SUMMARY OF COURSE FILE
SUBJECT: Bioresource Technology

1. VISION OF THE INSTITUTE

To establish a unique identity of a pioneer technical Institute by developing a high quality technical manpower and technological resources that aim at economic and social development of the Nation as a whole and the Region in particular keeping in view of the global challenges.

2. MISSION OF THE INSTITUTE

i) To create a strong and transformative technical educational environment in which fresh ideas, moral principles, research and excellence nurture with international standards.

ii) To prepare technically educated and broadly talented engineers, future innovators and entrepreneurs, graduate with understanding the needs and the problems of the industry, the society, the State, and the Nation.

iii) To inculcate the highest degree of confidence, professionalism, academic excellence and engineering ethics in budding engineers.

3. VISION OF THE DEPARTMENT

To be one of the leading chemical engineering departments in the Country, engaged with teaching, research and training to the students along with high moral values to solve the problems of the chemical and allied industries to meet the aspirations of the society.

4. MISSION OF THE DEPARTMENT

i) To create and sustain strong foundation of chemical engineering education, research and innovation.

ii) To produce well qualified, innovative chemical engineers with entrepreneurial skills & leadership qualities to face and solve the problems of the industries, and the society at large.

iii) To make professional leaders, academicians and engineers with highest moral values and ethics.

5. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

i) **PEO1**: Providing broad-based engineering education on the solid foundation of basic sciences, engineering sciences, humanities & social sciences and management through choice based credit systems.

ii) **PEO2:** Enable the students to become future leaders in engineering practices for the overall betterment of society, and instill in them a work culture based on foundations of ethics, scientific temperament, and team work.

iii) **PEO3**: Equip the students with knowledge, understanding and applications of chemical engineering tools that enables them to pursue innovative research.
iv) **PEO4**: Attain excellence in engineering and design through education in the principles and practices of chemical engineering.

6. PROGRAM OUTCOMES (POs)

i) **PO1: Engineering Knowledge**
Apply mathematics, natural science, engineering fundamentals and engineering specialization to the solution of complex engineering problems.

ii) **PO2: Problem Analysis**
Identify, formulate, research literature & analyze complex engineering problems using first principles of mathematics, natural sciences and engineering sciences.

iii) **PO3: Design/Development of Solutions**
Design solutions for complex engineering problems and design systems, components or processes with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

iv) **PO4: Conduct Investigations of Complex Problems**
Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions for complex problems.

v) **PO5: Modern Tool Usage**
Create, select and apply appropriate techniques, resources, modern engineering and IT tools including prediction and modeling to complex engineering problems with an understanding of the limitations.

vi) **PO6: The Engineer and Society**
Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.

vii) **PO7: Environment and Sustainability**
Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

viii) **PO8: Ethics**
Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

ix) **PO9: Individual and Team Work**
Function effectively as an individual, member or leader in diverse teams and in multidisciplinary settings.

x) **PO10: Communication**
Communicate effectively on complex engineering activities with the engineering community and the society at large, such as being able to comprehend, write effective

reports, design documentation, make effective presentation, and give and receive clear instructions.

xi) **PO11: Project Management and Finance**
Demonstrate knowledge and understanding of the engineering and management principles and take economic decisions in one's own work, or as a member and leader in a team, to manage projects in multidisciplinary environment.

xii) **PO12: Life Long Learning**
Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

7. PROGRAM SPECIFIC OUTCOMES (PSOs)

i) **PSO1**: Apply the principles and practices of Chemical Engineering along with the basic sciences and humanities to solve the complex engineering problems concerning the issues of environment, safety, economics, culture and society.

ii) **PSO2:** Acquire and apply the new knowledge with professional responsibility and ethics towards the advancement of academic and research pursuits in chemical and allied disciplines in the societal contexts.

iii) **PSO3:** Design, develop and modify the chemical processes and to analyze these by applying the physicochemical and biological techniques.

8. SYLLABUS-BIORESOURCE TECHNOLOGY (ChBC-82)

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.
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
Special topics: biofuels , biomaterials, specialty chemicals (gylcol, acetic acid and downstream chemicals), anhydrous alcohols-ethanol and butanol; biodiesel, bio-aviation turbine fuel (BATF).
Physico-chemical processes: Pretreatment, steam/acid/alkali hydrolysis, effect of temperature on hydrolysis.

