Kavayitri Bahinabai Chaudhari

NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Engineering

(Biotechnology Engineering)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
3rd Cycle

SYLLABUS

Semester – V & VI

W.E.F. 2020 – 21

Syllabus Structure for Third Year Engineering (Semester – V) (Biotechnology Engineering) (w.e.f. 2020 – 21)

Name of the Course	Group	Teaching Scheme				Evaluation Scheme					Credits
						Theory		Practical		Total	
		Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE	ESE	ICA	ESE		
Molecular Biology	D	3	-	-	3	40	60	-	-	100	3
Reaction Engineering	D	3	-	-	3	40	60	-	-	100	3
Enzyme Engineering	D	3	-	-	3	40	60	-	-	100	3
Professional Elective Course –I	E	3	-	-	3	40	60	-	-	100	3
Open Elective Course – I	F	3	-	-	3	40	60	-	-	100	3
LAB Molecular Biology	D	-	-	2	2	-		25	25(OR)	50	1
LAB Reaction Engineering	D	-	-	2	2	-		25	25(OR)	50	1
LAB- Pharmaceutical Biotechnology	D	-	-	2	2	-	-	25	25(OR)	50	1
Minor Project (Stage-I)	G	-	-	6	6	-	-	50	-	50	3
Constitution of India		-	-	-	-	-	-	-	-	-	0
		15	**0**	**12**	**27**	**200**	**300**	**125**	**75**	**700**	**21**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

Professional Elective Course – I		Open Elective Course – I	
1	Food Biotechnology	1	Biofuel & Alcohol Technology
2	System Biology	2	Bioorganic Chemistry
3	Biothermodynamics	3	Biomedical Instrumentation
4	Cell Biology	4	Energy Engineering

Syllabus Structure for Third Year Engineering (Semester – VI) (Biotechnology Engineering) (w.e.f. 2020 – 21)

Name of the Course	Group	Teaching Scheme				Evaluation Scheme					Credits
						Theory		Practical		Total	
		Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE	ESE	ICA	ESE		
Genetic Engineering	D	3	-	-	3	40	60	-	-	100	3
Mass Transfer	D	3	-	-	3	40	60	-	-	100	3
Bioprocess Engineering	D	3	-	-	3	40	60	-	-	100	3
Professional Elective Course – II	E	3	-	-	3	40	60	-	-	100	3
Open Elective Course – II	F	3	-	-	3	40	60	-	-	100	3
LAB Genetic Engineering	D	-	-	2	2	-	-	25	25(OR)	50	1
LAB Mass Transfer	D	-	-	2	2	-	-	25	25(OR)	50	1
LAB Bioprocess Engineering	D	-	-	2	2	-	-	25	-	25	1
Minor Project	G	-	-	6	6	-	-	50	25(OR)	75	3
Internship - II	H	-	-	-	-	-	-	-	-	-	-
		15	**-**	**12**	**27**	**200**	**300**	**125**	**75**	**700**	**21**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

Professional Elective Course – II		Open Elective Course – II	
1	Plant Biotechnology	1	Environmental Biotechnology
2	Protein Engineering	2	NanoBiotechnology
3	Metabolic Engineering	3	Enterprise Resource Planning & SAP
4	Stem Cell Technology	4	Bioprocess Instrumentation and Analysis

*Internship - II is a mandatory and non-credit course. It shall be during summer vacation after semester – VI. The satisfactory completion of Internship should be submitted to university at the end of semester VIII.

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SYLLABUS

Semester – V

W.E.F. 2020 – 21

Molecular Biology					
COURSE OUTLINE					
Course Title:	Molecular Biology	**Short Title:**	Mol Bio	**Course Code:**	

Course description:

This course is aimed at developing the basic knowledge and skills of molecular biology to undergraduate students. The background expected includes a prior knowledge of SE Biotechnology courses. The goals of the course are to understand the basic principles of Molecular Biology and their applications in engineering trade.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 11th, 12th Biology, SE Biotechnology courses

Course objectives:

1. To develop the basic knowledge and skills of molecular biology.
2. To explain central dogma of molecular biology and their role in biological systems.
3. To handle the analytical techniques in molecular Biology.
4. To describe the genetic code.
5. To use the modern concepts for protein synthesis.

Course outcomes:

After successful completion of this course the student will be able to:

1. Describe basic molecular and genetic concepts and principles.
2. Communicate the fundamental concepts of molecular biology both in written and in oral format.
3. Demonstrate nucleic acid replication and its types.
4. Critically evaluate data, develop and design experiments to address a novel problem in the form of project.
5. Demonstrate advanced knowledge in a specialized field of molecular biology.

COURSE CONTENT

Name of the Subject: Molecular Biology		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Introduction to Genetic Material

Introduction: Nucleic acids, DNA Chemical Composition, Chargoffs Equimolar Base Ratio, Molecular Structure of DNA, Watson and Crick Double Helical Model of DNA, forms of DNA (B-DNA, A-DNA, C-DNA, D-DNA, E-DNA, Z-DNA)

RNA: Occurrence, types of RNA: rRNA, tRNA, mRNA. Structure of ribosome's. Central Dogma, One Gene – One Polypeptide Hypothesis.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

DNA Replication

Replication: Overview, Basic rules and requirements of Replication, Types of DNA replication: Generalized Model for the DNA replication, Semi conservative method of replication, Meselson and Stahl experiment, bidirectional DNA replication, Molecular

mechanism of DNA replication, Enzymes and proteins involved in DNA replication: Structure and functions of DNA polymerase I,II,III, primase, polynucleotide ligase, endonuclease, helicase, single stranded binding proteins, topoisomerase, Replication Models Theta replication model, Rolling circle Model, D-Loop Model.

Unit–III:	No. of Lectures: 09 Hours	Marks: 12

Transcription

Transcription and Processing of RNA: Transcription, Mechanism of Transcription in Prokaryotes, RNA polymerase of prokaryotes (structure, types and function),Transcription Unit, Promoter Site, Molecular Mechanism of Transcription in Prokaryotes, , Molecular Mechanism of Transcription in Eukaryotes, RNA polymerase of Eukaryotes (structure, types and function), Transcription Factors, Eukaryotic promoters, RNA processing/Post transcriptional modification: Introduction, processing of the pre rRNA, tRNA, and the mRNA transcript(eukaryotic), RNA splicing (mechanism).

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Genetic Code and Protein Synthesis

Genetic code: Nature and characteristics of Genetic Code, Reasons for degeneracy, Biological Significance of Degeneracy of Genetic Code

Protein synthesis:- Mechanism of protein synthesis: Transcription Overview, Translation: Activation of the amino acids, attachment of activated amino acids with tRNA, stages during translation, Translation in Prokaryotes and Eukaryotes, Translocation of proteins, Post translational processing of Proteins (Protein Folding and Biochemical Modifications)

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Regulation of gene expression & DNA damage and repair

Gene regulation in prokaryotes, Mechanisms of gene regulation at Transcription level, Induction and repression, Lac Operon System, Tryptophan Operon System, Gene regulation and Translation level, Gene regulation in eukaryotes.

DNA damage and repair: Types of damages, damaging agents, repair mechanisms - photoreactivation, dark repair, postreplicational recombination repair, SOS repair.

Text Books:

1. Veer Bala Rastogi, Fundamentals of Molecular Biology, Ane Books Pvt. Ltd
2. P.K.Gupta, Cell and Molecular Biology, Third Edition, Rastogi Publications

Reference Books:

1. Lodish et al, Molecular Biology of cell
2. Singer M and Berg P., Genes and Genomes –

Reaction Engineering					
COURSE OUTLINE					
Course Title:	Reaction Engineering	**Short Title:**	RE	**Course Code:**	

Course description:

The goal of the course is intended to provide a strong foundation in concepts and principles of Chemical reactions used in bioprocess industries.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 12th Std. Science and SE Biotechnology Courses.

Course objectives:

1. To make the student familiar with various types of reactions.
2. To understand the kinetic study of various chemical.
3. To understand the kinetic study of various biochemical reactions.
4. To design various types of reactors used in process industries.
5. To interpret the experimental data.

Course outcomes:

After successful completion of this course the student will be able to:

1. Determine the rate and order of reaction from experimental data.
2. Analyze and interpret the kinetics of reactions.
3. Apply the fundamentals of chemical reaction engineering to design different types of reactors.
4. Explain heterogeneous system with its applications.
5. Use the various types of reactors for different types of homogeneous and heterogeneous reactions.

COURSE CONTENT

Name of the Subject: Reaction Engineering		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to chemical reaction engineering: Classification of chemical reactions, rate of reaction, order and molecularity of reaction, rate constant, activation energy, transition state theory and temperature dependency, comparison of theories, Reaction mechanism.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Collection and interpretation of kinetic data, ,integral and differential method of analysis of data, Half life method , Constant volume batch reactor ,Variable volume batch reactor.

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

Ideal reactors, mixed flow reactor, plug flow reactor, space time and space velocity, holding time and space time, comparison in mixed and plug flow reactors, Recycle reactor, Autocatalytic reaction.

Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**

Residence time distribution of fluid in PFR and CSTR, Conversion directly from tracer

information, Models for non-ideal flow, Dispersion models, Concept of micro and macro mixing.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Introduction to Rate equations for heterogeneous systems , Contacting patterns in Two –Phase system, Introduction to fluid particle reaction non-catalytic reactions, un reacted core model for Spherical particle of unchanging size, Rate of reaction for shrinking spherical particles , Determination of rate controlling step ,Various contacting patterns in fluid solid reactors for fluid-particle non-catalytic reactions.		
Text Books:		
1. Octave Levenspiel, Chemical reaction engineering, John Wiley and sons. 2. Scott Fogler, Elements of chemical reaction engineering, Prentice Hall New, Jersy. 3. S.D. Dawande, Principles of reaction engineering, Central Techno publication, Nagpur.		
Reference Books:		
1. J.M. Smith, Chemical engineering kinetics, McGraw Hill 2. Lanny D. Schimdt , Chemical reaction engineering, Oxford University Press.		

Enzyme Engineering					
COURSE OUTLINE					
Course Title:	Enzyme Engineering	**Short Title:**	EE	**Course Code:**	

Course description:

This course is introduced for learning the basic fundamentals of Enzyme Engineering to undergraduate students. The goals of the course are to understand the basic knowledge of Enzymes, their classification, production, purification and Immobilization to be use in different areas.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 12th Std. Science and SE Biotechnology Courses.

Course objectives:

1. To accustom knowledge of enzyme & its classification & its role in metabolic pathway of living systems.
2. To get acquainted with enzyme kinetics and its application in production of desired products.
3. To design and conduct experiments to analyze and interpret enzyme kinetic data for the design of enzyme reactor for production of value added products.
4. To get insights of various analytical techniques for characterization of enzymes.
5. To get acquainted application of enzymes in various industries used for the manufacturing of Bioproducts for the welfare of society.

Course outcomes:

After successful completion of this course the student will be able to:

1. Classify enzymes on the basis of their working mechanism.
2. Calculate the enzyme kinetics and activity by performing various assays.
3. Characterize the enzymes by using modern equipments.
4. Immobilize enzyme by various immobilization techniques for better stability and activity as well as to reduce their losses during use.
5. Apply molecular mechanism of various enzymes in different metabolic pathways.

COURSE CONTENT

Name of the Subject: Enzyme Engineering		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Introduction to Enzymes:

Classification, nomenclature, International units and types of enzymes, General characters of enzymes: characters such as specificity, catalysis and regulation and localization of enzymes in the cell, Structure of enzymes: Primary, secondary and tertiary structure of enzyme, Models of enzyme activity: Lock and key model, Induced fit, Substrate Strain model. Isoenzyme, with example and its application.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Enzyme Kinetics:

Introduction to kinetics: activation energy, transition state theory and energy, consideration, Enzyme kinetics, rate equation, Rate of reaction, First order and second order reaction, Michaelis – menten equation (Steady state kinetics) and Haldane relationship, Significance of Km, Lineweaver – Burk or Double – reciprocal plot, Eadie- Hofstee plot, Hanes plot, Turnover number, Specificity constant, Bisubstrate reaction.

