NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

SCHEME OF INSTRUCTION AND SYLLABI
FOR B.TECH PROGRAM

Effective from 2015-16

DEPARTMENT OF BIOTECHNOLOGY

NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

DEPARTMENT OF BIOTECHNOLOGY

VISION

To become a global centre of excellence for quality education, research, technological services and entrepreneurship in emerging areas of biotechnology

MISSION

- Imparting quality education to develop innovative, entrepreneurial and ethical professionals fit for globally competitive environment.
- Promoting scientific discovery and development in diversified fields of biotechnology through a fusion between engineering and life sciences.
- Fostering relationship with institutes of higher learning and research, alumni and industries.

GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

DEPARTMENT OF BIOTECHNOLOGY
B.TECH IN BIOTECHNOLOGY

PROGRAM EDUCATIONAL OBJECTIVES

PEO1.	Identify, analyze and solve the biotechnological problems in product and process development.
PEO2.	Identify and control hazards in bioprocess industries
PEO3.	Apply modern computational, analytical tools and techniques to address biotechnological challenges.
PEO4.	Pursue life-long learning as a means of enhancing the knowledge base and skills for professional advancements.
PEO5.	Communicate effectively and demonstrate entrepreneurial and leadership skills

Mapping of Mission statements with program educational objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4	PEO5
To develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.	2	2	3	3	3
To create a fusion of engineering and life sciences that promotes scientific discovery and development in diversified fields of biotechnology through education and research.	3	1	2	2	2
To foster relationship with other leading institutes of learning and research, alumni and industries in order to contribute to national and international needs.	1	1	3	3	3

Mapping of program educational objectives with graduate attributes

PEO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
PEO1	2	2	3	2	3	-	-	-	-	-	-	1
PEO2	2	1	1	3	2	3	3	-	-	-	-	1
PEO3	2	-	3	2	3	-	-	-	-	-	-	1
PEO4	1	-	-	-	-	3	-	3	2	1	1	3
PEO5	1	-	-	-	1	2	-	-	3	3	2	2

PROGRAM OUTCOMES: At the end of the program the student will be able to:

PO1	Apply basic science, engineering and program core to solve complex biotechnological problems.
PO2	Isolate, purify and characterize biological samples using sophisticated analytical experimental techniques.
PO3	Design process equipment, plants, biosensors and recombinant molecules for biotechnological and allied processes.
PO4	Apply research based knowledge and biotechnological methods to investigate complex biological problems
PO5	Apply modern software tools including prediction and modeling methods on biological databases to identify issues in biomedical problems
PO6	Assess personal, product and environmental safety, intellectual property and social responsibilities related to modern biotechnological research and development.
PO7	Identify measures for energy, environment, health, safety and society following ethical principles.
PO8	Work in multi-disciplinary teams to attain project objectives, document the activities and present reports effectively.
PO9	Apply engineering and management principles for effective implementation of projects
PO10	Pursue life-long learning to enhance knowledge and skills for professional advancement.

Mapping of program outcomes with program educational objectives

PO	PEO1	PEO2	PEO3	PEO4	PEO5
1	3	1	3	2	3
2	3	1	3	2	3
3	3	3	3	1	
4	3	3	3	2	
5	3	3	3	2	3
6	3	3	3	3	3
7	2	3	1	2	2
8	1	1	2	2	3
9	2		2	2	3
10	1		1	3	2

CURRICULAR COMPONENTS
Degree Requirements for B. Tech in Biotechnology

Category of Courses	Credits Offered	Min. credits to be earned
Basic Science Core (BSC)	32	32
Engineering Science Core (ESC)	33	33
Humanities and Social Science Core(HSC)	07	07
Program Core Courses (PCC)	88	88
Departmental Elective Courses (DEC)	24	18
Open Elective Courses (OPC)	6	6
Program major Project (PRC)	6	6
EAA: Games and Sports (MDC)	0	0
Total	**196**	190

