final Investigations, Types of Dams- Rigid Dams :- Gravity dams, Arch and buttress dams, Basic principles of design and details of construction.	6
5	EMBANKMENT DAMS: Earthen dams, rockfill dams, Design considerations.	5
6	SPILLWAYS : Types, Spillway gates, Design of stilling basins.	5
7	POWER HOUSE DETAILS: Forebay, Intakes, General layout of power house and arrangement of hydropower units; underground Power stations.	3
8	TRANSMISSION SYSTEMS: General introduction	2
9	Economic and Financial feasibility of Hydro Power plants.Small Hydropower Developments.	4
Total		**36**

10. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Barrows, H.K."Water Power Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi.	1999
2	Nigam, P.S. " Handbook of Hydroelectric Engineering" Nem Chand & Brothers, India.	1985
3	Sharma, Dandekar, M.M. " Water Power Engineering" , Vikas Publishing House, Gaziabad, U.P. India.	1985
4	Deshmukh, M.M. "Water Power Engineering", Danpat Rai & Sons, Nai Sarak, Delhi.	2002
5	Varshney, R.S. "Hydropower Structures", Nem Chand Brothers, Roorkee,.	2001

6	Arora, K.R. " Irrigation water power and Water Resources Engineering", Standard Publishers Distributors, Delhi.	2002
7	Das, M.M Saikia, M.S Irrigation and water Power Engineering. PHI Learning. Pvt. Ltd.	2009
8	Brown, G,, Hydroelectric Engineering Practice, CPS,.	1984
9	Creager and Justin, Hydro electric Hand Book, John Wiley.	1950

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-114 (ELECTIVE)**
2. Course Title: **Hydrometeorology and Climate Change**
3. Contact Hours **L : 2** **T: 1** **P : 0**
4. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
5. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
6. Credits : **3**
7. Semester : **Autumn**
8. Pre-requisite : **Nil**
9. Objective: To introduce the principles of atmospheric science for understanding impact of climate change.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Atmosphere: General circulation, composition and structure of atmosphere, role of meteorology in hydrology	4
2.	Precipitation Process: Adiabatic process, stability and instability of atmosphere	2
3.	Atmospheric Thermodynamics: Equation of state, Dalton's law of partial pressure, Poisson's law, equivalent potential temperature, concept of air parcel, virtual temperature, dry adiabatic lapse rate and saturated adiabatic lapse rate, hydrostatic equilibrium equation, dispersion of air pollutants	6
4.	Clouds: Classification, formation and characteristics,Monsoon circulation, monsoon troughs, monsoon depression and tropical cyclones	4

5.	Climate and Climate Change: Components, Phenomena, radiative forces, Energy budget and transport, atmospheric circulation, ocean circulation, land-surface process, carbon cycle	6
6.	Physical processes:Conservation of momentum, equation of state, temperature equation, continuity equation, conservation of mass	2
7.	Climate Models: Introduction to GCM and RCM simulations, SRES, downscaling GCM outputs	6
8.	ENSO: El Niño basic, Tropical pacific climatology, El Niño mechanism, ENSO indices, predictions and teleconnections	3
9.	Greenhouse effects and climate feedbacks:Global energy model, greenhouse effect and global warming, climate feedback	3
10.	Climate Model scenarios for global warming: Greenhouse gases, aerosols forcing, global-average response to GhG warming scenarios on temperature, rainfall, sea, ice/snow, extreme events	6
	Total	42

11. Suggested Books:

S. No.	Name of Authors/ Books / Publisher	Year of Publication/ Reprint
1.	Assessment Report 5, IPCC, WMO	2014
2.	David, J., "Climate change and Climate modelling", Cambridge University Press.	2011
3.	Shelton, ML, "Hydroclimatology", Cambridge University Press.	2009
4.	Singh, V.P. and Rakhecha, P. Book, Applied Hydrometeorology	2009
5.	Cotton R and Pielke RA, Human Impacts on Weather and Climate, Cambridge University Press.	2007
6.	Wallace, J.M. and Hubbs, P.V., "Atmospheric science – An Introductory Survey", Academic Press	1977
7.	Donn , W.,"Meteorology",Mc Graw Hill	1975
8.	Berry I.A., "Handbook of Meteorology", Mc Graw Hill	1973

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CSE-103 (ELECTIVE)** Course Title: **Advanced Concrete Technology**

2. Contact Hours **L : 2** **T: 1** **P : 0**

3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**

4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**

5. Credits : **3**

6. Semester : **Autumn**

7. Pre-requisite : **Nil**

8. Objective: To impart the understanding of various aspects of concrete as used in Civil Engineering works.

9. Details of Course:

S. No.	**Contents**	**Contact Hours**
1	Concrete Making Materials: Aggregates – Classification, IS specifications, Properties, Grading, Methods of combining aggregates, specified gradings, Testing of aggregates.	6
2	Chemical compoisition, Hydration of cement, structure of hydrated cement, special cements, water chemical admixtures.	4
3	Concrete: Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and Shrinkage, Variability of concrete strength.	5
4	Mix Design: Principles of concrete mix design, Methods of concrete mix design, Testing of concrete.	6
5	Special Concretes: Light weight concrete, Fibre reinforced concrete, Polymer concrete, Super plasticized concrete, Properties and applicatons.	7
6	Concreting Methods: Process of manufacturing of concrete, Methods of Transportation, placing and curing. Extreme weather concreting, Special concreting methods.	8
Total		**36**