Unit–III:	No. of Lectures: 09 Hours	Marks: 12

Enzyme inhibition, its kinetics and Catalysis:

Types of inhibition- Reversible and irreversible inhibition, Kinetics of inhibition. Catalytic efficiency- proximity and orientation effects, distortion or strain, Different mechanisms of enzyme catalysis, acid base and covalent catalysis and metal-ion catalysis, Molecular mechanism of action of chymotrypsin, Lysozyme, Chemical modification of enzymes, Bisubstrate or Multisubstrate reaction: Ping – Pong mechanism, sequential mechanism.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Allosteric and regulatory enzyme, enzyme production and purification:

Binding of ligands to Protein, Co-operativity models- MWC and KNF model, Regulations by allosteric enzymes, other mechanisms of enzyme regulation-enzyme induction and repression and covalent modification. Sources of enzymes-animal plant and microbial sources, large scale production of enzymes- basic methodology of production, extraction and purification of enzymes, Enzyme production and recombinant DNA technology.

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Enzyme immobilization:

Methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), and microencapsulation and gel entrapment, Properties of immobilized enzymes, Applications of immobilized enzymes.

Enzyme Applications: Applications of enzymes in food, sugar, leather, detergent industries etc., Uses of enzymes in drug, medicine, industries, Uses of enzymes to make amino acids and peptides, Legislative and safety aspects.

Text Books:

1. Lehninger, Nelson and cox. Principles of Biochemistry –Macmillan publishers.
2. Palmer, Enzymes, Oxford University press.

Reference Books:

1. Voet and Voet, Biochemistry, Wiley publisher.
2. Biotol series, Principles of Cell energetics , Butterworth- Heinemann Ltd, Jordan Hill, Oxford.
3. Murray moo-young, Comprehensive Biotechnology Pergemon Press(Vol 2)
4. Nicholascprice and Tewis stereous, Fundamentals of Enzymology, Oxford University press.
5. Michael L. Shuler, Fikret Kargi, Bioprocess Engineering, Basic concepts, Prentice Hall India Pvt. Ltd., New Delhi.

Professional Elective Course - I					
Food Biotechnology					
COURSE OUTLINE					
Course Title:	Food Biotechnology	**Short Title:**	**FBT**	**Course Code:**	

Course description:

This course is introduced to understand the constituents of food. This course deals with the study of microorganism present in food and the principles to control them.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- Microbiology, Unit operations and Biochemistry.

Course objectives:

1. To understand the various constituents of the foods and their role.
2. To understand the different microorganisms present and their role in causing food spoilage.
3. To give the knowledge to students how to preserve the food.
4. To get acquainted with production of different food products.
5. To introduce to the different unit operation involved in food industry.

Course outcomes:

After successful completion of this course the student will be able to:

1. Find out the different microorganism responsible for food spoilage.
2. Distinguish different constituents of the food and their role in body.
3. Use their knowledge to preserve the food.
4. Apply their knowledge of unit operation in food industry.
5. Use the techniques, skill and modern engineering tools necessary for engineering practice.

COURSE CONTENT

Name of the Subject: Food Biotechnology		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Food Biotechnology:

Introduction to food biotechnology, Constituents of food, the sources of dietary carbohydrates and their functional property, the sources of protein and their functions, requirements of vitamins, fatty acids in food.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Microorganisms in Food:

Types of microorganism in food, Microbial examination of foods, Role and significance of micro organism in foods, Factors influencing microbial activity, Food borne diseases: Food infection, Viral infection, Food borne parasites, Food intoxication.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12
Fermentation Processes Food Biotechnology: Food fermentation, Important microbial culture in food industry, Fermentation of dairy products, Fermentation for beverage, Single cell proteins, Fermentative production of sauerkraut, Fermentation for production of vinegar and Idly.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Food Spoilage and Preservation: Causes of food spoilage, Spoilage of various foods and food products, Deterioration of food quality, Food preservation using high temperature, Evaporation, Drying, Low temperature and Irradiation.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Food Storage and Packing: Storage and packaging of various food products like fruits and vegetables, milk and milk products, bakery products, confectionary products & other food products.		
Text Books:		
1. B. Sivashankar, Food Processing and Preservation, Prentice Hall ,India. 2. Powar and Daginawala, General Microbiology (vol 2), Himalaya Publishing House.		
Reference Books:		
1. Murray Moo-Young, Comprehensive Biotechnology (Vol: 3), Pergamon Press, An imprint of Elsevier. 2. S.S. Purohit, Microbiology: Fundamentals and Application, Agrobios India. 3. Fraizer, Food Microbiology ,TMH publication 4. Hiller, Genetic Engineering of Food: Detection of Genetic Modifications, Willy Publication. 5. Morries B. Jacobs, The chemical analysis of food and food products, published Van Nostrand Company Priceton New Jersey (3rd edition, 2006).		

Professional Elective Course - I

System Biology

COURSE OUTLINE

Course Title:	System Biology	**Short Title:**	**SB**	**Course Code:**	

Course description:

This course deals with basics of system biology. It also introduces various software involved in modeling and simulation. This course has also been dealt with various mathematical model constructions of biological pathways.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- Biochemistry, Molecular biology, Genetics.

Course objectives:

1. To introduce the basics of both theoretical and practical aspects of system biology approach.
2. To cover the basics of mathematical modeling part of Systems Biology.
3. To describe the gene network for steady state gene expression.
4. To describe the Modular Modeling Concept and Computational Cell Biology.
5. To construct Mathematical Models of Biological Signal Transduction Pathways.

Course outcomes:

After successful completion of this course the student will be able to:

1. Apply a network biology analysis approach to a wide range of molecular biology problems.
2. Critically assess the quality of high-throughput protein-protein interaction data.
3. Apply basics of biological networks.
4. Describe basic computational methods for biological networks based on high-throughput data.
5. Describe and apply basic algorithms.

COURSE CONTENT

Name of the Subject: System Biology		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

System Biology:

Introduction, System Structure Identification, System Behavior Analysis, System Control, System Design, Measurement Technologies and Experimental methods, System Structure Identification, The System Project, Impacts of System Biology.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Reverse Engineering And Data Mining From Gene Expression Data:

The DBRF Method For Inferring A Gene Network From Large-Scale Steady-State Gene Expression Data, Performance of The DBRF Method, Application To Yeast Gene Expression Data, The Analysis of Cancer Associated Gene Expression Matrices, Automated Reverse

Engineering of Metabolic Pathways From observed data by Means of Genetic Programming.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Software for Modeling And Simulation: The ERATO Systems Biology Workbench: An Integrated Environment For Multiscale And Multi Theoretic Simulations In Systems Biology, The Systems Biology Markup Language, The Systems Biology Workbench, Automatic Model Generation For Signal Transduction With Applications To MAP-Kinase Pathways, Mapk Pathway With Scaffolds: Experimental Background, Parameter Estimation.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Cellular Simulation: Towards A Virtual Biological Laboratory, Modular Modeling Concept, Computational Cell Biology, The Stochastic Approach, Modeling Bacterial Chemotaxis, Computer Simulation Of The Cell: Human Erythrocyte Model And Its Application.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
System-Level Analysis: Constructing Mathematical Models of Biological Signal Transduction Pathways: An Analysis of Robustness, Robust perfect adaptation and integral feedback control In Bacterial Chemotaxis, Combination of Biphasic Response Regulation And Positive Feedback As A General Regulatory Mechanism In Homeostasis And Signal Transduction, Regulation of MAPK Concentration.		
Text Books:		
1. Hiroaki Kitano, Foundations of Systems Biology edited; The MIT Press Cambridge 2. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, First edition; Chapman and Hall/CRC Publications.		
Reference Books:		
1. Eberhard Voit, First Course in Systems Biology; Garland Science. 2. Edda KlippSystems, Biology , Wolfram Liebermeister; First edition Wiley VCH		

Professional Elective Course - I					
Biothermodynamics					
COURSE OUTLINE					
Course Title:	Biothermodynamics	**Short Title:**	**BTH**	**Course Code:**	

Course description:

This course deals with basics of thermodynamics system biology. This course has also been dealt with various mathematical model constructions.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 12th STD

Course objectives:

1. To introduce the students with the basics of first law of thermodynamics both theoretical and practical aspects of thermodynamics.
2. To introduce the students with the basics of second law of thermodynamics both theoretical and practical aspects of thermodynamics.
3. To get familiar with the concepts of material and energy balance of the systems.
4. To understand the thermodynamic properties of fluids.
5. To explain the concepts of thermodynamic solutions.

Course outcomes:

After successful completion of this course the student will be able to:

1. Describe first and second law of thermodynamics.
2. Apply the concept of material and energy balance.
3. Discuss the thermodynamic properties of fluids.
4. Demonstrate the concept of thermodynamic properties of fluids.
5. Describe chemical concepts of ideal and non ideal solutions.

COURSE CONTENT

Name of the Subject: Biothermodynamics		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**42 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Basic Concepts In Engineering Thermodynamics:

First and Second law of thermodynamics; Calculation of Work, energy and property changes in reversible processes, Thermodynamics of flow processes; Power cycles and refrigeration cycles, Residual properties

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Material Balance:

Steady state and equilibrium, types of material balances, stoichiometry of growth and product formation, Electron balance, Theoretical oxygen demand

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Energy Balances:

Basic Energy concepts, Intensive and Extensive properties, general energy balance equations, Enthalpy calculations, State properties-reactive and non-reactive systems, Heat of solutions, Heat of combustion, Heat of reaction in non-standard condition; Energy balance equation for cell

culture with basic numerical calculations.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Thermodynamic Properties of Fluids: Estimation of thermodynamic properties using equations of state; Maxwell relationships and their applications; Calculation of flow processes based on actual property changes		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Solution Thermodynamics: Partial molar properties; concepts of chemical potential and fugacity Ideal non ideal solutions; Gibbs Duhem equation; Excess properties of mixtures; Activity Coefficient - corm position models		
Text Books:		
1. J M. Smith, H. C. Van Ness and M. M. Abbott. Introduction to Chemical Engineering Thermodynamics McGraw Hill. 2. P.M. Doaran, Bioprocess Engineering Principles, Academic Press,1995.		
Reference Books:		
1. M. D. Koretsky, Engineering and Chemical Thermodynamics, John Wiley and sons,2004.		

Professional Elective Course - I					
Cell Biology					
COURSE OUTLINE					
Course Title:	Cell Biology	**Short Title:**	**CB**	**Course Code:**	

Course description:

This course is introduced for learning the basic fundamentals of Life sciences to undergraduate students. The prospectus includes a prior knowledge of Biotechnology. The goals of the course are to understand the basic principles of Biotechnology and its applications in different areas.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 10th&12th STD Zoology, Botany.

Course objectives:

1. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
2. Students will understand how these cellular components are used to generate and utilize energy in cells.
3. Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or Physiological changes, or alterations of cell function brought about by mutation.
4. Students will learn the basic principles of inheritance at the molecular, cellular and Organism levels.
5. Students will understand relationships between molecule/cell level phenomena ("Modern genetics") and organism-level patterns of heredity ("classical" genetics).

Course outcomes:

After successful completion of this course the student will be able to:

1. Apply all knowledge about basic biology to all problems in molecular biology and genetics.
2. Understand the knowledge about living organisms which is main subject of molecular biology and genetics.
3. Describe the current concepts in Cell Biology, Stem Cell Biology and Development.
4. Illustrate the basic cellular processes including heredity, transcription/translation (the central dogma), cellular replication and their role in development, physiology and higher level biological organization.
5. Demonstrate the structure/function of the basic components of prokaryotic and eukaryotic cells including macromolecules and organelles.