SCHEME OF INSTRUCTION

B.Tech. (Biotechnology) Course Structure
B. Tech. I - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA101	Mathematics – I	4	0	0	4	BSC
2	HS101 ME102	English for Communication (or) Engineering Graphics	3 2	00	2 3	4 4	HSC ESC
3	PH101CY101	Physics (or) Chemistry	4 4	00	00	4 4	BSC BSC
4	EC101EE101	Basic Electronics Engineering (or) Basic Electrical Engineering	3 3	00	00	3 3	ESC ESC
5	CE102 ME101	Environmental Science & Engineering (or) Basic Mechanical Engineering	3 3	00	00	3 3	ESC ESC
6	CS101CE101	Prob. Solving and Computer Programming (or)Engineering Mechanics	4 4	00	00	4 4	ESC ESC
7	PH102CY102	Physics Lab (or) Chemistry Lab	00	00	3 3	2 2	BSC BSC
8	CS102ME103	Prob. Solving and Computer Programming Lab (or) Workshop Practice	00	00	3 3	2 2	ESC ESC
9	EA101	EAA: Games and Sports	0	0	3	0	MDC
		TOTAL	**21**	**0**	**11**	**26**	
			20	**0**	**12**	**26**	

B.Tech. I - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA151	Mathematics – II	4	0	0	4	BSC
2	ME102HS101	Engineering Graphics (or) English for Communication	2 3	00	3 2	4 4	ESC HSC
3	CY101PH101	Chemistry (or) Physics	4 4	00	00	4 4	BSC BSC
4	EE101EC101	Basic Electrical Engineering (or) Basic Electronics Engineering	3 3	00	00	3 3	ESC ESC
5	ME101 CE102	Basic Mechanical Engineering (or) Environmental Science & Engineering	3 3	00	00	3 3	ESC ESC
6	CE101CS101	Engineering Mechanics (or) Problem Solving and Computer Programming	4 4	00	0 0	4 4	ESC ESC
7	CY102PH102	Chemistry Lab (or) Physics Lab	00	00	3 3	2 2	BSC BSC
8	ME103CS102	Workshop practice (or) Problem Solving and Computer Prog. Lab	00	00	3 3	2 2	ESC ESC
9	EA151	EAA: Games and Sports	0	0	3	0	MDC
	Total		**20**	**0**	**12**	**26**	
			21	**0**	**11**	**26**	

II - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA201	Mathematics – III	4	0	0	4	BSC
2	BT201	Biochemical Thermodynamics	3	0	0	3	PCC
3	BT202	Biochemistry	4	0	0	4	PCC
4	BT203	Microbiology	4	0	0	4	PCC
5	CH235	Fluid Mechanics & Heat Transfer	4	0	0	4	ESC
6	BT204	Biochemistry Lab.	0	0	3	2	PCC
7	BT205	Microbiology Lab.	0	0	3	2	PCC
8	CH236	Fluid Mechanics & Heat Transfer Lab.	0	0	3	2	ESC
		Total	**19**	**0**	**9**	**25**	

II - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA251	Mathematics – IV	4	0	0	4	BSC
2	BT251	Molecular Biology & Genetics	4	0	0	4	PCC
3	BT252	Cell Biology	3	0	0	3	PCC
4	BT253	Bioprocess Calculations	4	0	0	4	PCC
5	CH285	Mass Transfer	4	0	0	4	ESC
6	BT254	Molecular Biology & Genetics Lab.	0	0	3	2	PCC
7	BT255	Instrumental Analysis Lab.	0	0	3	2	PCC
8	CH286	Mass Transfer Lab.	0	0	3	2	ESC
		Total	**19**	**0**	**9**	**25**	

III - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	BT301	Immunology	4	0	0	4	PCC
2	BT302	Bioprocess Engineering	4	0	0	4	PCC
3	BT303	Genetic Engineering	4	0	0	4	PCC
4		Elective –I	3	0	0	3	DEC
5		Elective – II	3	0	0	3	DEC
6	BT304	Immunology Lab	0	0	3	2	PCC
7	BT305	Bioprocess & Bioreaction Engg. Lab.	0	0	3	2	PCC
8	BT306	Genetic Engineering Lab.	0	0	3	2	PCC
		Total	**18**	**0**	**9**	**24**	