10. Suggested Books:

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication**
1.	Neville, A.M., Properties of Concrete, Pitman Publishing Ltd. London.	1978
2	Shetty, M.S., Concrete Technology, S. Chand and Company Ltd. Delhi.	1991
3	Rudhani,G., Light Weight Concrete, Academic Kiado Publishing Home of Hungarian Academy of Sciences.	1963

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **MTHM-104 (ELECTIVE)** Course Title: **Numerical Methods**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Autumn**
7. Pre-requisite : **Nil**
8. Objective: To impart the understanding of various numerical techniques used in solving mathematical problems.
9. Details of Course:

S. No.	**Contents**	**Contact Hours**
1	Numerical analysis, finite differences, interpolation, numerical solution of algebraic and transcendental equations, iterative algorithms, convergence, Newton-Rapson procedure	8
2	Solution of polynomial and simultaneous linear equations	4
3	Numerical integration, Euler-Maclaurin formula, Newton-Cotes formula, error estimates	5
4	Numerical solutions of ordinary differential equations: method of Euler, Taylor, Adams Runge-Kutta and predictor-corrector procedures, stability of solution, solution of boundary value problems, finite differences techniques, stability and convergence of solution, finite element method.	10
5	Special functions. Legendre's special function, Rodrigue's formula, generating functions for Legendre's polynomials and recurrence formulae, Bessel's function, recurrence formulae, Bessel's function of integral order.	9
Total		**36**

10. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Numerical methods for Scientists and Engineers by M.K. Jain, S.R. Iyengar & R.K. Jain, Wiley Eastern Ltd.	
2	Mathematical Numerical Analyis By S.C. Scarborough, Oxford and IBH Publishing Company.	
3	Introductory methods in Numerical Analysis by S.S. Sastry, Prentice Hall of India.	
4	Theory and problems in Numerical Methods by T. Veeranjan and T. Ramachandran, Tata McGraw-Hill Publishing Company, New Delhi.	2004.
5	Numerical Methods for Mathematics Sciences and Engineering 2nd ed. By John H. Mathews, Prentice Hall of India, New Delhi.	2003
6	Advanced Engineering Mathematics by R.K. Jain & S.R.K. Iyengar, Narosa-.	2001

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-121 (ELECTIVE)** Course Title: **River Engineering**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Autumn**
7. Pre-requisite : **Nil**
8. Objective: To impart understanding of various aspects related to flow of water and sediments through natural and artificial channels and design aspects thereof.
9. Details of Course:

S.No	Contents	Contact Hours
1.	Introduction to sediment and Fluvial hydraulics, nature of problems	2
2.	Origin and properties of sediments	3

3.	Incipient motion of sediment particles	3
4.	Regimes of flow	3
5.	Resistance equations	4
6.	Bed load computations	4
7.	Suspended load and total load transport- computations of	6
8.	sediment samplers	2
9.	Design of Stable alluvial channels	3
10	Alluvial streams and their hydraulic geometry	2
11	Variation in plan form of streams	2
12	Alluvial river models	4
	Total	38

10. Suggested Books:

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication**
1.	Garde, R.J. and RangaRaju, K.G.; Mechanics of Sediment Transport and Alluvial Stream Problems, New Age International Publications Pvt. (Ltd.)	2000
2	C.T Yang; Sediment Transport Theory and Practice, McGraw Hill Companies Inc.	1996
3	F.M.Henderson, Open Channel Flow, MacMillan, New York,	1996
4	H.H.Chang; Fluvial Processes in River Engineering, John Wiley.	1988

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-122 (ELECTIVE)**
2. Course Title: **Urban Hydrology**
3. Contact Hours **L : 2** **T: 1** **P : 0**
4. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
5. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
6. Credits : **3**
7. Semester : **Autumn**
8. Pre-requisite : **Nil**

9. Objective: To study the process of urbanization and its influence on urban hydrological processes and urban water supply system including, storm water modeling.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Urbanization process, urban planning, landuse/landcover changes, hydrological impacts of urbanization	5
2.	Urban hydrologic cycle and processes, rainfall analysis, IDF Curves and design storm computation,	8
3.	Urban runoff computations; Abstractions, Rational Method, Computation of overland flow at design point, empirical methods, SCS method, time-area and unit hydrograph approaches, Stream flow routing	8
4.	Guidelines for the design of Urban drain and other structure	6
5.	Storages inside urban areas, storm run-off, piped and open channel drainage, mixed transport of storm and waste water	3
6.	Urban water supply; Estimate of demand, sources of surface and ground water, potable water quality	4
7.	Urban flood modelling using urban hydrologic models namely SWMM and MOUSE	6
8.	Rain water harvesting	2
	Total	42

11. Suggested Books:

S.No.	Name of Authors/ Books / Publisher	Year of Publication/ Reprint
1.	Iyyer, M.J., "Urban Water Supply and Sanitation A Management Perspective", ICFAI University Press	2008
2.	Shamsi, U.M., "GIS Applications for Water, Wastewater, and Stormwater Systems", CRC Press	2005
3.	Debo,T.N and Reese, A., "Municipal Stormwater Management", 2nd Edition, CRC Press	2002
4.	Twort, A.C. and Ratnayaka, D.D., "Water Supply", 5th Edition, Butterworth-Heinemann	2001
5.	James, W., "Advances in Modeling the Management of Stormwater Impacts", CRC Press	1997
6.	Akan, O.S., "Urban Stormwater Hydrology", CRC Press	1993
7.	Chow, V.T., "Applied Hydrology", Mc Graw Hill	1988
8.	Lazaro, T.R. "Urban Hydrology: A Multidisciplinary Perspective", Ann Arbor Science Publishers Inc.	1979