COURSE CONTENT

Name of the Subject: Cell Biology		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	No. of Lectures: 08 Hours	Marks: 12
Cell Biology and Cell Theory: Structural organization of life, Concepts of modern cell, history of cell, Cell theory, Structure of cell:- Cell shape, size and cell number, Types of cells:- Prokaryotic cells and Eukaryotic cells, Chemistry of cells.		
Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**
Study of Intracellular Components of Cell: Cell organelles:-Structure & Functions of: Mitochondria, Plastids:- Chloroplast, Chromoplast, Nucleus, Ribosomes, Golgi complex, Endoplasmic Reticulum, Endosomes, Lysosomes, Peroxisomes.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Cell Division: Cell cycle, mitosis, meiosis, genetic and biochemical approaches for the study of cell division, mitotic cell division, cell cycle check points, meiotic cell division, embryonic cell division, cell death, the cell cycle of cancer, central cell cycle control systems.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Basic Concepts in Genetics: Introduction to gene, Mendels law of segregation, Assumption involved in segregation, physical basis of segregation, Law of Independent Assortment: - Introduction, two characters of independent segregation, test cross of dihybrid & trihybrid, physical basis of independent assortment, Gene vs Allele: A modified concept, fine structure of gene.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Elements of Genetics: Chromosomes:- Introduction, chromosome number, size, morphology, chemical composition of chromosome and function, Structural chromosomal aberrations:- Introduction, origin of structural aberrations, structure of chromosomal aberrations, variation in chromosomal number, Mutation:- Introduction, characteristics of mutations, classification, spontaneous and induced mutations, Population genetics:- Introduction, gene frequency, genotype frequency, gene pool.		
Text Books:		
1. B.D. Singh " Genetics" Kalyani Publications. 2. P.K.Gupta" Cell & MolegcularBiology"Rastogi Publications. 3. S.C. Rastogi" Cell& Molecular Biology" New Age International Publications.		
Reference Books:		
1. C.B. Pawar" Cell Biology" Himalaya Publications. 2. C.B. Pawar" Cell and Molecular Biology" Himalaya Publications.		

Open Elective Course - I

Biofuel and Alcohol Technology

COURSE OUTLINE

Course Title:	Biofuel and Alcohol Technology	**Short Title:**	**BAT**	**Course Code:**	

Course description:

This course is aimed to develop the basic knowledge and operations of Biofuel and alcohol technology to undergraduate students. The background expected includes a prior knowledge of BE Biotechnology courses. The goals of the course are to understand the basic principles biofuels production & fermentations for production of organic solvents and Biofuel production processes and their applications in engineering trade.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- Bioprocess engineering, Fermentation technology, Biochemistry.

Course objectives:

1. To develop the basic knowledge and skills in alcohol production.
2. To develop the basic knowledge and skills in Biofuel production.
3. To understand the concepts of Renewable & Nonrenewable energy resources.
4. To classify the various types of fermentation processes.
5. To use different recycling processes for alcohol production.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand Biofuel and biomass production.
2. Critically appraise logistical issues associated with implementing large scale biofuel and biomass energy production.
3. Perform technical, economic and environmental comparisons of various energy systems.
4. Implement the various methods of fermentations processes.
5. Illustrate the alcohol recycling & biochemistry of alcohol.

COURSE CONTENT

Name of the Subject: Biofuel and Alcohol Technology		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Introduction to Fuel Technology:

Renewable & Nonrenewable energy resources, Useful features of biofuels, Undesirable features of biofuels, Biogas technology, Biodiesel Production, Biohydrogen production.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Bioenergy from biomass:

Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion, Biomass conversion to biofuel: Thermochemical conversion, syngas fermentation.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12
Alcohol Technology: Introduction to Alcohol Technology, Raw Material of Alcohol Industry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Study of yeast production as single protein cell.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Alcoholic Fermentations: Study of different alcoholic fermentation techniques, Batch fermentation, Continuous fermentation, Modem techniques of Continuous fermentation, Bio still fermentation, Encillium process Wet milling of grain for alcohol production, Grain dry milling cooking for alcohol production, Use of cellulosic feed stocks for alcohol production, Scaling in distilleries, Fusel oil separation.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Biochemistry & Recycling of Alcohol: Study of different recycling process, Biochemistry of alcohol production, The management of fermentation in the production of alcohol, Alcohol distillation-The fundamental, Parameters & affecting alcoholic fermentations, By product of alcoholic fermentation, Distillery quality control, Alcoholometry.		
Text Books:		
1. B.D. Singh, Kalyani Publications. 2. Charles E Dryden; Rao, M. Gopala,; Sittig, Marshall. ,Out lines of Chemical Technology.		
Reference Books:		
1. Olaf A Hougen, Kwenneth M. Watson, and Roland A Ragatz, Chemical Process Principles – Part I, Material and Energy Balances by CBS Publishers and Distributors (1995). 2. T. P. Lyons ,Text books of alcohol tech.		

Open Elective Course - I

Bioorganic Chemistry

COURSE OUTLINE

Course Title:	Bioorganic Chemistry	**Short Title:**	**BC**	**Course Code:**	

Course description:

This course is aimed to develop the basic knowledge determination of molecular compounds. The goals of the course are to understand the basics of aliphatic compounds, alkanes alkynes etc.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):-

Course objectives:

1. To develop the basic knowledge and skills in Bioorganic compounds.
2. To identify the types of compounds.
3. To describe molecular structure of aromatic compounds.
4. To use techniques for qualitative and quantitative analysis of alcohols.
5. To demonstrate the industrial production of organic solvents.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand determination of molecular formula of organic compounds.
2. Apply the industrial level production of alcohol and carbonyl compounds.
3. Illustrate the structure of aromatic rings.
4. Perform the manufacturing process of organic solvents.
5. Demonstrate the techniques used for qualitative and quantitative analysis of alcohols.

COURSE CONTENT

Name of the Subject: Bioorganic Chemistry		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Fundamentals And Stereo Isomerism:

Fundamentals analysis- molecular weight, empirical and molecular formula determination. Basics of optical and geometrical isomerism- sequence rules, R and S configurations, E &Z notation, stereo isomerism of aliphatic hydrocarbons (cyclohexane and its derivatives only).

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Aliphatic Compounds:

Alkanes: preparation by Wurtz reaction, Kolbe electrolytic method, free radical substitution(mechanism of halogenations), energy of activation and transition state. ALKANES: Industrial preparation of ethylene 1,2 elimination reaction(E1 and E2 mechanism), electrophilic and free radical additionreactions (Markonikov's and Anti Markanikon's rule), isoprene rule, rubber vulcanization, compounding of rubber, elastemers.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12
Alkynes: Industrial method of preparation of acetylene, acidity of alkynes, dines-1,2 and 1,4 addition, diels-Alder reaction. Cyclo alkanes: preparation and properties of simple cycloalkanes, Bayer's strain theory		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Aromatic compounds: Benzene: structure of benezene, aromatic character, electrophilic aromatic substitution(mechanism of nitration, sulphonation, halogenations, Friedel crafts alkylation and acylation). Orientation of disubstituted benzens- activating and deactivating groups. Arenes:preparation of arenas, clemenson and WolfKishner reductions, Arylhalides: preparation of arylhalides by sand Meyer and Gattermann reaction, nucleophilic aromatic substitution.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Alcohols and carbonyl compounds: Alcohols- industrial method of preparation of ethyl alcohol, differentiation tests for primary, secondary and tertiary alcohols, Grignard synthesis of alcohols, Ethers: preparation of ethers and epoxides- Williamson synthesis		
Text Books:		
1. R.T Morrison and R.N Boyd, Text book of organic chemistry. 2. I.L Finar, Longman group publishers, A text book of organic chemistry vol.1.		
Reference Books:		
1. L.G.Wade, jr.,Pearson, A text book of organic chemistry. 2. Francis A. Carey, Tata, A text book of organic chemistry. Mc Graw-Hill Publication.		

Open Elective Course - I					
Biomedical Instrumentation					
COURSE OUTLINE					
Course Title:	Biomedical Instrumentation	**Short Title:**	**BMI**	**Course Code:**	

Course description:

This course gives basic knowledge of the principle of operation and design of biomedical instruments.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- Concept of Biotechnology.

Course objectives:

1. To analyze of biological systems and the technological advancement for health care.
2. To apply in an ethically responsible manner for the good of society.
3. To demonstrate the use of variety of software used in various biomedical instrumentations.
4. To explain basic functions of Cardiac Pacemakers and Defibrillators.
5. To use the techniques, skill and modern engineering tools.

Course outcomes:

At end of the course Student will be able to:

1. Understand principle, Working and application of biomedical instruments.
2. Analyze results related to engineering and biological problems.
3. Design variety of software used in various biomedical instrumentations.
4. Develop ability to use the techniques, skill and modern engineering tools.
5. Explore the options for biomedical instruments in higher study.

COURSE CONTENT

Name of the Subject: Biomedical Instrumentation		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Electrode Electrolyte interface, half cell potential, Polarization, polarisable and non polarizable electrodes, Ag/AgCl electrodes, Electrode circuit model; motion artifact. Body Surface recording electrodes for ECG, EMG, and EEG, Internal electrodes, needle and wire electrodes, Micro electrodes, metal microelectrodes, Electrical properties of microelectrodes, Electrodes for electric stimulation of tissue.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Vascular Systems:

Cardiovascular systems, Physiology of heart, ECG lead configuration, Blood Pressure Characteristics of blood flow, Measurement of blood flow and cardiac output.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Biophysical Techniques:

Function of kidneys, Artificial kidney, Dialysers, Membranes for Heamo-dialysis Heamo-

dialysis Machine, Portable kidney machine, Mechanics of respiration Artificial ventilation, ventilators Types, ventilator terms, classification of ventilators Modern ventilators, HF ventilators, Nebulisers and Aspirators.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Cardiac Pacemakers and Defibrillators: Need for pacemakers, external pacemakers, and Implantable pacemakers, recent developments, pacing system analyzer, need for defibrillators, DC defibrillators, Implantable defibrillators, and Defibrillators analyzers, measurement of blood PCO2.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Nervous System: Nervous system ,Classification of Nervous system, Anatomy of Nervous system, Organization of Brain Neuronal communication, Neuronal receptors, Somatic and Autonomic nervous system Spinal reflexes ., Neuronal firing measurements, EEG measurement.		
Text Books:		
1. Cromwell - Biomedical Instrumentation, Pearson / PHI. 2. Khandpur - Handbook of Biomedical Instrumentation		
Reference Books:		
1. Vander, Sherman, Human Physiology. The Mechanism of Body Function, TMH Ed.1981 2. Carr & Brown Introduction To Biomedical Equipment Technology		

Open Elective Course - I

Energy Engineering

COURSE OUTLINE

Course Title:	Energy Engineering	**Short Title:**	**EE**	**Course Code:**	

Course description:

Energy engineering aims to give students real-world technical expertise in strategic renewable energy disciplines, as well as an in depth understanding of the issues associated with renewable energies and their development, including the short and medium-term technical, technological, geopolitical and environmental challenges.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):-

Engineering Chemistry, physics and Mathematics.

Course objectives:

1. To impart introduction to energy engineering. Energy resources and forms of energy.
2. To study about Conventional Energy Sources like Coal and types of coal and byproduct, Petroleum, Natural gas and Refinery Products.
3. To study about solar energy, wind energy, geothermal, tidal energy, Bio energy.
4. To impart the knowledge of Chemical Energy Sources- Fuel cell, Hydrogen, Methanol, Nuclear energy.
5. To give the knowledge of Energy conversion processes and devices, Power plants with conventional energy sources.

Course outcomes:

At end of the course Student will be able to:

1. Apply knowledge of mathematics, science, and engineering to various processes,
2. Analyze and interpret the data.
3. Understand the conventional and nonconventional source of energy.
4. Explain the National energy strategy and energy plans, energy power management.
5. Describe the energy audit, various energy conversion processes, devices and about the power plants.

COURSE CONTENT

Name of the Subject: Energy Engineering		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Energy engineering and energy technology: Law of conservation of Energy, Generalized equation of Energy conservation, Energy resources and forms of energy, Energy demand, Changing energy consumption trends, National energy strategies of India, Crucial Issue in India's energy planning. Energy power management and Energy planning in India. Energy Audit- Types of Energy Audits Conservation and recycling.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Conventional Energy Sources:

Coal: Type of coal, classification of Indian coal. Important Properties of coal. Exploration, Coal Preparation, Removal of sulphur, Storage and Transportation of coal. Coal gasification, coal liquefaction. Petroleum, Natural gas and Refinery Products: Introduction to Petroleum and Natural gas and Naphtha. Exploration of petroleum. Production of crude oil and Natural gas. Transportation of crude oil and Natural gas. Refining of crude oil and Natural gas Refinery. Liquefaction of Natural gas

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Chemical Energy Sources:

Fuel cells: Introduction, Design and operation of aFuel cell. Classification of fuel cells: Types of fuel cells, Advantages and disadvantages of fuel cells, Applications of fuel cells. Hydrogen: Introduction, Applications of Hydrogen, Production of Hydrogen, Storage and transportation safety and management, Hydrogen technology development in India.