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Text Books

i) Tripathi, G., "*Bioresource Technology*", CBS Publications (2002).
ii) Pandey, A., "*Concise Encyclopaedia of Bioresource Technology*", CRC Press (2004).
iii) Shuler, M., Kargi, F., "*Bioprocess Engineering, Basic Concept",* Prentice Hall of India Pvt. Ltd. (2004).
iv) Chakraverty, A., "*Biotechnology and other Alternative Technologies*", Oxford and IBH Publishing Co. Pvt. Ltd. (1995).
v) Rao, M.G., Sittig, M., "*Dryden's Outlines of Chemical Technology- for the 21st Century.* East-West Press (1997).
vi) Austin, G.T., "*Shreve's Chemical Process Industries*", McGraw-Hill Book Company 1984).

9. COURSE OUTCOMES (COs)

CO1:	Fundamental understanding of the bioresources and 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 bioresources and bioresource technology.
CO4:	Understanding about analysis of data and their applications in design of the systems and development of the bioprocess.

10. COs MAPPING WITH POs AND PSOs (WITH PROPER JUSTIFICATIN)

COs-POs and COs-PSOs Mapping

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	2	3	3	3	1	1		1	3	3	3
2	3	3	3	3	2	3	3	2		2		2	3	3	3
3	3	3	3	2	2	3	3	2	1	2		2	3	3	3
4	3	3	3	3	2	3	3	2	1	2		2	3	2	3

3: Excellent (highly correlated), 2: Good (moderate), 1: Satisfied (Low), Blank: Not correlated

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COs-POs Mapping Justification

COs	POs		Justification
CO1	PO1	3	Fundamental understanding of the bioresources and its applications in the fields of generation of energy, control of environmental pollution, manufacturing of various products and attainment of sustainability in terms of energy, environment and renewable raw materials does require the knowledge of mathematics, science and engineering specialization for solution of complex engineering problems. As a result CO1 and PO1 are highly correlated.
	PO2	3	Fundamental understanding of the bioresources and its applications in the fields given also requires identification, formulation and review of the literature in order to reach substantial conclusion with respect to the complex problems where fundamental principles of mathematical, natural and engineering sciences are involved.
	PO3	3	Fundamental understanding of the bioresources and its applications in the fields mentioned are also helpful in design and development of the systems for solution of complex engineering problems with respect to public health and safety, cultural, societal, and environmental considerations. Thus, the CO and PO are highly correlated.
	PO4	3	Basic knowledge of the bioresources and its applications in the various fields as illustrated, are highly significant from the stand point of conducting investigation for the complex problems where research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information are involved in order to attend valid results. Therefore, CO and PO may be highly correlated.
	PO5	2	There may be involvement of the modern tools such as software and sophisticated equipments in fundamental understanding of the bioresources and its applications in the fields of energy, environment, product synthesis and sustainability. They are moderately correlated.
	PO6	3	Engineer, society, bioresources and the bioresource technology have got intimate relationships. Fundamental understanding of the bioresources and its applications do require contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. They are highly correlated.
	PO7	3	Fundamental understanding of the bioresources and its applications are greatly focused on environment and sustainability. CO1 and PO7 are greatly correlated.
	PO8	3	Commitment towards professional ethics and responsibly plays an important role in fundamental understanding and applications of the bioresources towards attainment of social objectives with respect to energy, environment, product, and sustainability. Therefore, CO1 and PO8 may be greatly correlated.
	PO9	1	Minimally correlated as the students are sometimes asked questions in group which creates the sense of individual, member or leader.
	PO10	1	The whole process of teaching, learning and examination are based on the written and oral communication of the teacher and the taughts. This improves the communication skills of both. Therefore, CO1 and PO10 may be said to be minimally correlated.
	PO11		Not correlated.
	PO12	1	Applications of fundamental knowledge for attainment of social objectives with respect to energy, environment, product, sustainability is a life-long learning process may be said to be minimally correlated.
	PSO1	3	Basic sciences and humanities are involved to solve the complex engineering problems concerning the issues of environment, safety, economics, culture and society. CO1 and PSO1 are highly correlated.
	PSO2	3	Justification for mapping of CO1 and POs justifies high correlation with CO1 and PSO2.
	PSO3	3	Justification for mapping of CO1 and POs also justifies high correlation between CO1 and PSO3.
CO2	PO1	3	Acquiring knowledge with respect to the properties of the bioresources and the conversion technologies do apply mathematics, natural science, engineering fundamentals and engineering specialization to the solution of complex engineering problems. Therefore, CO2 and PO1 are highly correlated.
	PO2	3	The first principles of mathematics, natural sciences and engineering sciences do apply to acquire the fundamental knowledge of basic properties of the bioresources and the conversion technologies. .
	PO3	3	Due considerations for public health, safety, culture and environment are taken into account while designing solutions for complex engineering problems and systems, components or processes with respect to the properties of bioresources and the conversion technologies.
	PO4	3	Research based-knowledge and research methods which include design of experiments, analysis and interpretation of data, and synthesis of information are involved in acquiring knowledge of properties of bioresources and the conversion technologies.