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SEMESTER – II

NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-201** Course Title: **Water Resources Systems**

2. Contact Hours **L : 2** **T: 1** **P : 0**

3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**

4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**

5. Credits : **3**

6. Semester : **Spring**

7. Pre-requisite : **Nil**

8. Objective: To impart know how regarding the planning and management aspects of water Resources projects.

9. Details of Course:

S.No	Contents	Contact Hours
1.	Objective of water resources development	2
2.	economic analysis and discounting techniques, conditions of project optimality	4
3.	Graphic optimization techniques for multipurpose projects, analytical optimization techniques for water resources projects by linear Programming. Nonlinear programming and dynamic programming, Optimization by simulation	13
4.	mathematical models for large scale Multipurpose projects, different case studies	5
5.	stochastic optimization Techniques, water quality subsystems	4
6.	optimum operation model for Reservoir systems by incremental dynamic programming	4
7.	sequencing of Multipurpose project	4
Total		36

10. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Arthur Mass et el., Design of Water Resources Systems, MacMillan.	1962
2	L.D. James and R.R.Lee, Economics of Water Resources Planning, McGraw-Hill New York.	1971
3	Loucks, D.P., J.R. Stedinger D.A., Haith: Water Resources ystems, Planning and Analysis, Prentice Hall.	1981
4	Biswas A.K. Systems Approach to Water Management , McGraw Hill, Kogakusha Ltd.	1976
5	Votruba L. Analysis of Water Resources Systems Elsevier.	1988

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-202** Course Title: **Open Channel Flow**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Spring**
7. Pre-requisite : **Nil**
8. Objective: To develop skills in solution of highly varied problems in gravity type natural and artificial water courses and hence impart understanding of several aspects related to development and management of surface water resources.
9. Details of course:

S.No	Contents	Contact Hours
1.	Basic Fluid Flow Concepts, Classification of channels basic equation; Uniform flow in rigid boundary channels, Shear stress and its	5

	distribution, conveyance of a channel, relation with depth	
2	Mobile boundary channels, regimes, resistance to flow, design of rigid and alluvial channels,	7
3.	Specific energy, Specific forces and Critical depth; Applications of Specific energy	7
4.	Gradually varied flow-types and governing equation, non-Prismatic channels; Hydraulic exponents, Gradually flow computations	5
5.	Hydraulic Jumps, Forced hydraulic Jump, Jump in rectangular and non-rectangular channels;	5
6.	Channel Controls and transition, Subcritical and Supercritical flow transition; Unsteady flow, Waves, Celerity of a wave, Surge, Method of characteristics, Flood Routing through channels etc.	7
	Total	36

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	V.T.Chow ; Open Channel Hydraulics, McGraw Hill Publishing Co., Inc.,	1973
2	K.Subramanaya "Open channel Flow"3rd.Tata McGraw Hill Pub.Co.New Delhi	1999
3.	Ranga Raju, K.G., "Flow Through Open Channels", 2nd.Tata McGraw Hill Publishing Company Ltd., New Delhi,1986	1999
4.	Henderson F.M; Open Channel Flow, Mac Millan Publishing Co., New York	1986
5.	Richard H.H. French; Open Channel Hydraulics, Mac Millan Publishing Co. New York, 1986	1986
6	Asawa G.L. , Flow of Fluids in Pipes and Channels, CBS Publishers and Distributors	2009

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-203** Course Title: **Ground Water Hydrology**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**

5. Credits : **3**

6. Semester : **Spring**

7. Pre-requisite : **Nil**

8. Objective: To impart understanding of different aspects of groundwater movement, exploitation, management and quality issues.
9. Details of course:

S.No	Contents	Contact Hours
1.	Occurrence of ground water types of aquifers, ground water in different formations, aquifer properties.	5
2	Ground water movement: Basic equations of steady and unsteady groundwater flow in confined and unconfined aquifers	6
3.	Well Hydraulics: mechanics of well flow into fully and partially penetrating wells in confined aquifers, leaky aquifers, unconfined aquifers, approximate solutions, multiple well systems , aquifer tests, well design criteria, ground water control.	9
4.	Techniques of artificial recharge	2
5.	solution to transit problems of ground water mounds	3
6.	theory of subsurface drainage	2
7.	stream aquifer systems	3
8.	ground water quality, Sea water intrusion into coastal aquifers	3
9.	digital and analogue models for evaluation of aquifer response	3
Total		36

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	El-Kadi A.; Ground water Models for Resource Analysis and Management, Lewis Publications, Boca Raton.	1995
2	S. Ne-Zheng; Inverse Problems in Ground water Modelling, Kluwer Academic Dordrecht.	1994
3.	USEPA; Handbook of Groundwater, Vols. I & II, Scientific Publications, Jodhpur Reprint.	1994
4.	E. Custodio(Editor); Study and Modelling of Salt water Intrusion into Aquifers, CIMNE publications, Barcelona, Spain.	1993
5.	Walton W.c.; Groundwater Modellling Utilities, Lewis Publications, Boca-Raton.	1992
6	Karanth K.R.; Groundwater Assessment Development and Management, Tata McGraw Hill New Delhi.	1990
7	R. Willis and W.W.G. Yeh; Groundwater Systems Planning and Management, Prentice Hall New Jersey.	1987