III - Year II – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	SM335	Engg. Economics & Accountancy	3	0	0	3	HSC
2	BT351	Bioreaction Engineering	3	0	0	3	PCC
3	BT352	Bioprocess Instrumentation & Control	4	0	0	4	PCC
4	BT353	Downstream Processing in Biotechnology	4	0	0	4	PCC
5		Elective – III	3	0	0	3	DEC
6		Open Elective-I	3	0	0	3	OPC
7	BT354	Bioprocess Instrumentation & Control Lab.	0	0	3	2	PCC
8	BT355	Downstream Processing Lab.	0	0	3	2	PCC
		Total	**20**	**0**	**6**	**24**	

IV - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	ME435	Industrial Management	3	0	0	3	ESC
2	BT401	Bioinformatics	3	1	0	4	PCC
3	BT402	Bioprocess Plant Design Modelling & Simulation	4	0	0	4	PCC
4		Elective – IV	3	0	0	3	DEC
5		Open-Elective – II	3	0	0	3	OPC
6	BT403	Bioinformatics Lab	0	0	3	2	PCC
7	BT404	Modelling & Simulation of Bioprocesses Lab	0	0	3	2	PCC
8	BT441	Seminar	0	0	3	1	PCC
9	BT449	Project Work – Part A	0	0	3	2	PRC
		Total	**16**	**1**	**12**	**24**	

IV - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	BT451	Bioethics, Biosafety & IPR Issues	3	0	0	3	PCC
2	BT452	Biostatistics	3	0	0	3	PCC
3		Elective – V	3	0	0	3	DEC
4		Elective –VI	3	0	0	3	DEC
5		Elective – VII	3	0	0	3	DEC
6	BT499	Project Work – Part B	0	0	6	4	PRC
		Total	**15**	**0**	**6**	**19**	

List of Electives

III Year-I Semester

BT311	Industrial Microbiology and Enzyme Technology
BT312	Fermentation Technology
BT313	Analytical Methods in Biotechnology
BT314	Plant Biotechnology
BT315	Biofuels
BT316	Biofertilizer Technology

III Year-II Semester

BT361	Animal Biotechnology
BT362	Environmental Biotechnology
BT363	Medical Biotechnology

IV Year-I Semester

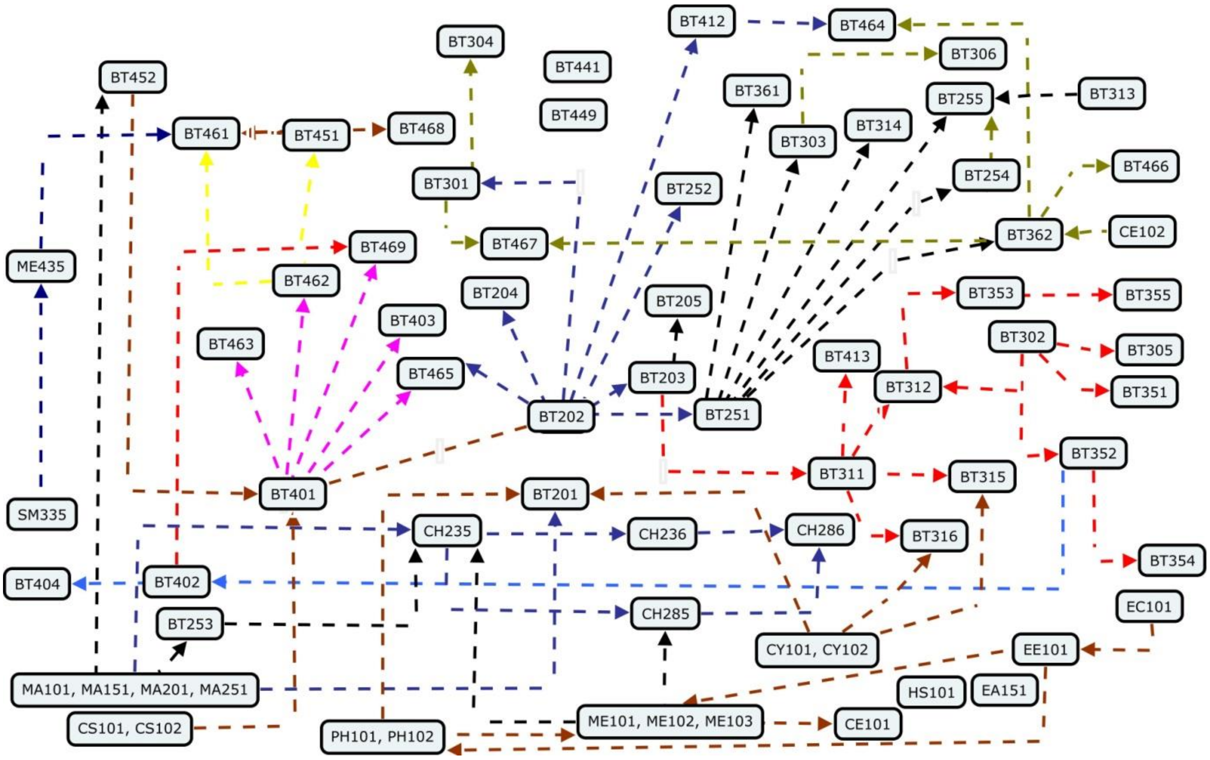
BT411	Bio Nanotechnology
BT412	Biomaterials Technology
BT413	Biotransformations and Biocatalysis