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	PO5	2	Creation, selection and application of appropriate techniques, resources, modern engineering and IT tools including prediction and modeling to complex engineering problems with an understanding of the limitations may be involved to acquire knowledge with respect to the properties of the bioresources and the conversion technologies.
	PO6	3	Professional engineering practices and solutions to complex engineering problems with respect to the properties of the bioresources and the conversion technologies do apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities of engineers.
	PO7	3	The knowledge of the properties of the bioresources and the related conversion technologies have the impact in professional engineering solutions in societal and environmental contexts. The sustainable development do have close relationship with properties of bioresources and the conversion technologies.
	PO8	2	Maintenance of ethical values in acquiring the knowledge of characteristics of bioresources and the conversion technology is integral part of professional ethics. Therefore, CO2 and PO8 may be moderately correlated.
	PO9		
	PO10	2	As the whole process of teaching, learning and examination are based on the written and oral communication of the teacher and the taughts, improvements in communication skills do occur. Therefore, CO2 and PO10 may be be at least moderately correlated.
	PO11		
	PO12	2	Better understanding of the bioresource properties and the related conversion technologies may recognize the need for, and have the preparation and ability to engage in independent and life-long learning and broadest context of technological changes. CO2 and PO12 may be said to have moderate correlations.
	PSO1	3	Acquiring knowledge with respect to the properties of the bioresources and the conversion technologies is not possible without applying the principles and practices of Chemical Engineering along with the basic sciences and humanities to solve the complex engineering problems concerning the issues of environment, safety, economics, culture and society. Therefore, CO2 and PSO1 are highly correlated.
	PSO2	3	CO2 and PSO2 are greatly correlated as acquiring knowledge w.r.t. the properties of bioresources and the conversion technologies for power generation and product synthesis do apply new knowledge with professional responsibility and ethics towards the advancement of academic and research pursuits in chemical and allied disciplines in the societal contexts.
	PSO3	3	Knowledge of the physical, chemical and biological properties of the bioresources do help in physicochemical and biological techniques applied in design, development and modification of the processes with respect to generation of energy and product. Thus, CO2 and PSO3 are highly correlated.
CO3	PO1	3	Exhibiting knowledge of the systems used for bioresources and bioresource technology apply mathematics, natural science, engineering fundamentals and engineering specialization to the solution of complex engineering problems. Therefore, CO3 and PO1 are highly correlated.
	PO2	3	Exhibiting knowledge of the systems used for bioresources and bioresource technology do involve identification, ,formulation, research literature & analysis of the complex engineering problems using first principles of mathematics, natural sciences and engineering sciences. Therefore, CO3 and PO2 are also greatly correlated.
	PO3	3	Design/development of solutions of complex engineering problems and design systems, components or processes with appropriate consideration for public health and safety, cultural, societal, and environmental considerations do have intimate relationship with the systems used for bioresources and bioresource technology. Therefore the course outcome CO3 and PO3 are greatly correlated.
	PO4	2	Exhibiting knowledge of the systems used for bioresources and bioresource technology may require research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions. Thus, CO3 and PO4 may be said to have moderate relationship.
	PO5	2	Acquiring knowledge of the systems used for bioresources and bioresource technology may apply appropriate techniques, resources, modern engineering and IT tools including prediction and modeling to complex engineering problems with an understanding of the limitations. Therefore, CO3 and PO5 may be correlated moderately.
	PO6	3	Exhibiting knowledge of the systems used for bioresources and bioresource technology do require reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. CO3 and PO6 may be said to have highly correlated.
	PO7	3	Environmental issues and sustainability are the fundamental context of bioresource technology. Therefore CO3 and PO7 are highly correlated.
	PO8	2	Application of ethical principles and commitments towards professional ethics and responsibilities are involved everywhere including the systems applied for bioresources and bioresource technology. Therefore, CO3 and PO8 may also be said to have moderate relations.