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Nuclear Energy:

Nuclear energy and application compared with coal, Fuels for Nuclear Fission
Reactor. Storage and Transportation. Energy from Nuclear fission reactor. Fast breeder Reactor. Boiling water reactor. Pressurized heavy and Light Water reactor. Uranium Enrichment Process. Nuclear Waste Management.

Solar Energy:

Terms and definition ,units. Application of solar heater solar energy storage, Thermal storage, battery storage. Applications of Solar energy. Wind energy: Basic Principles of wind energy conversion. Site Selection Considerations. Classification of wind energy conversion system, Wind power density, Power in wind stream, Forces on the blades of a propeller, Energy pattern factor, Definition of wind speed for Turbines.

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Bio energy:

Biomass energy resources, Biomass conversion processes, direct combustion of biomass, Thermo chemical conversion of biomass, Biochemical conversion, Ethanol from biomass, Applications, Biodiesel. Energy conversion technologies and Electrical powerplants: Power plants with conventional energy sources, Coal fired steam thermal power plants, Combined cycle power plants, Integrated coal gasification combined cycle power plants, Plant factors and reserves.

Text Books:

1. S. Rao and Dr. B.B. Parulekar, “Energy Technology” Non Conventional, Renewable and Conventional, Khanna Publishers, New Delhi.
2. G.D. Rai “Non conventional Energy Sources”, Khanna Publishers,New Delhi.

Reference Books:

1. S.B. Pandya, “Conventional Energy Technology” Fuelsand Chemical Energy Tata McGrawHill Publishing Company Ltd, New Delhi
2. S.P. Sukhatme, “Solar Energy”, Principals of thermal collection and Storage. Tata McGrawHill Publishing Company Ltd, New Delhi
3. Thipse, S. S. “ Alternative fuels” Jaico Publishing House; First edition , 2010
4. OP Gupta, Energy Technology, Khanna Book Publishing Co. (P) Ltd., Delhi 2.
5. Chakrabarti A ,Energy Engineering & Management, PHI

Lab Molecular Biology					
LAB COURSE OUTLINE					
Course Title:	Lab Molecular Biology	**Short Title:**	Lab Mol Bio	**Course Code:**	

Course description:

In this laboratory, course emphasis is on the understanding of basics of Molecular Biology techniques. The learner can use this knowledge and apply in allied branches of Biotechnology as required.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	14	28	01

End Semester Exam (ESE) Pattern:	**Practical (OR)**

Prerequisite course(s):- 11th, 12th Biology, SE Biotechnology courses

Course objectives:

1. To impart the fundamental knowledge of molecular biology at the research level to the students.
2. To develop their ability to apply the specific procedures to analyze the experimental results.
3. To get familiar with the molecular Biology lab techniques which they can apply in research.
4. To develop lab protocols to perform gene expression at in vitro level.
5. Identify the separated nucleic acids qualitatively and quantitatively

Course outcomes:

After successful completion of lab Course, student will be able to:

1. Isolate the genetic material e.g. DNA & RNA from different cells.
2. Calculate molecular weight by using DNA marker with agarose gel electrophoresis
3. Extract of chromosomal DNA from onion cells
4. Determine the melting temperature (Tm) and base composition of DNA from thermal denaturation characteristics.
5. Quantify Nucleic acids.

LAB COURSE CONTENT

Lab Molecular Biology		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	**25 marks**
		Internal Continuous Assessment (ICA):	**25 marks**

List of Experiments (Note: Minimum Eight Experiments from the following)

1. Isolation of genomic DNA from bacteria.
2. Isolation of RNA from yeast.
3. Isolation of total plasmid DNA from bacteria.
4. Calculation of molecular weight by using DNA marker with agarose gel electrophoresis.
5. DNA extraction from blood.
6. Spooling of chromosomal DNA from onion cells.
7. Determination of melting temperature (Tm) and base composition of DNA from thermal denaturation.
8. Isolation of genomic DNA from plant material.
9. Isolation of genomic DNA from yeast.

Text Books:
1. David Plummer, Introduction to Practical Biochemistry, Third Edition. 2. S. Sadasivam, A. Manickam, Biochemical Methods, Second Edition, New Age International Ltd, Publishers.
Guide lines for ICA:
Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.
Guidelines for ESE:
ESE will be based on the oral examination of laboratory experiments submitted by the students in the form of journal.

Lab Reaction Engineering					
LAB COURSE OUTLINE					
Course Title:	Lab Reaction Engineering	**Short Title:**	Lab RE	**Course Code:**	

Course description:

The goal of the Lab course is intended to provide a strong foundation in concepts and principles of Chemical reactions used in bioprocess industries.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
Laboratory	02	14	28	01

End Semester Exam (ESE) Pattern:	**Oral (OR)**

Prerequisite course(s): 12th Std. Science and SE Biotechnology Courses.

Course objectives:

1. To impart the fundamental knowledge of Chemical reaction engineering to the students.
2. To develop their ability to apply the specific procedures in industries.
3. To analyze the experimental results.
4. To apply absorption and adsorption processes for heterogeneous systems.
5. To analyze & interpret data obtained during performance of the experiment

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Understand the kinetic study of various chemical and biochemical reactions used in process industries
2. To design various types of Reactors.
3. Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
4. Demonstrate the understanding of professional and ethical responsibilities.
5. Understand the environmental issues and to provide solutions for green and clean technologies

LAB COURSE CONTENT

Lab Reaction Engineering		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	**25 marks**
		Internal Continuous Assessment (ICA):	**25 marks**

List of Experiments (Note: Minimum Eight Experiments from the following)

1. To determine the reaction rate constant {k} for given reaction.(CSTR / BATCH / SEMIBATCH / PFR)
2. To determine the effect of temperature on reaction rate constant. .(CSTR / BATCH / SEMIBATCH / PFR)
3. To determine the activation energy {E} for the given reaction. .(CSTR /BATCH / SEMIBATCH / PFR)
4. To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance { σ2} and skewness { S3} for plug flow reactor.
5. To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance {σ_2} and skewness{S_3} for annular reactor.
6. To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm}

variance {σ2} and skewness {S3} for packed Bed reactor.
7. To study the cascade CSTR.
8. To study the kinetic in tubular flow reactor [coiled tube] for the given reaction.

Text Books:

1. H. Scott Fogler, Elements of chemical reaction engineering, Prentice Hall New, Jersy.
2. 2. Octave Levenspiel, Chemical reaction engineering, John Wiley and sons.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Guidelines for ESE:

ESE will be based on the oral examination of laboratory experiments submitted by the students in the form of journal.

Lab Pharmaceutical Biotechnology						
LAB COURSE OUTLINE						
Course Title:	Lab Pharmaceutical Biotechnology		**Short Title:**	Lab PBT	**Course Code:**	
Course description:						
In this laboratory, course emphasis is on the understanding of basics techniques of pharmaceutical processes. The learner can use this knowledge and apply in allied branches of Biopharmaceutical and Biotechnology as required.						
Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**		
Laboratory	02	14	28	01		
End Semester Exam (ESE) Pattern:		**Oral (OR)**				
Prerequisite course(s): Microbiology, Bioprocess Engineering.						
Course objectives:						
1. To impart the fundamental knowledge of pharmaceutical processes at the research level. 2. To develop their ability to apply the analytical techniques for interpreting experimental results. 3. To Estimate the antimicrobial assay of antibiotic, introduction to zone of inhibition and calculation. 4. To Study Immobilization of enzymes/cells by calcium alginate/gelatin/agar. 5. To Determination of thermal death time and thermal death point.						
Course outcomes:						
Upon successful completion of lab Course, student will be able to:						
1. Isolate the microbes by air microbiology: solid and liquid impingement methods. 2. Apply the use coliform count of water by MPN technique. 3. Identify the sterility as per IP. 4. Explain the functions of selective media: McConkey Agar, Cetrimide Agar, Vogel Johnson, Salt mannitol agar. 5. Study various immunology and biochemical test.						
LAB COURSE CONTENT						
Lab Pharmaceutical Biotechnology			**Semester:**	**V**		
Teaching Scheme:			**Examination scheme**			
Practical:	**2 hours/week**		**End semester exam (ESE):**		**25 marks**	
			Internal Continuous Assessment (ICA):		**25 marks**	
List of Experiments (Note: Minimum Eight Experiments from the following)						
1. Air microbiology by solid and liquid impingement methods. 2. Coliform count of water by MPN technique. 3. Test for sterility as per IP (Injection water/ nonabsorbent cotton/soluble powder/ear drops). 4. Microbial limit test on excipients as per I.P. – Hard gelatin, tragacanth, starch, lactose 5. Studies on selective media: McConkey Agar, Cetrimide Agar, Vogel Johnson, Salt mannitol agar. 6. Antibiotic sensitivity test by disc method. 7. Widal test tube agglutination method. 8. Biochemical tests (Catalase, Oxidase, Urease, Nitratase, Protease, Amylase and						

IMVIC).
9. Antimicrobial assay of antibiotic, introduction to zone of inhibition and calculation.
10. Immobilization of enzymes/cells by calcium alginate/gelatin/agar.
11. Isolation of DNA.
12. Selection and isolation of bacteria by replica plating.
13. Determination of thermal death time and thermal death point.
14. Effect of Ultra-Violet exposure on growth of E coli.
15. Demonstration of electrophoresis either by PAGE or Agarose gel electrophoresis.

Text Books:

1. Kanai L. Mukherjee, Medical Laboratory Technology: A Procedure Manual for Routine Diagnostic Tests Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Desmond S. T. Nicholl, An Introduction to GENETIC ENGINEERING, 2nd Edition, Cambridge University Press.
3. Wulf Crueger & Anneliese Crueger, Panima, Biotechnology: A Textbook of Industrial Microbiology, 2nd Edition, Publishing Corporation, New Delhi/Bangalore.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Guidelines for ESE:

ESE will be based on the oral examination of laboratory experiments submitted by the students in the form of journal.

Minor Project (Stage – I)

LAB COURSE OUTLINE

Course Title:	**Minor Project (Stage – I)**	**Short Title:**	**MPROJ-S-I**	**Course Code:**	

Course description:

Minor project represent the culmination of study towards the Bachelor of Engineering degree. The minor project offers the opportunity to apply and extend material learned throughout the program. The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	6	**14**	**84**	**3**

End Semester Exam (ESE) Pattern:	**----**

Prerequisite course(s):

Course objectives:

1. To understand the basic concepts & broad principles of projects.
2. To understand the value of achieving perfection in project implementation & completion.
3. To apply the theoretical concepts to solve problems with multidisciplinary approach.
4. To demonstrate professionalism with ethics.
5. To present effective communication skills and relate engineering issues to broader societal context.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Conduct an engineering project.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

LAB COURSE CONTENT

Minor Project (Stage – I)		**Semester:**	**V**
Teaching Scheme:		**Examination scheme:**	
Practical:	**6 hours/week**	**Internal Continuous Assessment (ICA):**	**50 marks**

At third year the students shall carry out a minor project in a group of maximum up to 5 students. The project work spans both the semesters. By the end of Semester – V the students shall complete the partial work, and by the end of Semester – VI the students shall complete remaining part of the project. Assessment for the project shall also include presentation by the students. Each teacher can guide maximum 04 groups of minor projects.

The students should take project work, as specified in the curriculum, based on the knowledge acquired by the students during the degree course till Semester – IV. The project may be either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department. The work may also be Study/Survey/Design.

Minor Project (Stage – I) may involve literature survey, problem identification, design methodology, collection of data etc. The project work shall involve sufficient work so that students get acquainted with different aspects of design and analysis. Approximately more than 50% work should be completed by the end of Semester – V. Each student group should submit partial project report in the form of thermal bound at the end of Semester –V.

Each student group is required to maintain separate log book for documenting various activities of the project.

Suggestive outline for the partial project report is as follows.

Abstract
Chapter 1. Introduction
Chapter 2. Project Planning and Literature Survey
Chapter 3. Methodology
Chapter 4. Implementation and Analysis
Chapter 5. Testing
Chapter 6. Result and Discussion
Chapter 7. Conclusion & Future Work
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Appendix

Guide lines for ICA:

The Internal Continuous Assessment (ICA) for project shall be based on continuous evaluation of students' performance, active participation, knowledge / skill acquired throughout semester and presentation by the students. The assessment shall be done jointly by the guide and departmental committee. A three-member departmental committee including guide, appointed by Head of the department, shall be constituted for the assessment. The assessment for Minor Project (stage – I) in Semester – V shall be as per the guidelines given in Table – A.