8	Todd D.K. , Groundwater Hydrology, John Wiley & Sons.	2005

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-204** Course Title: **Lab-2**
2. Contact Hours **L : 0** **T: 0** **P : 3**
3. Examination Duration (Hrs.) : **Mid-term** **1** **End-term** **1**
4. Relative Weightage : **Mid Term** **50** **End Term** **50**
5. Credits : **1**
6. Semester : **Spring**
7. Pre-requisite : **Nil**
8. Objective: To impart understanding of various fluid flow measurement in open channels
9. Details of Course:

S. No.	Contents	Contact Hours
1	To study the variation of discharge with brink depth in a laboratory flume.	3
2	To study the formation of hydraulic jump in a laboratory channel	3
3	To study the permeability of a soil sample using constant/ varying head permeameter.	3
4	To study gradually varied flow water surface profiles in a laboratory flume.	3
5	To study the velocity distribution in an open channel and to determine the energy and momentum correction factors.	3
	Total	**15**

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-211 (ELECTIVE)** Course Title: **Embankment Dams**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Spring**
7. Pre-requisite : **Nil**

8. Objective: To impart skills in solution of typical problems in embankments and hence impart understanding of several aspects related to safety criteria for embankments.

9. Details of course:

S.No	Contents	Contact Hours
1.	Introduction, Types and advantages of Embankment dams,	5
2.	Factors affecting the design of Embankment dams, safety criteria,	7
3.	Theoretical analysis of seepage through embankment and its applications, Control of seepage through embankment dams,	7
4.	Stability analysis including seismic stability	5
5.	Construction methods, Instrumentation, quality control	5
6.	Typical problems and their solutions in Embankment dams.	7
Total		36

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	Anderson, M.G. and Richards, K.S.; Slope Stability, John Wiley.	1987
	Sherard, J.L.;Woodward, R.J. Gizienski; and Clevenger, W.A.; Earth and Earth Rock Dams, John Wiley.	1963
3.	McCarthy, R.N.; Essentials of Soil Mechanics and Foundations, Prentice Hall.	1988
4.	Chowdhury, D.F.; Slope Analysis, Prentice Hall.	1988
5.	Bramhead, E.N; The Stability of Slopes, Blackey Academic and Professionals Publications, Glasgow.	1986

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NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-212 (ELECTIVE)** Course Title: **Surface water quality modeling**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Spring**
7. Pre-requisite : **Nil**
8. Objective: To impart understanding of modeling of quality of surface waters i.e., to predict the water quality behavior of surface water bodies due to discharge of waste load.
9. Details of course:

S.No	Contents	Contact Hours
1.	River hydrology and derivation of stream equation	5
2	Distributon of water quality in Estuaries. Derivation of estuary equation	4
3.	Physical and hydrologic characteristics of lakes. Finite difference steady state lake models.	6
4.	Waste load allocation principles	6
5.	Nature of inputs. Fate of indicator bacteria, pathogens and viruses in water	7
6.	Engineering control for dissolved oxygen in streams and rivers, lakes and estuaries.	8
Total		36

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	Thoman, R.V. and Mueller, J.A; Principles of Surface Water Quality Modelling and Control, Harper and Row Publishers, New York.	

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-213 (ELECTIVE)** Course Title: **GIS & Remote sensing applications in Civil Engineering**

2. Contact Hours **L : 2** **T: 1** **P : 0**

3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**

4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**

5. Credits : **3**

6. Semester : **Spring**

7. Pre-requisite : **Nil**

8. Objective: To impart understanding of basic principles of remote sensing, image processing and applications.
9. Details of course:

S.No	Contents	Contact Hours
1.	Principles of Remote Sensing: Introduction to remote sensing, Remote sensing system, electromagnetic spectrum, Black body, Atmospheric windows, spectral characteristics of earth's surface, range of sensing system.	5
2	Platforms, Sensors and Data Products: Ground aircraft, Spacecraft platforms, photographic sensors, scanners, radiometers, radar and mission planning, data types and format, scale and legend.	5
3.	Interpretation and Analysis Techniques: Multispectral, multitemporal, multisensoral, multistage concepts, photo interpretation techniques for aerial photo and satellite imagery, interpretation elements, false colour composition, etc.	11
4.	Photogrammetry: Photogrammetry- Basic application, applications of aerial photo interpretation to water resources engineering.	4
5.	Digital Analysis: Preprocessing and processing, image restoration/enhancement procedures, pattern recognition concepts, classification algorithms, post processing procedures.	5
6.	Application in Water Resources Engineering: River drainage and flood flow, watershed delineation and characteristic studies, command area mapping, drought assessment, groundwater inventory, soil moisture study, water quality assessment and monitoring, disaster management.	6
Total		**36**

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	Thomas, M. Lillisandand R.W.Kiefer; Remote Sensing and Image Interpretation, John Wiley.	1987
2	Sabins and Floyd, F.J.R; Remote Sensing Principles and Interpretation, W.H. Freeman, Sanfrancisco.	1978
3.	C. Elachi; Introduction to Physics and Techniques of Remote Sensing, New York Wiley.	1987
4.	Phillip, H. Swain and Shirley, M. Davis; Remote Sensing- The Quantitative Approach, McGraw Hill Publications.	1978
5.	Johnson, R. Jenson; Introductory Digital Image Processing, Prentice hall.	1986

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CGE-202 (ELECTIVE)** Course Title: **Advanved Foundation Engineering**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Spring**
7. Pre-requisite : **Nil**
8. Objective: To impart understanding of various aspects related to Foundations in the field of Civil Engg.
9. Details of course:

S.No	Contents	Contact Hours
1.	**a. Introduction to Foundation Engineering:** • Construction materials, engineered structures, foundation materials. • Load transfer device/interfacing element, superstructures, foundation structures/sub-structures, Need for load transfer device, objectives.	12

	• Principles of foundation Engineering, challenging problems. • Design requirements/ information needed for foundation design. • Classification of foundations (Flexible, rigid, shallow and deep foundations). **b. Terminology involved in Foundation Analysis and Design:** Gross bearing capacity, ultimate bearing capacity, net-ultimate bearing capacity, safe bearing capacity, net safe bearing capacity, safe bearing pressure, allowable bearing pressure. **c. Design Criteria for Foundation Design:** Locatoin and depth criteria, shear failure criteria (safe bearing capacity criteria), settlement criteria (safe bearing pressure criteria). **d. Factors for Selection of Type of Foundation:** Function of the structure and the loads it must carry, sub-surface condition of the soil, cost of super-structure.	
2	**Basic Design parameters for safe foundation design:** • service loads (DL, LL, WL, EQL, SL,etc and their combination and reduction factors) • safe bearing capacity • size of footing (structural design by limit state design as in case of other RC members) • soil pressure on foundation • conventional analysis of foundations subjected to vertical loads and moments • thickness of footing and its requirements • minimum reinforcement requirement (IS:456) **Bearing Capacity of Shallow foundations** 1. Bearing capacity based on the classical earth pressure theory of Rankine 2. Semi-empirical solutions based on theory of plasticity (a). Prandtl's theory (b). Terzaghi's theory (c). Meyerhof's theory (d). Brinch Hansen's theory - (e). Vesic's theory (f). Balla's theory - - (g). Skempton's theory (h). Caquot & Kerisel's theory (i). Frochlicl's theory 3. Exact methods based on theory of plasticity: (a). Sokolovski's theory (1960) (b). KO etal's (1973) Non-dimensional sol. 4. Semigraphical methods of: (a). Fellinius for clay soils, and (b). Button, Brown, Meyerhof and Vesic for two layer stratified deposits. 5. Penetration Tests (insitu-tests): (a). SPT- Standard penetration test, (b). SCPT- Static cone penetration test (c). DCPT- Dynamic cone penetration test (d). PMT- pressure meter test. (e). VST- vane shear test. (f). PLT- plate load test (Insitu- test). **Settlement of shallow foundations, Need for Raft foundations and design methods.**	14

3.	**Pile Foundations:** • Types of piles, selection and installation, behaviour of single pile under vertical load : load transfer mechanism, methods of determining ultimate load bearing capacity of a single pile (c, c-ϕ & ϕ soils)- skin resistance (straight shaft, tapered piles) point bearing capacity, vertical bearing capacity of pile groups, settlement of pile groups, effect of negative skin friction on bearing capacity. • Vertical Piles Subjected to lateral loads: • Solution for laterally loaded single pile, closed form solution for pile of infinite length, P-y curves for the solution of laterally loaded piles in sand and clay, modulous of subgrade reaction, finite difference method, • Pile groups subjected to vertical and lateral loads. • Design and construction of well foundations/caissons • Foundations on expansive and collapsible soils. • Foundation soil improvements.	10
Total		**36**

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	Kasmalkar, J.B. Foundation Engineering, Pune Vidyarthi Graha Prakashan-1786, Pune-411030.	1997
2	Bowels, Joseph E. Practical Foundation Engineering Handbook. 5th edition, McGraw-Hill, New York.	1996
3.	Das, Braja M. Principles of foundation Engineering, 4th edition, PWS publishing, Pacific Grov. Calif.	1999
4.	Peck, Ralph B., Hansen, Walter E., and Thornburn, Thomas H. Foundation Engineering. John Wiley & Sons, New York.	1974
5.	Praksh, Shamsher, and Sharma, Hari D. Pile foundation in Engineering Practice, John Wiley & Sons, New York.	1990
6	Som, N.N., and Das, S.C. Foundation Engineering: Principles and Practice. Prentice –Hall of India Pvt. Ltd. New Delhi-001.	2003
7	Varghese, P.C. Foundation Engineering Prentice –Hall of India Pvt. Ltd. New Delhi-001.	2005
8	Tomlonson, Michael J. Foundation Design and Construction. 6th edition. John Wiley & Sons, New York.	1995

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-214 (ELECTIVE)**
2. Course Title: **Flood Forecasting**
3. Contact Hours **L : 2** **T: 1** **P : 0**
4. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
5. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
6. Credits : **3**
7. Semester : **Spring**
8. Pre-requisite : **Nil**
9. Objective: To introduce the details of various methods of flood estimation, forecasting and control.
10. Details of Course:

S.No.	Contents	Contact Hours
1.	Definitions, objectives and importance of flood estimation and real time forecasting; Classification of hydrological forecasts	3
2.	Flood estimation and forecasting methods, statistical and deterministic approaches, basic concepts and formulations	4
3.	Monitoring networks;Site selection and installation of instruments, river monitoring and raingauge networks design, automatic weather stations and G and D station; Data transmission	4
4.	Meteorological forecasting and quantitative precipitation forecasting	5
5.	Graphical and statistical models for flood forecasting adopted by CWC and other operational models; Case studies	6
6.	Unit hydrograph and Soil conservation service – curve number based deterministic models for flood forecasting; Autoregrenive (AR), Moving Average (MA), Autoregrenive moving average (ARMA) models: basic concepts, formulations and updating of parameters using adaptive filter models	6
7.	Physically based models for flood forecasting;Fundamentals and overview of operational models, Choice of appropriate methods or models for flood forecasting	6
8.	Calibration and validation of forecasts, dissemination of forecast, Early warning system	4
9.	Potential applications from emerging technologies	4
	Total	42