IV Year-II Semester

BT461	Drug and Pharmaceuticals Biotechnology
BT462	Drug Design and Development
BT463	Molecular Modelling and Drug Design
BT464	Tissue Engineering
BT465	Genomics and Proteomics
BT466	Stem Cell Technology
BT467	Immuno Technology
BT468	IPR Management in Biotechnology
BT469	Metabolic Regulation and Engineering

B.TECH IN BIOTECHNOLOGY

PRE-REQUISITE CHART



DETAILED SYLLABUS

MA101	MATHEMATICS – I	BSC	4 – 0 – 0	4 Credits

Pre-requisites: None.

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

CO1	Solve linear system equation
CO2	Determine the Eigen values and vectors of a matrix
CO3	Determine the power series expansion of a function
CO4	Estimate the maxima and minima of multivariable functions
CO5	Solve any given first order ordinary differential equation
CO6	Solve any higher order linear ordinary differential equation with constant coefficients

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3			2		3				
CO2	3			2		3				
CO3	3			2		3				
CO4	3			2						3
CO5	3			2		3				
CO6	3			2		3				

Detailed Syllabus:

Matrix Theory: Elementary row and column operations on a matrix, Rank of matrix – Normal form – Inverse of a matrix using elementary operations –Consistency and solutions of systems of linear equations using elementary operations, linear dependence and independence of vectors - Characteristic roots and vectors of a matrix - Caley-Hamillton theorem and its applications, Complex matrices, Hermitian and Unitary Matrices - Reduction to diagonal form - Reduction of a quadratic form to canonical form – orthogonal transformation and congruent transformation.

Differential Calculus: Rolle's theorem; Mean value theorem; Taylor's and Maclaurin's theorems with remainders, Expansions; Indeterminate forms; Asymptotes and curvature; Curve tracing; Functions of several variables, Partial Differentiation, Total Differentiation, Euler's theorem and generalization, maxima and minima of functions of several variables (two and three variables) – Lagrange's method of Multipliers; Change of variables – Jacobians.

Ordinary differential equations of first order: Formation of differential equations; Separable equations; equations reducible to separable form; exact equations; integrating factors; linear first order equations; Bernoulli's equation; Orthogonal trajectories and Newton's law of cooling.

Ordinary linear differential equations of higher order : Homogeneous linear equations of arbitrary order with constant coefficients - Non-homogeneous linear equations with constant coefficients; Euler and Cauchy's equations; Method of variation of parameters; System of linear differential equations, Vibrations of a beam.