Table – A

		Assessment by Guide					Assessment by Departmental Committee		
Sr. No.	Name of the Student	Attendance / Participation	Problem Identification / Project Objectives	Literature Survey	Methodology / Design	Report	Depth of Understanding	Presentation	Total
	Marks	5	5	5	5	5	10	15	50

Constitution of India

Basic features and fundamental principles:

The Constitution of India is the supreme law of India. Parliament of India cannot make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions: National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21

Kavayitri Bahinabai Chaudhari

NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Engineering

(Biotechnology Engineering)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
3rd Cycle

SYLLABUS

Semester – VI

W.E.F. 2020 – 21

Genetic Engineering					
COURSE OUTLINE					
Course Title:	Genetic Engineering	**Short Title:**	GE	**Course Code:**	

Course description:

This course is introduced for learning the basic fundamentals of Genetic Engineering to undergraduate students. The goals of the course are to understand the basic knowledge of Genetics, different enzymes used to engineer the genes, rDNA technology, and applications of rDNA technology.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 12th Std. Science and SE Biotechnology Courses.

Course objectives:

1. To provide the basic knowledge of Genetics.
2. To explain the role of different types of enzyme in genetic engineering studies.
3. To demonstrate the mechanism of rDNA technology, and its applications.
4. To classify the various techniques of gene sequencing.
5. To use the various types of genetic/molecular markers in genetic research.

Course outcomes:

After successful completion of this course the student will be able to:

1. Apply the knowledge of rDNA technology for the construction of novel gene for the better use with wide functionality.
2. Use various vector systems to study functionality of inserted gene.
3. Demonstrate various techniques in gene sequencing.
4. Apply the knowledge of genetics for human welfare in disease diagnosis, in criminal cases as well as pharmaceuticals for drug designing and development.
5. Explain mechanism of molecular markers that are used in genetic engineering study.

COURSE CONTENT

Name of the Subject: Genetic Engineering		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Recombinant DNA technology:

The recombinant DNA concept, Important Discoveries, Principles of cloning, Biohazards and Bioethics of Genetic Engineering.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

The Tools: Enzymes:

Nucleases, The Restriction Endonucleases Type I, II, III, star activity, isoschizomers Phosphodiesterase, Polynucleotidekinase, DNAligase, DNApolymeraseI, Reversetranscriptase, Terminal deoxynucleotidyl transferase, Poly A polymerase.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

The Tools: Vector Systems:

E coli systems – the host cells , E. coli – Plasmid Vectors , E .coli – Bacteriophage vectors , E. coli systems –Plasmid-Phage combination vectors , Other Prokaryotic Host-Vector systems , Eukaryotic Host-Vector Systems: Yeast, Eukaryotic Host-Vector Systems: Animals, Eukaryotic Host-Vector Systems: Plants.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Molecular research procedures: DNA sequencing techniques PCR, Blotting Techniques, Gene silencing techniques, RNAi, Knockout Technology, SAGE.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Significance of rDNA technology and Human Welfare: Gene therapy, Restriction fragment length polymorphism (RFLPs), Random amplified polymorphic DNA (RAPD), SNPs, AFLP, microarray, DNA fingerprinting.		
Text Books:		
1. Benjamin Lewin, Benjamin Cummings; Genes VIII, United States edition. 2. R.C.Dubey, Textbook of Biotechnology, S. Chand & Co. P Ltd, New Delhi.		
Reference Books:		
1. B.D.Singh, Textbook of Biotechnology, Kalyani Publication. 2. U.Satyanarayana, Textbook of Biotechnology , Books and Allied Pvt.Ltd. 3. Genes and Genomes – Singer M and Berg P.		

Mass Transfer					
COURSE OUTLINE					
Course Title:	Mass Transfer	**Short Title:**	MT	**Course Code:**	

Course description:

The goal of the course is intended to provide a strong foundation in concepts and principles of mass transfer operations used in industries.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 12th Std. Science and SE Biotechnology Courses.

Course objectives:

1. To understand the basic principles of separation techniques.
2. To design various mass transfer equipments.
3. To identify the appropriate criteria for selection among alternative separation technologies
4. To improve yield and purity of various products in process industries.
5. To describe the various types of separation techniques.

Course outcomes:

After successful completion of this course the student will be able to:

1. Demonstrate the knowledge of various mass transfer operations and its application in process industries.
2. Explain & apply knowledge of different separation techniques in downstream processing.
3. Apply appropriate criteria for selection among alternative separation technologies.
4. Increase yield and purity of various products in process industries by applying knowledge.
5. Ability to analyze and design mass transfer equipments.

COURSE CONTENT

Name of the Subject: Mass Transfer		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to mass transfer:

Equilibrium for mass transfer process: Local two phase mass transfer. Local overall mass transfer coefficient, Use of local overall coefficient. Material balances for steady state co current, countercurrent, cross flow cascade, counter flow cascade.

Introduction to mass transfer operations, Steady state molecular diffusion in fluid at rest, Multi component mixture diffusion, Maxwell's law of diffusion. Diffusion in solids, Unsteady state diffusion. Mass transfer coefficient in laminar and turbulent flow Theories of mass transfer.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Distillation:

Introduction to distillation process, Vapor liquid equilibrium, The methods of distillation (Binary mixture), The fractionating column, McCabe Thiele & Lewis Sorel method, Batch

distillation, Azeotropic, extractive and steam distillation.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Extraction & Leaching: Introduction to extraction process, Liquid equilibria, Material balances for stage wise contact methods, Stage contact and continuous contact type extractors. Leaching: General principles of leaching, working principle of moving-bed leaching equipments: Bollman extractor, Hildebrandt extractor.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Adsorption and ion exchange operation: Introduction to adsorption operation, Type of adsorption operation, Nature of adsorbents, Adsorption equilibria, Adsorption of liquids, Material balances for stage wise for operation, Continues contact process for adsorption, Principle of ion exchange operation, Rate of ion exchange operation, Application of ion exchange operation.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Crystallization and Drying: Introduction to crystallization, Effect of impurities in crystallization, Effect of temperature on solubility, Caking and yield of crystals, Different type of crystallizers. Introduction to Drying operation: Rate of drying, Mechanism of moisture movement during drying, Drying equipments, Different methods of drying.		
Text Books:		
1. R. E. Treybal , Mass transfer operation ,McGraw Hill Publication 2. Coulson and Richardson Chemical Engineering (Vol. I and II), Pergamon Press		
Reference Books:		
1. Christie J. Geankoplis ,Transport Processes and Unit Operations ,Prentice Hal inc 2. P. Chattopadhayay , Unit operation in Chemical Engg. (Vol. I and II), Khanna Publications Delhi. 3. B.K. Dutta, Principles of Mass Transfer and Separation Processes, PHI Publication .		

Bioprocess Engineering					
COURSE OUTLINE					
Course Title:	Bioprocess Engineering	**Short Title:**	BPE	**Course Code:**	

Course description:

This course is aimed at introducing the fundamentals of bioprocess engineering. The basics of bioreactor designing have also been incorporated in the course. The course also includes study of various types of bioreactors.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 12th Std. Science and SE Biotechnology Courses.

Course objectives:

1. To provide the basic knowledge of fermentation processes.
2. To analyze various media preparations along with the sterilization procedures.
3. To describe the various parameters involved in bioreactors designing.
4. To provide the knowledge of various types of industrially used bioreactors.
5. To understand the basic concepts of solid and submerged fermentations.

Course outcomes:

After successful completion of this course the student will be able to:

1. Apply knowledge of chemical and mechanical engineering for design of biological system in biotech industries.
2. Design and conduct experiments on different bioreactors and to analyze and interpret data for optimization of process.
3. Design various bioprocess equipment to meet desired needs of mankind within realistic constrain like social, ethical, health and safety.
4. Get the knowledge of properties of materials and its view in designing bioprocess equipment within the standards prescribed by regulating authority in India and world.
5. Integrate knowledge of bioscience, biochemical engineering, in commercial context to solve a substantial range of bio- processing and biological engineering problems and issues for production of value added products for societal development.

COURSE CONTENT

Name of the Subject: Bioprocess Engineering		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Introduction to Fermentation process & Media for Industrial Fermentation Process:

Upstream Process, Downstream Process, Range of fermentation process, Component parts of fermentation process , Medium Sterilization. Batch Sterilization: Continuous sterilization, Fermenter Sterilization, Feed Sterilization, Filter sterilization.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Design of Bioreactors:

Introduction, Basic objective in design of a reactor, aseptic operation and containment, body construction, aeration and agitation, stirrer glands and bearings, baffles design, sparger system,

achievement and maintenance of aseptic conditions, valves and steam traps, types of valves and pressure control valves. Scale up of fermenters, design condition for scale up, scale-up methods.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Types of Bioreactors:

Batch bioreactors, Continuous bioreactors, Semi continuous bioreactors, Stirred tank bioreactors, Airlift bioreactor systems, Trickle bed bioreactor, Airlift external loop bioreactors, waldhof-type fermenter, Tower fermenter, Cylindro- conical vessel, Deep jet fermenter, Cyclone column, Rotating disc fermenter, Reactor dynamics: Dynamic models and stability

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Solid state & Submerged Fermentation, Process monitoring & Control:

Introductions, types of solid state fermenter, Submerged Fermentation , Brief introduction to pipe joints, Physical and chemical sensors for medium and gases, Online/ Offline sensors.

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

Bioreactor Design Considerations:

Design consideration: Design codes, maximum working pressure, design pressure, design temperature, design stress, factor of safety, and selection of factors of safety, design of wall thickness, corrosion ratio, Poisson ratio, criteria of failure. Materials of construction: mechanical properties, materials, corrosion, protective coating, choice of materials, corrosion prevention.

Text Books:

1. Bailey JE and Ollis DF, Biochemical Engineering Fundamentals (1986) (2/e), McGraw-Hill International Editions CES, Singapore.
2. Blanch HW and Clark DS, Biochemical Engineering (1997) Marcel Dekker Inc., USA.
3. Shuler ML and Kargi F, Bioprocess Engineering: Basic Concepts (2002), Pearson Education Pvt. Ltd., Singapore.

Reference Books:

1. Stanbury PF, Whitaker A and Hall SJ, Principles of Fermentation Technology (1995) 2nd Edition, Butterworth- Hienemann Ltd., UK
2. Moo-Young M, Comprehensive Biotechnology Vol. 2 (1985) Pergamon Press Ltd., UK.
4. Doran PM, Bioprocess Engineering Principles (1995) Academic Press Ltd, USA.

Professional Elective Course - II					
Plant Biotechnology					
COURSE OUTLINE					
Course Title:	Plant Biotechnology	**Short Title:**	PBT	**Course Code:**	

Course description:

This course is framed to develop the basic knowledge of plant tissue culturing methods to undergraduate students. The goals of the course are to understand the basic principles of plant tissue culturing and their applications in the field of Biotechnology.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 12th STD, Genetic engineering and Fermentation Technology.

Course objectives:

1. To develop the basic knowledge and skills of plant tissue culturing, like explants, callus, anther, ovary, etc.
2. To understand the mechanism of making of genetically modified plants for understanding their role in the field of Biotechnology.
3. To explain the concept of totipotency.
4. To demonstrate the mechanism of gene transfer techniques.
5. To classify the types of plant tissue culture techniques.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the bioethical issues related to plant Biotechnology.
2. Apply the advanced techniques in plant tissue culturing for making the modified varieties of plants.
3. Develop the disease and pest resistant plants.
4. Produce the value added products which are having commercial value by applying the protocols of fermentation technology.
5. Explore the options for plant biotechnology in higher study.