11. Suggested Books:

Sl. No.	Name of Authors/Books/Publisher	Year of Publication/Reprint
1.	Manual on flood forecasting and warning- WMO publication no. 1072	2011
2.	Montgomery, D.C., Jennings, C.L. and Kulahci M., "Introduction to Time Series Analysis and Forecasting", John Wiley & Sons	2008
3.	Abraham, B. and Ledolter, J., "Statistical Methods for Forecasting", John Wiley & Sons	2005

4.	Maidment, D.R., "Handbook of Hydrology", McGraw Hill	1993
5.	"Manual on Flood Forecasting, River Management Wing", Central Water Commission, India	1989
6.	"Manual on Flood Forecasting, Central Flood Forecasting Organisation", Central Water Commission, India	1980
7.	Kottegoda N.T., "Stochastic Water Resources Technology", John Wiley & Sons	1980
8.	"Hydrological Forecasting Practices, Operational Hydrology", World Meteorological Organization, Report No. 6	1975

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-221 (ELECTIVE)** Course Title: **Computational Fluid Dynamics**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Spring**
7. Pre-requisite : **Advanced Fluid Mechanics (CWE-103)**
8. Objective: The aim of this course is to offer a programme of study which will enhance the skills of the graduate student providing a detailed introduction to the fundamentals of Computational Fluid Dynamics (CFD) together with an insight into the applications of CFD across the breadth of the subject.
9. Details of course:

S.No	Contents	Contact Hours
1.	Introduction: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description.	3
2.	Classification and Overview of Numerical Methods: Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods.	4
3.	Finite Difference Technique: Finite difference methods; different means for formulating finite difference equation; Taylor series expansion, integration over element, local function method; treatment of boundary	3

	conditions; boundary layer treatment; variable property; interface and free surface treatment; accuracy of f.d. method.	
4.	Finite Volume Technique: Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.	4
5.	Finite Element Methods: Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications.	4
6.	Methods of Solution: Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform.	4
7.	Time integration Methods: Single and multilevel methods; predictorcorrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems.	4
8.	Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping.	4
9.	Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods.	4
10.	Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.	4

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	Ferziger, J. H. and Peric, M.. Computational Methods for Fluid Dynamics. Third Edition, Springer-Verlag, Berlin.	2003
2	Versteeg, H. K. and Malalasekara, W.. Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education.	2008
3.	Anderson, D.A., Tannehill, J.C. and Pletcher, R.H. Computational Fluid Mechanics and Heat Transfer. Taylor & Francis.	1997

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-222 (ELECTIVE)** Course Title: **Environmental Impact Assessment of Civil Engg. Projects**

2. Contact Hours **L : 2** **T: 1** **P : 0**

3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**

4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**

5. Credits : **3**

6. Semester : **Autumn**

7. Pre-requisite : **Nil**

8. Objective: To impart knowledge related to socio-economic aspects of water resources projects and their environmental impact assessment.

9. Details of course:

S. No.	Contents	Contact Hours
1	Water Resources Projects: Need and importance of Water Resources Projects, Types of projects.	4
2	Environmental policy and laws	2
3	Environment: Eco systems, Habitat assessment, Environmental objectives, study of available resources, Environmental monitoring, Eco-friendly projects, public involvement	6
4	Environmental Impact Assessment (EIA): Introduction, historical background, Types of EIA, EIA process , components of EIA report, Environmental evaluation techniques.	10
5	Prediction and assessment of impacts	4
6	Project Evaluation: Evaluation and impact of projects like irrigation, Power Supply, Water Supply, Flood Control, Sewage, etc. Facilities generated, negative effects- inundation, migration, etc.	6
7	Case studies and evaluation of some important water Resources Projects in India and abroad.	4
Total		36

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	Canter L.W. . Environmental Impact Assessment. McGraw-Hill, Inc. Printed in the United States of America. 331pp.	1977
2	Eccleston, H.C. Environmental Impact Statements. John Wiley & Sons, Inc. Canada. 346 pp.	2000
3.	Lee, N. and C. George (editors). Environmental Assessment in	2000

	Developing and Transitional Countries. John Wiley & Sons Ltd, England. 290 pp.	
4.	United Nations. Environmental Impact Assessment: A Management Tool for Development Projects. Proceedings of the Expert Group Meeting on Environmental Impact Assessment of Development Projects Bangkok, Thailand. 155pp.	1988
5	Modi, P.A. Economic development and Environmental Issues	
6	Abbasi. S.A. Water Resources and their Environmental Impacts	

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CSE-201 (ELECTIVE)** Course Title: **Finite Element Methods in Civil Engineering**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Spring**
7. Pre-requisite : **Nil**
8. Objective: To impart understanding of applications of finite element analysis to Civil Engineering problems.
9. Details of course:

S.No	Contents	Contact Hours
1.	Introduction to Finite Element Method, Brief history of development, Advantages and disadvantages of FEM. Finite Element Method- the displacement approach	2
	Foundations of the FEM-Energy principles. One dimensional Finite elements, stiffness matrix for the basic bar and beam element representation of distributed loading. The assembly process within the PMPE approach. Element stresses. Shape functions and interpolation polynomials, refined 1-D elements	6
	Finite Elements for two dimensional planar bodies. Triangular elements	6

	for plane stress or strain conditions. Higher order rectangular elements. Rectangular elements for plane stress or strain conditions. Higher order rectangular elements: Lagrange element family.	
	Finite Element for three dimensional analysis. Tetrahedral elements. Higher order tetra-hedra. Rectangular –hexahedral elements. Higher order rectangular hexahedra: Lagrange element family.	6
	Advanced concepts in the formulation of two and three dimensional elasticity elements. Natural coordinates. Area or triangular coordinates. Serendipidity Rectangules and hexahedra. The isoparametric concept. Properties of isoparametric elements. Numerical integration.	6
	Finite element for plate bending analysis. A 12-degree of freedom rectangulat element (R1). Triangular elements.	6
		4
Total		**36**

10. Suggested Books:

S.No	Name of Books/authors/Publishers	Year of Publication
1.	Cook, R.D.; Malkus D.S. and Plesh, M.E. " Concepts and Applications of finite element analysis", John wiley and Sons Inc., New York.	1989
2	Bathe, K.J. "Finite element procedures in Engineering analysis" Prentice Hall.	1990
3.	Reddy, J.N. " An introduction to Finite Element Method". McGraw Hill	1984
4.	Dave, D.J. " Matrix and Finite Element displacement analysis of structures" Clarinton Press Oxford	1984

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-223 (ELECTIVE)** Course Title: **Stochastic Hydrology**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Autumn**
7. Pre-requisite : **Nil**

8. Objective: The objective is to provide an understanding of the theory and application of various probability and stochastic models for the modelling of hydrologic processes. The basic tools required for forecasting, simulation and frequency prediction of hydrological processes are presented.
9. Details of Course:

S.No	Contents	Contact Hours
1.	Characteristics of Hydrological Data: Population and sample, mean, median, mode, range, standard deviation, skewness, hypothesis testing, goodness of fit tests. Introduction to hydrological statistics.	4
2.	Probability Distributions: Discrete Distributions: Binomial and Poisson Continuous Distributions: Normal, log-normal, Gamma distribution, Pearson type-III, Gumbel's extreme distribution.	7
3.	Frequency Analysis: Introduction to frequency analysis, analytical frequency analysis	8
4.	Multiple Regression and Correlation : Correlation and regression , partial correlation, SLR, MLR, regression diagnostics.	5
5.	Introduction to Time Series: Stationarity and ergodicity, Purely Stochastic Models: Markov processes, Auto Correlation and Partial Auto Correlation. Auto Regressive Moving Average Models (Box- Jenkins models) - model identification;Parameter estimation ; calibration and validation; Simulation of hydrologic time series ;Applications to Hydrologic Forecasting – case studies.	12
Total		36

10. Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Ross, S.M., 'Introduction to Probability Models',Academic Press, Elsevier.	2007
2	Hipel, K. and McLeod, A. 'Time-series Modellingof Water Resources and EnvironmentalSystems', Elsevier,.	1993
3	Kottegoda, N.T. 'Stochastic Water ResourcesTechnology', Macmillan, London	1980
4	Haan, C.T. Statistical methods in Hydrology, First East-West Press Edition, New Delhi,.	1995
5	Warren, Viessman, etal. Introduction to Hydrology, Prentice Hall	2003

6	Clarke, R.T., "Statistical Models in Hydrology", John Wiley, Chinchester.	1994

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-224 (ELECTIVE)**
2. Course Title: **Rural Water Supply and Sanitation**
3. Contact Hours **L : 2** **T: 1** **P : 0**
4. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
5. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
6. Credits : **3**
7. Semester : **Spring**
8. Pre-requisite : **Nil**
9. Objective: The objective of this course is to provide training on planning to water supply and sanitation programs in the rural sector.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Village environment, Sources of water: quantity, quality and accessibility; Assessment of demands, planning and construction of direct and community water supply schemes; Source protection measures; Cost effective water treatment technologies	5
2.	Type and source of wastes; Management of solid and liquid waste; Low cost sanitation planning and construction including household toilets, community toilets; Innovative and adaptable initiatives like compost pits, vermin composting, common and individual bio gas plants, and low cost drainage apart from collection, segregation, and disposal of household waste at the village level, Disposal and Reuse issues	5
3.	Public health concepts, review of key health determinants, public health priorities in emergency and development settings, sustainable community health/hygiene: mechanisms for delivery and management	4
4.	Social, cultural, political and economic aspects linked to water and sanitation practices, Initiatives of National and International agencies in empowerment of communities by promoting pro-community policies, programs and financial support and skill upgradation in developing countries	4
5.	Assesment of current conditions and trends in water and sanitation services in low and middle-income countries; Strategies to improve water and sanitation conditions; lessons learned; key interventions	3
6.	Soft Skills for Water and Sanitation Professionals	3
7.	Case studies and projects	4
	Total	28

11. Suggested Books:

S. No	Name of Author/ Books/ Publishers	Year of Publication/Reprint
1.	Ministry of Drinking Water and Sanitation, Operation and Maintenance Manual for Rural Water Suppliers	2013
2.	Ministry of Drinking Water and Sanitation, Manual for preparation of detailed Project Report for Rural Piped Water Supply Schemes	2013
3.	Ministry of Drinking Water and Sanitation, Handbook on Technical Option for On-Site Sanitation	2013
4.	Community Led Total Sanitation (CLTS) TrainingManual for Natural Leaders	2010
5.	Sustainable Water Supply and Sanitation (SWSS) Project	2010
6.	Manual on The Right to Water and Sanitation	2007
7.	The CPHEEO manuals on Water Supply	2002