Reading:

1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, 2008.
2. Erwyn Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8^{th} Edition, 2008.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009

HS101	ENGLISH FOR COMMUNICATION	HSC	3 – 0 – 2	4 Credits

Pre-requisites: None.

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

CO1	Understand basic grammar principles
CO2	Write clear and coherent passages
CO3	Write effective letters for job application and complaints
CO4	Prepare technical reports and interpret graphs
CO5	Enhance reading comprehension
CO6	Comprehend English speech sound system, stress and intonation

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1								3	3	
CO2								3	3	
CO3								3	3	
CO4								3	3	
CO5								3	3	
CO6								3	3	2

Detailed syllabus

Grammar Principles and Vocabulary Building: -Exposure to basics of grammar- parts of speech, with emphasis on tenses—active and passive voice- their usage- reported speech -Idioms and Phrases—their meanings and usage, Vocabulary development through prefixes, suffixes and word roots

Effective Sentence Construction –clarity and precision in construction—strategies for effectiveness in writing

Paragraphs: Definition- structure- Types and Composition-unity of theme- coherence- organization patterns

Note-making – its uses- steps in note-making—identification of important points- reduction to phrases –selection of suitable note format- types of notes—tree diagram, block list, table-

Letter Writing: Business, Official and Informal letters-- communicative purpose-strategy- letter format and mechanics- letters of request, complaint and invitation-

Reading techniques: Skimming and Scanning – quick reading for gist and –suggesting titles- looking for specific information
Description of Graphics- kinds of graphs- their construction and use and application in scientific texts- interpretation of graphs using expressions of comparison and contrast

Reading Comprehension – reading to retrieve information ––techniques of comprehension -find clues to locate important points- answering objective type questions –inference, elimination

Technical Report-Writing - kinds of reports-proposals, progress and final reports- their structure- features- process of writing a report-editing

Book Reviews- Oral and written review of a chosen novel/play- a brief written analysis including summary and appreciation- oral presentation of the novel before class

Reading

A Textbook of English for Engineers and Technologists (combined edition, Vol. 1 & 2); Orient Black Swan 2010.

PH101	PHYSICS	BSC	4 – 0 – 0	4 Credits

Prerequisites: None.

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

CO1	Solve engineering problems using the concepts of wave and particle nature of radiant energy
CO2	Understand the use of lasers as light sources for low and high energy applications
CO3	Understand the nature and characterization of acoustic design, nuclear accelerators and new materials
CO4	Apply the concepts of light in optical fibers, light wave communication systems, and holography and for sensing physical parameters
CO5	Construct a quantum mechanical model to explain the behaviour of a system at microscopic level

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3					2			2	
CO2	3					2			2	
CO3	3					2			2	
CO4	3					2			2	
CO5	3					2			2	

Detailed Syllabus:

Interference: Superposition principle, Division of amplitude and wave front division, Interferometers (Michelson, Fabry-Perot, Mach-Zehnder), Applications; Diffraction: Fraunhoffer diffraction (single, double & multiple slits), Resolving power, Dispersive power, Applications.

Polarization: Production & detection of polarized light, wave plates, optical activity, Laurents Half-shade polarimeter, photoelasticity and applications; LASERS: Basic principles of Lasers, He-Ne, Nd-YAG, CO_2 and semiconductors lasers, applications of lasers, Holography and holographic NDT.

Optical fibers: Light propagation in Optical fibers, types of optical fibers, optical fibers for communication and sensing.

Functional materials: Fiber reinforced plastics, fiber reinforced metals, surface acoustic wave materials, biomaterials, high temperature materials, smart materials and their applications, Introduction to Nano materials.

Modern physics: Qualitative review of different experiments, de-Broglie waves, Dual nature of matter, Schrodinger wave equation, wave function and its interpretation, potential well problems in one dimension, Tunneling, Uncertainty principle, Particle Accelerators: Cyclotron, Synchro Cyclotron, Betatron and applications.

Acoustics: Introduction, Reverberation and reverberation time, growth and decay of energy, Sabine's formula, absorption coefficient and its measurement, factors affecting architectural acoustics; Production, detection and applications of Ultrasound.