COURSE CONTENT

Name of the Subject: Plant Biotechnology		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Plant Tissue Engineering-I:

Introduction to tissue engineering, Media components (micro and macro nutrients) and preparation, Media selection, Cellular totipotency, Practical application of cellular totipotency, Criteria for selection of explants, Classification of tissue culture, callus culture, cell suspension culture, Application of callus culture and cell suspension culture, single cell culture, Meristem culture.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Plant Tissue Engineering-II:

Bioprocess consideration in using plant cell cultures, Bioreactors for suspension cultures,

Bioreactors for organized tissue, Production of secondary metabolites, Anther culture, Ovary culture, Embryo culture, Protoplast culture, Synthetic seeds and preservations.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Plant transformation Technology: Agrobacterium mediated gene transfer; Agrobacterium based vectors, viral vectors and their application. Direct gene transfer methods; chemical methods, electroporation, microinjection, particle bombardment.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Plant Tissue culture, Genetic Engineering for Productivity and Performance-I: Somatic embryogenesis, organogenesis; Protoplast isolation culture and fusion, Production of haploids, Somaclonal variations, Germplasm conservation (Cryopreservation), Herbicide resistance, Insect resistance plants, Disease resistance plants, virus resistance plants.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Molecular farming & Industrial products, Genetic Engineering for Productivity and Performance-II and Metabolic Engineering: Abiotic stress tolerance; Drought, temperature, salt, Metabolic engineering for plant primary metabolites and secondary metabolites, Application of Plant biotechnology for the production of quality oil, Industrial enzymes, Therapeutic Proteins, Antigens (edible vaccine) and plantibodies.		
Text Books:		
1. B.D.Singh, Biotechnology: Expanding Horizons, Kalyani Publishers, New Delhi, Second Revised Edition, 2008. 2. J.Hammond,P.McGarvey and V.Yusibov (Eds.), Plant Biotechnology New Products and Applications, Springer. 3. S.S.Purohit, Biotechnology: Fundamentals and Applications, Agrobios (India), 4th Edition, 2005.		
Reference Books:		
1. R.A.Dixon and Gonzales, Plant Cell Culture : A Practical Approach, IRL Press. 2. Roberta Smith, PlantTissue Culture:Techniques and Experiments. 2nded., Academic Press,2000. 3. Bhojwani, S.S.and Rajdan, Plant Tissue Culture: Theory and Practice,2004.		

Professional Elective Course - II					
Protein Engineering					
COURSE OUTLINE					
Course Title:	Protein Engineering	**Short Title:**	PE	**Course Code:**	

Course description:

This course is aimed to develop the knowledge of basics proteins, its role and functions in living systems.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 12th STD, Cell Biology, Biochemistry

Course objectives:

1. To develop the basic knowledge and skills of protein structure determination.
2. To understand the concept of protein engineering and applications of proteins in Biotechnology research.
3. To explain the analytical techniques for protein structure determination.
4. To develop the various techniques for protein extraction and purification.
5. To understand the software used in protein modeling and drug design.

Course outcomes:

After successful completion of this course the student will be able to:

1. Determine the various structures of proteins.
2. Handle analytical instruments for protein structure determination.
3. Design the drugs with the help of computational methods.
4. Classify the various techniques of protein purification.
5. Explain the various applications of proteins in the field of Biotechnology.

COURSE CONTENT

Name of the Subject: Protein Engineering		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Proteins:

Introduction, biosynthesis of protein, post translation modification, primary, secondary, tertiary and quaternary structure of proteins, conformational analysis and forces that determine protein structure, energy status of a protein , effect of amino acids on structure of proteins with example, structure and functional relationship.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Structure Determination:

Methods of protein isolation, purification and quantification, physical methods to determine protein structure: X-ray crystallography, NMR spectroscopy; amino acid sequencing methods.

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

Protein Engineering:

Mutagenesis, types of mutagenesis, site directed mutagenesis, protein engineering,

modifications to 3D structure of proteins, design and synthesis of peptides, PCR, PCR insite directed mutagenesis.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Application of Protein Engineering: Specific examples of engineered enzymes, Tryesyl tRNA synthetase, Dihydrosolate reductase, Subtilisin, Pepsin class of enzymes, Lysozyme, charging tRNA, Peptide vaccines, Engineered Proteins in medical application, Chemical modifications: phosphorylation, glycosylation, methylation, formylation, Application of engineered proteins.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Protein Modeling and Drug Design: Protein database, structure database, alignment methods to determine protein function and similarity, structure prediction, molecular modeling, structural similarities and superimposition techniques, Molecular interactions: docking, calculation of molecular properties, energy calculation in docking, introduction to software used in protein modeling and drug design.		
Text Books:		
1. Klaus Demobowsky, .Novel Therapeutic Proteins.: Wiley Publications. 2. Ronald Kellner et al., .Microcharacterisation of proteins., 2nd ed. Wiley, Publications 3. Susane Brakmann, .Directed Molecular Evolution of Proteins.- Wiley Publications		
Reference Books:		
1. Walsh,Protein: Biotechnology and Biochemistry., 2nd ed., Wiley Publications 2. Westermeier . .Proteomics in Practice.- Wiley Publications. 3. Buchanan B.B. Grussem. W. and Jones. R.L. 2000. .Biochemistry and Molecular 4. Biology of Plants.. American Society of Plant Physiologists, Maryland, USA. 5. Messer- Schmidt, .Handbook of Metaloproteins. . Wiley Publications.		

Professional Elective Course - II

Metabolic Engineering

COURSE OUTLINE

Course Title:	Metabolic Engineering	**Short Title:**	ME	**Course Code:**	

Course description:

This course is aimed to develop the knowledge of basics of metabolic engineering, metabolic regulations, and analysis of pathways.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- Cell Biology, Biochemistry

Course objectives:

1. To develop the basic knowledge and skills of metabolic reaction of living systems in research projects.
2. To understand the Computational Methods for metabolic Pathways.
3. To explain the concepts of metabolic flux.
4. To describe the Different models for cellular reactions.
5. To understand thermodynamic cellular process.

Course outcomes:

After successful completion of this course the student will be able to:

1. Explain metabolic pathways of living systems.
2. Demonstrate knowledge of regulations in metabolic regulations in living systems
3. Analyze computational methods in metabolic pathways.
4. Explain the concept of metabolic flux and its applications.
5. Demonstrate the concept of thermodynamics of cellular processes.

COURSE CONTENT

Name of the Subject: Metabolic Engineering		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Introduction to Metabolic Engineering:

Basic concepts of metabolic engineering, overview of cellular metabolism, introduction to various metabolic pathways, primary and secondary metabolites, medical and Agriculture, importance of secondary metabolites.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Metabolic Regulation:

Metabolic regulation of genome level, Jacob and Monad model, coordinate regulation of prokaryotic gene expression, lactose operon, tryptophan operon, feedback regulation, cumulative feedback regulation, regulation of gene expression.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12
Computational Methods for Pathways: Introduction, Analysis of pathways: metabolic pathways, genetic pathways, signaling pathways, pathway resources, metabolic control analysis, simulation of cellular activities, biological markup languages.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Metabolic Flux: Metabolic pathway synthesis algorithms, metabolic flux analysis and its application, mathematical calculation for the flow of carbon and nitrogen fluxes, methods for experimental determination of metabolic fluxes by isotope labeling, stereochemistry of regulatory molecules, concepts of regulatory analogs.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Different models for cellular reactions, genetic regulation of metabolic fluxes, examples of metabolic pathway manipulations and engineering, analysis of metabolic control and structure metabolic networks, thermodynamics of cellular processes.		
Text Books:		
1. James Bower and Itamid Bodour, Computational modeling of Genetic and Biochemical Networks, 2. Valino, Metabolic Flux Analysis. 3. Vittal.R.Srinivas, Bioinformatics: A Modern Approach, PHI.		
Reference Books:		
1. S.C.Rastogi, N.Mendiratta, P.Rastogi, Bioinformatics: Methods and Applications, PHI. 2. D. Voet and J.G. Voet 1990, Biochemistry, John Willey and Sons. 3. Szallasi, Stelling, Periwal, System Modeling in Cellular Biology: From Concepts to Nuts and Bolts, PHI, New Delhi.		

Professional Elective Course - II					
Stem Cell Technology					
COURSE OUTLINE					
Course Title:	Stem Cell Technology	**Short Title:**	SCT	**Course Code:**	

Course description:

This course is aimed to develop the knowledge of basics of stem cell biology, pluripotency and induced pluripotency, adult, embryonic and cancer stem cells, and the barriers to regenerative medicine, including scientific, ethical, regulatory and proprietary issues to undergraduate students. The goals of the course are to understand the basic principles of modern aspects of stem cell technology and the techniques of stem cell science.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- Cell Biology, Immunology.

Course objectives:

1. To develop the basic knowledge and skills of stem cell science in research projects.
2. To understand the concepts of embryonic stem cells.
3. To identify the different stem cells.
4. To demonstrate the mechanism of cell signaling.
5. To use understand the phenomenon of Stem cells in tissue engineering.

Course outcomes:

After successful completion of this course the student will be able to:

1. Grow the embryonic stem cell in lab
2. Understand stem cell in regeneration of cells.
3. Perform stem cell therapies.
4. Understand the ethical issues related to stem cell technology.
5. Illustrate various therapeutic applications of stem cells.

COURSE CONTENT

Name of the Subject: Stem Cell Technology		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Stem cells:

Introduction: Tissue organization, Stem cells, Sources, Unique properties of stem cells, classification, Embryonic stem cells, adult stem cells, similarities and differences between adult and embryonic stem cells, Functional characterization.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Embryonic stem cells:

Stem cells and their developmental potential, In vitro fertilization-culturing of embryos blastocyst-inner cell mass-isolation and growing ES cells in lab- Identification and

characterization of human ES cells-Cloning and controlled differentiation of human embryonic stem cells, Applications of Embryonic stem cells – Gene knock in – Gene knock out.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Adult stem cells: Somatic stem cells, test for identification of adult stem cells, adult stem cell differentiation, different types of adult stem cells, liver stem cells, skeletal muscle stem cells, bone marrow derived stem cells, Induced pluripotent cells.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Cancer stem cell signaling: Introduction**:** Tumor stem cells, Breast Cancer Stem Cells: Identification - Signalingpathways: Notch signaling – Wnt signaling in stem cells and cancer cells.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Stem cells in tissue engineering: Introduction: Biomaterials, Cell and biomaterial interactions, Haematopoietic Stem Cells, Mesenchymal stem cells, Bone tissue engineering, Cartilage tissue engineering, Cardiovascular tissue engineering, Neural tissue engineering, Therapeutic applications, Parkinson's disease, Diabetes: Pancreatic cells regeneration. Stem cell based gene therapy and benefits to human.		
Text Books:		
1. Ariff Bongso, EngHin Lee “Stem Cells: From Bench to Bedside” World Scientific Publishing Company. 2005. 2. C S Potten “Stem Cells” Elsevier,1996. 3. Daniel R. Marshak “Stem cell biology” Cold Spring Harbor Laboratory Press.		
Reference Books:		
1. Robert Lanza “Essentials of Stem Cell Biology” Elevier, 2009. 2. Peter Quesenberry “Stem cell biology and Gene Therapy” Wiley, Liss,1988.		

Open Elective Course - II					
Environmental Biotechnology					
COURSE OUTLINE					
Course Title:	Environmental Biotechnology	**Short Title:**	EBT	**Course Code:**	

Course description:

This course is framed to develop the basic knowledge of Environmental Engineering to undergraduate students. The goals of the course are to understand the basic principles of Environmental Engineering and their applications in the field of Biotechnology.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- Microbiology and Bioprocess engineering.

Course objectives:

1. To develop the basic knowledge and skills of Environmental Biotechnology.
2. To explain the mechanism of Bioremediation.
3. To describe the concepts of xenobiotics.
4. To demonstrate the detail mechanism of Bioleaching & understanding their role in the field of Biotechnology.
5. To understand the mechanism of Hazardous Waste Management& Biological Control.

Course outcomes:

After successful completion of this course the student will be able to:

1. Analyze a research problem and write clear, step-by-step instructions for conducting experiments or testing hypothesis.
2. Provide examples of current applications of biotechnology and advances in the different areas i.e. environmental, bioremediation, bioleaching and xenobiotics etc.
3. Identify the role of microorganisms in biological waste treatment.
4. Describe methods used to detect and identify microorganisms in the environment.
5. Exhibit approaches to anaerobic digestion of wastes and solve related problems.