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SEMESTER – III

NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-301** Course Title: **Water quality and Environment**
2. Contact Hours **L : 2** **T: 1** **P : 0**
3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**
4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**
5. Credits : **3**
6. Semester : **Autumn**
7. Pre-requisite : **Nil**
8. Objective: To impart understanding of various aspects related to supply of pure and safe drinking water to communities and some environmental issues.
9. Details of Course:

S.No	Contents	Contact Hours
1.	Introduction: The composition and characteristics of natural waters. Effect of Temperature, Equilibria in water systems.	3
2.	Water Quality Characteristics :	8

	Physical, Chemical and Biological Characteristics of Water. Standard methods of determination of important physical and chemical parameters of water quality, eg. PH, turbidity, electrical conductivity, total Solids, alkalinity, hardness etc., Units of measurements and expression of results, Bacteriological Indicators, and determination of Coliforms	
3.	Instrumental Methods of Chemical Analysis: Concepts of Instrumental/ Analysis on Selective Electordes, Atomic Absorption spectrophotometric methods, potentiometry including o_2 electrodes, Gas chromatography.	3
4.	Concepts in Organic and Biochemical Methods: Biochemical cycles of C, N, P and S, Trace Organics, Detergents, Pesticides, Fertilisers , etc.	3
5.	Water Quality Representation and Standards: Water Quality Criteria, Guidelines, and Standards for Various uses.	2
6.	Water Pollution Natural factors affecting water quality and pollution from various wastes , mechanisms of surface water pollution, point and Non-point sources , Effect of Geological formations on Water quality.	4
7.	Water Quality in Receiving Water Bodies: Lakes and Impoundments , Stratification and Eutrophication , Water Quality in Rivers , self purification and Reaeration , Dissolved Oxygen Balance in Rivers , Thermal Pollutions.	4
8.	Ground Water Quality: Sources and Mechanisms of Groundwater Pollution. Groundwater Pollution from Lnadfills and Waste Dumps.	6
9.	Case Studies: Case Studies on Environmental Impact of Dam and Irrigation Schemes , and Land Reclamation Projects.	4
	Total	37

10. Suggested Books:

S.No.	**Name of Books/Authors/Publishers**	**Year of Publication**
1.	Metcalf And Edduy, Inc.; Waste Water Engineering, Treatment, Disposal, Reuse, Tata McGraw Hill.	2002
2	Masters G.M.; Introduction to Environmental Engineering and Science, Pretice hall of India.	1994
3	Garg S.K. Water supply Engineering Vol.I, Khanna Publishers, New Delhi.	2003

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NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR, J&K

NAME OF THE DEPARTMENT/CENTRE : **Department of Civil Engineering**

1. Subject Code: **CWE-302** Course Title: **Hydraulic Structures**

2. Contact Hours **L : 2** **T: 1** **P : 0**

3. Examination Duration (Hrs.) : Minor-1 **1** Minor-2 **1** **Major** **2**

4. Relative Weightage : **M1** **20** **M2** **20** **Major** **50** **CWA** **10**

5. Credits : **3**

6. Semester : **Autumn**

7. Pre-requisite : **Nil**

8. Objective: To provide the knowledge about various Hydraulic Structures constructed for the purpose of harnessing and using Water Resources and also for preventing the negative and destructive actions of water on the surrounding environment.

9. Details of course:

S. No.	Contents	Contact Hours
1	**Storage Structures**: Types, Selection of Type Earthen Dams- Causes of failure, Elements of Earth Dam, Seepage, Stability Gravity Dams-Site Selection, Forces on Gravity Dam, Stability Analysis, Elementary and Practical profile, Design	10
2	**Flow Control Structures**: Spillways, Outlets Types and Design Features	6
3	**Reservoirs** Investigations for Reservoir Planning, Reservoir Sedimentation, Operation of Reservoir, Reservoir Flood Routing	6
4	**Head Works** Types of Head Works, Components of Diversion Head Works, Types of Weirs, Design of Weirs, Canal Head Regulator. Theory Of Seepage Bligh's Creep Theory, Method of Independent Variable of Khosla,	10
6.	**Cross Drainage Works** Types of Cross-Drainage Works, Design of Cross-Drainage Works , causeways, culverts, bridges, estimation of design discharge, fixation of waterway, foundation depth and spans	10

10. Suggested Books:

S.No.	Names of Books/Authors/Publishers
1.	Hydraulic Structures; P. Novak, AIB Moffat, C. Nalluri, and R. Narayanan: Taylor & Francis, New York
2	Engineering for Dams, Vol I & Vol II; Creager, Justin and Hinds; John Wiley
3	Water Resources Engineering; JB Franzini, DL Freyberg, G Tchobanoglous; McGraw Hill

4	Design Textbooks in Civil Engineering – Irrigation Engineering – Vol VI – Dams; L Leliavsky; Chapman & Hall
5	Design of Small Dams; USBR; Oxford & IBH
6	Fundamentals of Irrigation Engineering; Bharat Singh; Nem Chand
7	Irrigation and Water Power Engineering; BC Punmia, BBL Pande; Laxmi Pub.
8	Irrigation, Water Power and Water Resources Engineering; KR Arora; Standard Pub.
9	Theory and Design of Irrigation Structures; Varshney, Gupta, Gupta; Nem Chand.
10	Irrigation Engineering and Hydraulic Structures; SK Garg; Khanna Pub.