Reading:

1. Halliday, Resnic and Walker, Fundamentals of Physics, 9th Ed.,John Wiley, 2011.
2. Beiser A, Concepts of Modern Physics, 5th Ed., McGraw Hill International, 2003.
3. Ajoy Ghatak, Optics, 5th Ed., Tata McGraw Hill, 2012.
4. M. Armugam, Engineering Physics, Anuradha Agencies, 2003.

CY101	CHEMISTRY	BSC	4 – 0 – 0	4 Credits

Pre-requisites: None.

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

CO1	Understand and apply the concepts in electrochemistry and corrosion science
CO2	Understand the concepts in molecular interactions
CO3	Understand the synthesis and analysis of modern materials
CO4	Apply the concepts of organic chemistry for synthesis
CO5	Understand the synthesis and applications of polymer science
CO6	Identify the structure of organic molecules using photo chemistry and chemical spectroscopy

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3		2		2		2	
CO2	3	3	3		2		2		2	
CO3	3	3	3		2		2		2	
CO4	3	3	3		2		2		2	
CO5	3	3	3		2		2		2	
CO6	3	3	3		2		2		2	

Detailed Syllabus:

Electrochemistry - Review of the concepts of electrode potentials, Nernst equation, Reference electrodes, Ion selective electrodes – Concept – Glass electrode – Determination of pH of a solution using a glass electrode – Derivation of equation between E_{cell} and pH, Determination of F^- ion using fluoride electrode (Numerical calculations), Chemically modified electrodes (CMEs) – Concept, CMEs as potentiometric and amperometric sensors, Electrochemical energy systems, Electrochemistry of secondary cells e.g. Lead – acid and Ni-Cd cells, Rechargeable lithium batteries, Fuel cells – Electrochemistry of a H_2–O_2 fuel cell, methanol–O_2 fuel cell.

Corrosion and Its Prevention - Electrochemical theory of corrosion, Corrosion due to dissimilar metal cells (galvanic cells), Corrosion due to differential aeration cells, Uniform corrosion, pitting corrosion and stress corrosion cracking, Effect of pH, Potential-pH diagram for Iron, temperature and dissolved oxygen on corrosion rate, Corrosion prevention and control by cathodic protection.

Molecular Interactions - Molecular orbital theory applicable to understanding of bonding in heteronuclear diatomic molecules, e.g. CO and NO, Molecular orbital energy diagram of an Octahedral complex, MO diagram of a molecule involving charge transfer (e.g. $KMnO_4$),

Nature of supramolecular interactions: ion-ion interactions, ion-dipole interactions, dipole-dipole interactions, hydrogen bonding, cation-л interactions, л-л interactions, van der Walls forces, Concept of self-assembly involving different types of interactions (Micellar formation; Membrane Formation; Surface films).
Chemistry of Nanomaterials - Introduction to Nanomaterials, Chemical synthesis of nanomaterials: sol-gel method, Reverse micellar method, electrolytic method, Characterization of nanoparticles by BET method, Characterization of nanomaterials by TEM (includes basic principle of TEM), Applications of nanomaterials in Industry as drug delivery materials, as catalysts, in water treatment.
Basic Principles Of Organic Chemistry – Introduction, Homolytic and Heterolytic cleavages and free radicals Carbocations, carbanions and addition reactions Elimination and substitution reactions.
Stereochemistry: chirality, optical activity, enantiomers and diastereomers, Projection formulae and geometrical isomerism, Reactions - Hofmann reaction and Riemer-Tiemann reaction, Diels-Alder reaction and Cannizaro reaction, Skraup synthesis.
Polymer Chemistry - Concept of polymerization – Types of polymerization, Chain growth polymerization – mechanisms of free radical and cationic polymerizations, Mechanisms of simple anionic polymerization and co-ordination anionic polymerization (complex forming mechanism), Step-growth polymerization ,Mechanism and examples.
Thermoplastic resins and Thermosetting resins- examples and applications, conducting polymers: Mechanism of conduction in polymers – Examples – and applications.
Review Of Chemical Spectroscopy - Review of electromagnetic spectrum, Quantization of energy, Born – Oppenheimer approximation, Frank Condon Principle Vibrational spectra (Infra-red) of diatomic molecules – Selection rules Determination of force constant Problems, Identification of functional groups using IR spectroscopy Electronic spectroscopy - Types of electronic transitions –calculation of chromophoric absorptions For Diene and ene-one chromophors Qualitative analysis by electronic spectroscopy, Lambert – Beer's law-Applications in Quantitative analysis and problems.
NMR spectroscopy: Basic principles, Concept of chemical shift. Concept of spin-spin splitting and examples, Applications of UV,I.R and ^{1}H NMR spectra in the determination of structures of Ethyl alcohol, Dimethyl ether, Acetic acid and Benzyl alcohol.
Photo Chemistry – Principles of photochemistry – Rates of intermolecular processes, Jablonski diagram – fluorescence, phosphorescene and Chemiluminescence, Types of Photochemical Organic reactions, Laws of photochemistry and quantum yields-problems, Photosensitized reactions.