COURSE CONTENT

Name of the Subject: Environmental Biotechnology		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Environmental Pollution & Environmental Safety Regulations:

Water, air, noise and radiation (introduction, source and effects of pollutions): Types of waste, properties, global warming, Environment Protection Act- Air, Water and Forest Conservation, Methanogenesis-Methanogenic, acetogenic and fermentative bacterial processes and conditions.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Microbial Biodiversity: Diversity on earth:

Extent and importance, recovery problem, Finding New diversity, biodiversity of bacteria:

level of bacterial diversity, isolation strategies, Fungal biodiversity: isolation and identification, Recovering biodiversity using environmental DNA, accessing uncultured microbes, Environmental genomics: Screening environmental libraries, barriers and challenges		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Bioremediation: Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation, Solid phase bioremediation -land farming, prepared beds, soil piles, Phytoremediation, Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Hazardous Waste Management& Biological Control: Introduction - Xenobiotic compounds, recalcitrance, hazardous wastes - biodegradation of Xenobiotics , Biological detoxification, Biological control of foliar pathogens and pests with bacterial biocontrol agents: biocontrol agents, ecology of the plant pathogen or pest, source of antagonist, Empirical approaches to select biocontrol agents		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Treatment of Industrial Wastes: Waste water characteristics; biological waste treatment; kinetic models, unit operations, design, principle and modelling of activated sludge process. Trickling filters, fluidized reactor, up flow anaerobic sludge blanket reactor, contact process, packed bed reactor, hybrid reactors, sequential batch reactors; Bioconversions of agricultural and organic waste material into gainfully utilizable products- cellular hydrogen, food and feed stocks.		
Text Books:		
1. Metcalf Eddy – Waste water Engineering – 3rd Ed., THM publications. 2. R.S. Ramalho, - Introduction to Waste Water treatment.		
Reference Books:		
1. S.K.Agarwal, Environmental Biotechnology. 2. Martin Alexander, Biodegradation & Bioremediation (1999), Academic press.		

Open Elective Course - II					
NanoBiotechnology					
COURSE OUTLINE					
Course Title:	NanoBiotechnology	**Short Title:**	NBT	**Course Code:**	

Course description:

This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment. The goal of this course is to provide an insight into the fundamentals of nanotechnology in biological and biomedical research.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- Microbiology, Biochemistry, Molecular biology

Course objectives:

1. To understand the essential features of nanotechnology and biology that are converging to create the new area of NanoBiotechnology.
2. To recognize the structural and functional principles of NanoBiotechnology.
3. To employ bionanomaterials for analysis and sensing techniques.
4. To apprehend and explain the biomedical applications of nanotechnology.
5. To prepare nanoparticles.

Course outcomes:

After successful completion of this course the student will be able to:

1. It will also guide the students to understand how Nanomaterials can be used for a diversity of analytical and medicinal rationales.
2. Students will be able to synthesize and characterize the Nanomaterials.
3. Apply their knowledge of drug delivery by using Nanomaterials.
4. Access the toxicity of nanomaterial.
5. Apply knowledge in medical and agriculture field, waste treatment.

COURSE CONTENT

Name of the Subject: NanoBiotechnology		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Introduction to nanotechnology, Nanobiotechnology definition and concept, Cellular Nanostructures: S-layers, Nanopores, Biomolecular motors, rhodopsin, Criteria for suitability of nanostructures for biological applications, Bottom-up versus top-down models.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Methods of preparation of nanoparticles, properties of nanomaterials; nanoparticle synthesis using microbes, Basic characterization techniques**,** Electron microscopy (SEM, TEM and STM); Atomic force microscopy; Photon correlation spectroscopy and others, Introduction to BioMEMS; Recent developments in BioMEMS.

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

Concepts and advantages of microfluidic devices, Materials and methods for the manufacture

of microfluidic component, Fluidic structure,Nanostructures for drug delivery (Nanovesicles; Nanospheres; Nanocapsules, Magnetic nanoparticles; Liposomes; Dendrimers), concepts, targeting, routes of delivery and advantages.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Fluorescent nanomaterials for Biosensors and Biolabelling, Quantum dots, imaging and biosensors; Nanodevices for sensor development, Antimicrobial activity and wound healing, Artificial implants, Tissue engineering, Identification of pathogenic organisms by magnetic nanoparticle-based techniques.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Effect of nanomaterials on human health, environment and safety, Recent progress and challenges in the risk assessment of Nanomaterials, Assessment of the toxic effects of nanoparticles based on in-vitro laboratory tests.		
Text Books:		
1. Niemeyer C. M., Nanobiotechnology: Concepts, Applications and Perspectives, Wiley – VCH, 2006. 2. David S Goodsell, Bionanotechnology, John Wiley & Sons, 2004.		
Reference Books:		
1. Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon Shahidi, Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences. 2. Buddy D. Ratner, Allan S. Hoffman , Frederick J. Schoen , Jack E. Lemons. Biomaterials Science: An Introduction to Materials in Medicine 3rd Edition.		

Open Elective Course - II					
Enterprise Resource Planning & SAP					
COURSE OUTLINE					
Course Title:	Enterprise Resource Planning and SAP	**Short Title:**	ERP & SAP	**Course Code:**	

Course description:

This course is aimed at introducing foundation understanding of enterprise systems and how these systems fit into today's business operations. Enterprise Systems are now essential infrastructure to both large corporate entities, as well as to small-to-medium organization, as they remove the need to have a large number of separate individual computer-based applications.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- Industrial Management

Course objectives:

1. To know the basics of Enterprise Resource Planning and SAP.
2. To explain the concepts ERP Risk, Benefits and Related Technologies.
3. To explain about ERP Functional Modules and Implementation.
4. To explain ERP and eBusiness.
5. To explain the architecture of the SAP web application server.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the business processes.
2. Use different ERP and Related technologies.
3. Understand the functional modules of ERP.
4. Demonstrate ERP and eBusiness.
5. Understand the architecture of the SAP web application server.

COURSE CONTENT

Name of the Subject: Enterprise Resource Planning and SAP		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

ERP Introduction:

a) Enterprise – An Overview: Introduction, Business Function and Business Processes, Integrated management Information, Role of enterprising ERP system, Business Modeling, Integrated data model

b) Introduction to ERP: Introduction, Common ERP Myths, A Brief History of ERP, The Advantages of ERP, Roadmap for the successful ERP Implementation

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

ERP Risk, Benefits and Related Technologies: a) Risks and Benefits of ERP: The

quantifiable benefits from ERP system, The Intangible Benefits of ERP, Risks of ERP, Risks factor of ERP implementation, Benefits of ERP

a) ERP and Related Technologies: Introduction, BPR, Data warehousing, Data Mining, OLAP, PLM, SCM, CRM, GIS, Internet and Extranet.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

ERP Functional Modules and Implementation:

a) ERP Functional Modules: Introduction, Functional Modules of ERP software, Supply chain and customer relationship application
b) ERP Implementation Life Cycle: Introduction, Objective of ERP Implementation, Different phases of ERP Implementations

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

ERP Consultants, Vendor & Employees, eBusiness and Future Direction:

a) Consultants, Vendors and Employees: Introduction, In-house implementation Pros and Cons, Vendors, Consultants, Employee and Employee resistance, Reason for employee resistance, Dealing with employee resistance
b) ERP and eBusiness: Introduction, ERP and eBusiness, eBusiness-supply chain integration, The eBusiness process model, Components of the eBusiness supply chain, ERP/eBusiness integration, ERP internet and WWW
c) Future Direction and Trends in ERP: Introduction, New market new channel and faster implementation methodologies

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

SAP Introduction and Architecture of Web Application Server:

a) SAP Introduction: SAP Transformation into a Global Business, SAP for industries, SAP R/3 Releases and Fundamentals, SAP Enterprise Core

Application Overview, SAP Services Overview:

b) The Architecture of the SAP Web Application Server: The SAP Web Application Server, Basic Architectural Concepts, Services Work Process Types, Building the Client/Server SAP web AS System

Text Books:

1. Alexis Leon, " Enterprise Resource Planning", Second Edition, Tata Mcgraw Hill
2. Jose A. Hernandez, Jim Keogh, Franklin Foster Mertinez, " SAP R/3 Handbook", Third Edition, Tata McGraw Hill

Reference Books:

1. V.K. Garg, N .K. Venkita Krishnan, "ERP Ware: ERP Implementation Framework, PHI.
2. Annetta Clewwto and Dane Franklin, "Guide to Planning ERP Application", McGRaw-Hill, 1997.
3. George Anderson, Danielle Larocca, "Teach yourself SAP in 24 hours", Pearson Education.

Open Elective Course - II

Bioprocess Instrumentation and Analysis

COURSE OUTLINE

Course Title:	Bioprocess Instrumentation and Analysis	**Short Title:**	BIA	**Course Code:**	

Course description:

This course describes basic principles of instrumentation and instrumental analysis. This course will make the students knowledgeable in various types of measuring instruments used in process industries.

Lecture	**Hours/week**	**No. of Weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):- 12th Std. Science and SE Biotechnology Courses

Course objectives:

1. To accustom the student with various types of Measurement techniques.
2. To impart the knowledge of various types of controller.
3. To make the student familiar with various methods of composition analysis.
4. To understand basic principles behind the working of different analytical instruments.
5. To apply the various applications of instruments in industries.

Course outcomes:

After successful completion of this course the student will be able to:

1. Get familiar with various standards and calibration methods used in Instrumentation and Instrumental Analysis.
2. Get knowledge of basic principles behind the working of different analytical instruments and its application in industries.
3. Use suitable measurement technique for process industries.
4. Control system for monitoring of various parameters in bioprocess industries and to maintain safety.
5. Get insights of flame photometry and microscopy.

COURSE CONTENT

Name of the Subject: *Bioprocess Instrumentation and Analysis*		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Qualities of Measurement:

The meaning of measurement, the elements of instruments, Temperature measuring devices: Introduction, Constant volume gas thermometer, Bimetallic Thermometer, Industrial pressure spring thermometer, Industrial thermocouples. Pressure and Vacuum measuring devices: Introduction, Indicating pressure gage, Bellows pressure element, Mclead vacuum gage.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12
Process Control System: Closed loop and open loop control system, Proportional Control ,Integral Control. Derivative controller, Feed forward and feed back control , Ratio and Cascade Control, Controller Tuning.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
pH measurement: Introduction, Method of pH Indicator, Potentiometric Method, Application of pH Measurement. Infrared Spectroscopy: Introduction, Instrumentation, Application of Infrared spectroscopy. Xray diffraction: Introduction, Application of X- ray diffraction.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Refractrometry: Introduction, Abbe refractometer, Applications of refractometer. UV Spectrophotometer: Introduction, Instrumentation, Applications of UV Spectrophotometer. Colorimetery: Introduction, Theory.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Flame photometry: Introduction, Instrumentation, Applications of Flame photometry. Scanning Electron Microscope: Introduction, Instrumentatio and Applications of Scanning Electron Microscope, Transmission Electron Microscope: Introduction, Instrumentation, Application of Transmission Electron Microscope.		
Text Books:		
1. D.P.Eckman, Industrial Instrumentation, Willey Eastern Ltd., New Delhi. 2. Gurdeep Chatwal and Sham Anand, Instrumental methods of Chemical analysis, Himalaya publication House, Mumbai.		
Reference Books: 1. Nakra B.C. and K.K. Chaudhary, Instrumentation Measurement & Analysis, Tata – McGraw Hill, New Delhi.		

Lab Genetic Engineering					
LAB COURSE OUTLINE					
Course Title:	Lab Genetic Engineering	**Short Title:**	Lab Gen Engg	**Course Code:**	

Course description:

In this laboratory, course emphasis is on the understanding of basics of Genetic Engineering techniques. The learner can use this knowledge and apply in allied branches of Biotechnology as required.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	14	28	01

End Semester Exam (ESE) Pattern:	**Practical (OR)**

Prerequisite course(s):- 11th, 12th Biology, SE Biotechnology courses

Course objectives:

1. To impart the fundamental knowledge of Genetic Engineering at the research level to the students and
2. To develop their ability to apply the specific procedures to analyze the experimental results.
3. To familiar with the Genetic Engineering lab techniques which they can apply in research and Development in the field of Biotechnology.
4. To transform DNA by using various vectors
5. To impart the knowledge of Southern, Northern and western blotting for the detection of target DNA, RNA and proteins.