	PO9	1	The technology is the outcome of multidisciplinary efforts. Thus, CO3 and PO9 may be remotely correlated.
	PO10	2	The whole teaching-learning activities of teacher and taught are based on communication skills, i.e. oral as well as written. Therefore, CO3 and PO10 may be moderately correlated.
	PO11		
	PO12	2	Advent of bioreource technology and systems using bioresources are the outcomes of continuous multidisciplinary efforts. The changes brought about are the outcomes of continuous life-long learning process. Therefore, CO3 and PO12 may be moderately correlated.
	PSO1	3	The principles and practices of Chemical Engineering along with the basic sciences and humanities are the foundations stones, do apply in the bioresource systems and bioresource technology. Therefore, CO3 and PSO1 may be said to have intimate relationship and they are greatly correlated.
	PSO2	3	Systems used for bioresources and bioresource technology do require the new knowledge with professional responsibility and ethics towards the advancement of academic and research pursuits in chemical and allied disciplines in the societal contexts.Therefore, CO3 and PSO2 are highly correlated.
	PSO3	3	Physicochemical and biological techniques do play significant role in design, development and modification of bioresource systems and bioresource technology. Therefore, CO3 and PSO3 are highly correlated.
CO4	PO1	3	Understanding about analysis of data and their applications in design of the systems and development of the bioprocess do apply mathematics, natural science, engineering fundamentals and engineering specialization to the solution of complex problems. Therefore, CO4 and PO1 are highly correlated.
	PO2	3	The basic principles of mathematics, natural sciences and engineering do play significant roles while identifying, formulating and analyzing the complex problems with respect to analysis of data and their applications in design of the systems and development of the bioprocess. Thus, CO4 and PO2 can be greatly correlated.
	PO3	3	The philosophy of bioresource technology are based on proper consideration of public health and safety, cultural, societal, and environmental issues. Therefore, CO4 and PO3 may be said to have intimate relationship.
	PO4	3	Application of research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions for complex problems do help in analysis of data and their applications in design of the systems and development of the bioprocess.
	PO5	2	Modern engineering and IT tools including prediction and modeling to complex engineering problems with an understanding of the limitations may be used in analysis of data and their applications in design of the systems and development of the bioprocess. Therefore, CO4 and PO5 may be moderately correlated.
	PO6	3	Engineer and the society cannot be separated from each other. Understanding about analysis of data and their applications in design of the systems and development of the bioprocess do apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.
	PO7	3	Understanding the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development do have significant consideration while analyzing the data with respect to the design and development of bioprocess in bioresource technology.
	PO8	2	Ethical principles and commitment towards professional ethics and responsibilities have proper consideration in analysis of data and their applications in design of the systems and development of the bioprocess. CO4 and PO8 can be moderately correlated.
	PO9	1	Minimally correlated.
	PO10	2	During the course of question answer session in the class, the students are allowed to ask questions. They are also asked to answer the questions related to the topics covered. Sometimes they also face surprise tests. This improves their communication skills (oral as well as written).
	PO11		Understanding about analysis of data and their applications in design of the systems and development of the bioprocess.
	PO12	2	The knowledge for bioprocess data analysis and its application are used in solving the problems in energy, environment, safety and societal context. This embodies an urge to continue with life-long learning for further advancement in chemical engineering and allied areas.
	PSO1	3	The basic principles and practices of engineering, sciences and humanities are the foundations stones, do play significant role in analysis of data and their applications in design, and development of the bioresource technology. Therefore, CO4 and PSO1 may be said to have intimate relationship and they are greatly correlated.
	PSO2	2	New knowledge with professional responsibility and ethics towards the advancement of academic and research pursuits in the societal contexts may be required in analysis of data sand their applications in design and development of the bioprocess in bioresource technology .Therefore, CO4 and PSO2 may be moderately correlated.

	PSO3	**3**	Physicochemical and biological techniques do play significant role in analysis of the data and their application in design, development and modification of the bioprocess in bioresource technology. Therefore, CO4 and PSO3 are highly correlated.

11. CONTENTS BEYOND SYLLABUS

a. 1st International Conference on Bioresource Technology for Bioenergy, Bioproducts & Environmental Sustainability (BIORESTEC)

a. Biofuel production: Challenges and opportunities
b. Bioresource utilisation by sustainable technologies in new value added biorefinery concepts: Two case studies from food and forest industry.
c. BioResource World: An Integrated database of Biological Resources
d. Utilization of bioresources for sustainable biofuels: A Review
e. Energy production from biomass (part 1): Overview of biomass
f. National Policy on Biofuels
g. Biofuel Production in India: Potential, Prospectus and Technology
h. Natural Resources as a Basis for Sustainable Development: Bioresources - Russia