Course outcomes:

After successful completion of lab Course, student will be able to:

1. Use restriction digestion enzyme for various applications of DNA study
2. Use ligation enzyme to join different DNA to form new product
3. Prepare plasmid for various applications
4. Use DNA fingerprinting method by RFLP for various applications.
5. Map the genomic DNA

LAB COURSE CONTENT

Lab Genetic Engineering		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	**25 marks**
		Internal Continuous Assessment (ICA):	**25 marks**

List of Experiments (Note: Minimum Eight Experiments from the following)

1.Restriction digestion of genomic DNA of bacteria
2. Ligation of bacterial DNA.
3. Plasmid preparation.
4. DNA fingerprinting (by RFLP)
5. DNA mapping using restriction enzymes
6. Transformation of E.coli with plasmid pBR 322
7. Transduction
8. Southern Blotting
9. Northern Blotting

Text Books:

1. David Plummer, Introduction to Practical Biochemistry, Third Edition.

2. S. Sadasivam, A. Manickam, Biochemical Methods. Second Edition, New Age International Ltd, Publishers.
Guide lines for ICA:
Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.
Guidelines for ESE:
ESE will be based on the oral examination of laboratory experiments submitted by the students in the form of journal.

Lab Mass Transfer

LAB COURSE OUTLINE

Course Title:	Lab Mass Transfer	**Short Title:**	Lab MT	**Course Code:**	

Course description:

The goal of the course is intended to provide a strong foundation in concepts and principles of mass transfer operations used in industries.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
Laboratory	02	14	28	01

End Semester Exam (ESE) Pattern:	**Oral (OR)**

Prerequisite course(s): 12th Std. Science and SE Biotechnology Courses.

Course objectives:

1. To reinforce concepts of Mass Transfer operation through experimentation.
2. To accustom of unit operations like absorption, humidification, crystallization, drying operation etc.
3. To analyze & interpret data obtained during performance of the experiment for understanding the Mass Transfer lecture course.
4. To improve technical skills & ability by formulating a solution through experimentation.
5. To demonstrate the understanding of professional and ethical responsibilities.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Recognize types of diffusion and the mechanism of diffusion.
2. Demonstrate an ability to solve the mass transfer problems by calculating the Mass Transfer Coefficient.
3. Use practical considerations for designing and operation of mass transfer operations / equipments.
4. Identify, formulate, design and provide the solution to various chemical engineering problems.
5. Understand the environmental issues and to provide solutions for green and clean technologies

LAB COURSE CONTENT

Lab Mass Transfer		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	**25 marks**
		Internal Continuous Assessment (ICA):	**25 marks**

List of Experiments (Note: Minimum Eight Experiments from the following)

1. To determine mass transfer coefficient for dissolution of benzoic acid without chemical reaction.
2. Simple Distillation: To verify Rayleigh's equation for simple distillation
3. To study Bubble Cap Distillation.
4. Liquid – Liquid Extraction: To study and determine the efficiency of cross Current liquid- liquid extraction.

5. To construct ternary diagram for acetic acid –water –benzene
6. To plot Tie line diagram for acetic acid –water –benzene
7. To determine the percentage leaching of NaOH from a mixture of NaOH and CaCo3.
8. Adsorption: To study adsorption of acet ic acid on activated charcoal
9. To calculate percentage yield of crystals obtained with and without seeding in saturated solution of solute.
10. To Study Batch /Tray drying .

Text Books:

1. R. E. Treybal , Mass transfer operation ,McGraw Hill Publication
2. Coulson and Richardson Chemical Engineering (Vol. I and II), Pergamon Press

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Guidelines for ESE:

ESE will be based on the oral examination of laboratory experiments submitted by the students in the form of journal.

Lab Bioprocess Engineering					
LAB COURSE OUTLINE					
Course Title:	Lab Bioprocess Engineering	**Short Title:**	Lab BPE	**Course Code:**	

Course description:

In this laboratory course, emphasize has given on the understanding of basics of bioreactor design, various sterilization procedures involved, kinetics of the processes and fermentation procedure of various products.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	14	28	01

End Semester Exam (ESE) Pattern:	--

Prerequisite course(s):- 11th, 12th Biology, SE Biotechnology courses

Course objectives: To,

1. Impart the basic knowledge of bioprocess engineering.
2. Focus on various sterilization techniques involved in the field of bioprocess engineering.
3. Study of kinetics and other aspects of microbial cultures.
4. Learn the growth kinetics of microorganisms
5. Techniques of various fermentation processes for biomolecules fermentation

Course outcomes:

After successful completion of lab Course, student will be able to:

1. Understand the basic design of the fermenter.
2. Apply the knowledge to study kinetics of the process.
3. Apply the knowledge of sensors and various sterilization techniques involved in the process.
4. Perform various fermentation processes
5. Perform immobilization of various bioproducts

LAB COURSE CONTENT

Lab Bioprocess Engineering		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	**--**
		Internal Continuous Assessment (ICA):	**25 marks**

List of Experiments (Note: Minimum Eight Experiments from the following)

1. Introduction to the fermenter.
2. Feed Sterilization.
3. Fermenter Sterilization.
4. Growth kinetics of microorganisms using shake flask method.
5. Determination of specific thermal death rate constant (Ka).
6. Determination of Volumetric oxygen transfer coefficient (KLa), effect of aeration and agitation speed.
7. Preparation of Immobilized enzymes and cells and evaluation of kinetic parameters.
8. Kinetics study of Product formation.
9. Effect of substrate and product concentration on biomass yield for baker's yeast production.
10. Studies on settling characteristics of various microbial cultures.
11. Study of Physical and chemical sensors for medium and gases.
12. Fermentative production of Sauerkraut.

Text Books:
3. David Plummer , Introduction to Practical Biochemistry, Third Edition. 4. S. Sadasivam, A. Manickam, Biochemical Methods, Second Edition. New Age International Ltd, Publishers.
Guide lines for ICA:
Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Minor Project

LAB COURSE OUTLINE

Course Title:	**Minor Project**	**Short Title:**	**MPROJ**	**Course Code:**	

Course description:

Minor project represent the culmination of study towards the Bachelor of Engineering degree. The minor project offers the opportunity to apply and extend material learned throughout the program. The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	6	**14**	**84**	**3**

End Semester Exam (ESE) Pattern:	**Oral (OR)**

Prerequisite course(s):

Course objectives:

1. To understand the basic concepts & broad principles of projects.
2. To understand the value of achieving perfection in project implementation & completion.
3. To apply the theoretical concepts to solve problems with teamwork and multidisciplinary approach.
4. To demonstrate professionalism with ethics;
5. Present effective communication skills and relate engineering issues to broader societal context.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Conduct an engineering project
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

LAB COURSE CONTENT

Minor Project		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme:**	
Practical:	**6 hours/week**	**End semester exam (ESE): (OR)**	**25 marks**
		Internal Continuous Assessment (ICA):	**50 marks**

In continuation with Minor Project (Stage – I) at Semester – V, by the end of Semester – VI, the student should complete implementation of ideas as formulated in Minor Project (Stage – I). It may involve coding, experimentation, data analysis within realistic constraints such as economic, environmental, social, ethical, health and safety, and sustainability. It may also include testing, results and report writing. Each student group should submit complete project report at the end of Semester-VI in the form of Hard bound. Assessment for the project shall also include presentation by the students.

Each student group is required to maintain separate log book for documenting various activities

of the project.

Suggestive outline for the complete project report is as follows.

Abstract

Chapter 1. Introduction

Chapter 2. Project Planning and Literature Survey

Chapter 3. Methodology

Chapter 4. Implementation

Chapter 5. Analysis

Chapter 6. Results and Discussion

Chapter 7. Conclusion & Future Scope

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Appendix

Guide lines for ICA:

The Internal Continuous Assessment (ICA) for project shall be based on continuous evaluation of students' performance, active participation, knowledge / skill acquired throughout semester and presentation by the students. The assessment shall be done jointly by the guide and departmental committee. A three-member departmental committee including guide, appointed by Head of the department, shall be constituted for the assessment. The assessment for Minor Project in Semester – VI shall be as per the guidelines given in Table – B.

Table – B

		Assessment by Guide				Assessment by Departmental Committee			
Sr. No.	Name of the Student	Attendance / Participation	Implementation	Results	Report	Depth of Understanding	Presentation	Demonstration	Total
	Marks	5	5	5	5	10	10	10	50

Guidelines for ESE:

In End Semester Examination (ESE), the student may be asked for presentation / demonstration and questions on Project. Evaluation will be based on answers given by students in oral examination.

Internship:

Internship is a mandatory and non-credit course. It is mandatory for all admitted students to undergo Internship during the degree course. The course shall be of THREE weeks duration during summer vacation after Semester - VI. Following are the intended objectives of internship training:

- Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Experience gained from the 'Industrial Internship' will be used in classroom discussions.
- Create conditions conducive to quest for knowledge and its applicability on the job.

Students shall choose to undergo Internship / Innovation / Entrepreneurship related activities for Internship. Students shall choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations / Micro / Small / Medium enterprises / academic institutions / research institutions. In case student want to pursue their family business and don't want to undergo internship, a declaration by a parent may be submitted directly to the Department Head / TPO.

During the last year of FOUR year Bachelor of Engineering course the student should take project work, as specified in the curriculum, based on the knowledge acquired by the student during the degree course and during Internship. The project work provides an opportunity to build a system based on area where the student likes to acquire specialized skills. The work may also be on specified task or project assigned to the student during Internship.

The internship activities and list of sub-activities for Internship are as under.

- Innovation / Entrepreneurship:
    - Participation in innovation related Competitions for eg. Hackathons Robocon, Baha, IIT TechFest, Chemcon, Dipex etc
    - Development of new product/ Business Plan/ registration of start-up
    - Participation in Entrepreneurship Program of THREE weeks duration
    - Online certification courses by SWAYAM, NPTEL, QEEE etc.
    - Working for consultancy/ research project within the institutes
    - Training on Software (As per the need of respective branch);
    - Field Survey / Case Study
    - Work experience at family business
- Internship:
    - Internship with Industry/Govt. / NGO/ PSU/ Any Micro/ Small/ Medium enterprise/ academic institutions / research institutions
    - Online Internship.

- Rural Internship
    - Any Long Term Goals may be carried out by students in teams:
        - Prepare and implement plan to create local job opportunities.

- Prepare and implement plan to improve education quality in village.
- Prepare an actionable DPR for doubling the village Income.
- Developing Sustainable Water Management system.
- Prepare and Improve a plan to improve health parameters of villagers.
- Developing and implementing of Low Cost Sanitation facilities.
- Prepare and implement plan to promote Local Tourism through Innovative Approaches.
- Implement/Develop Technology solutions which will improve quality of life.
- Prepare and implement solution for energy conservation.
- Prepare and implement plan to Skill village youth and provide employment.
- Develop localized techniques for Reduction in construction Cost.
- Prepare and implement plan of sustainable growth of village.
- Setting of Information imparting club for women leading to contribution in social and economic issues.
- Developing and managing efficient garbage disposable system.
- Contribution to any national level initiative of Government of India. For eg. Digital India/ Skill India/ Swachh Bharat Internship etc.

Faculty Mentor/Supervisors have to play active roles during the internship and minimum 20 students are to be supervised by each faculty mentor or as per the departmental strength. Mentor shall be responsible for selection of Internship activities by the student under his/her supervision and shall avoid repetition of activities by the student. The college / Institute shall facilitate internship for the students.

Every student is required to prepare a file for Internship containing documentary proofs (daily training diary, comprehensive report and completion certificate) of the activities done by him/her. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily training diary should include Date, Time of Arrival, Time of Departure, Main points of the day. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working.

After completion of Internship, the student should prepare a comprehensive report to indicate what he / she has observed and learnt in the training period. The report should include Internship Objectives (in measurable terms), Internship Activities, and Internship Outcome.

The completion certificate should be signed by the supervisor / in charge of the section where the student has been working with performance remark as Satisfactory / Good / Excellent.

The evaluation of Internship shall be in Semester – VII. The evaluation shall be done by expert committee constituted by the concerned department including Department Head/ TPO/ faculty mentor or guide. It should be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Originality.

- Adequacy and purposeful write-up.
- Practical applications, relationships with basic theory and concepts taught in the course.
- Skill / knowledge acquired

Hence the satisfactory completion of Internship shall be submitted to the university at the end of Semester - VIII of FOUR year Bachelor of Engineering course. Only after successfully completion of Internship, Internship should be printed in the final year mark sheet as COMPLETED.