Reading:

1. P. W. Atkins & Julio de Paula, Atkins Physical Chemistryl Chemistry, Oxford University Press York, 7th Edn, 2002.
2. Shashi Chawla, A Text Book of Engineering Chemistry, 3rd Edition, Dhanpat Rai & Co New Delhi, 2007.
3. S. Vairam, P. Kalyani & Suba Ramesh, Engineering Chemistry, Ist Edn, John Wiley & Sons, India, 2011.
4. Lee J.D., Concise Inorganic Chemistry, 7th Edn, Blackwel Science Publications Oxford, London, 2004.
5. Jerry March., Advanced Organic Chemistry, 6th Edn, John Wiley & Sons, New Jersy, 2007.
6. FehFuYen, Chemistry for Engineers, Imperial College Press, 2008.
7. Octave Levenspiel, Chemical Reaction Engineering, 2nd Edition, Wiley India, 2006.
8. Smith J.M., Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.

EC101	BASIC ELECTRONICS ENGINEERING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Characterize semiconductors, diodes, transistors and operational amplifiers
CO2	Design simple analog circuits
CO3	Design simple combinational and sequential logic circuits
CO4	Understand functions of digital multimeter, cathode ray oscilloscope and transducers in the measurement of physical variables
CO5	Understand fundamental principles of radio communication

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3								1	
CO2	3								1	
CO3	3								1	
CO4	3								1	
CO5	3								1	

Detailed Syllabus:

Electronics Systems: Introduction to electronics, review of p-n junction operation, diode applications, Zener diode as regulator.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications, simple RC coupled amplifier and frequency response. Cascaded amplifiers, FET and MOSFET characteristics and applications.

Feedback in Electronic Systems: open loop and closed loop systems, Negative and positive feedback merits and demerits, Principle of oscillators, LC and RC oscillators.

Integrated Circuits: Operational amplifiers, Applications: adder, subtractor, Integrator and Differentiators.

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DAC's).

Electronic Instrumentation: Measurement, Sensors, Laboratory measuring instruments: digital multi-meters and Cathode Ray Oscilloscopes (CRO's).

Principles of Communication: Need for Modulation, Modulation and Demodulation techniques.

Reading:

1. Neil Storey, “Electronics A Systems Approach”, 4/e - Pearson Education Publishing Company Pvt Ltd, 2011.
2. Salivahanan, N Suresh Kumar, “Electronic Devices and Circuits” 3/e, McGraw Hill Publications, 2013.
3. Bhargava N. N., D C Kulshreshtha and S C Gupta, “Basic Electronics & Linear Circuits”, Tata McGraw Hill, 2/e, 2013 .

EE101	BASIC ELECTRICAL ENGINEERING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Analyze and solve electric and magnetic circuits
CO2	Identify the type of electrical machines for a given application
CO3	Recognize the ratings of different electrical apparatus
CO4	Identify meters for measuring electrical quantities

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3								1	
CO2	3								1	
CO3	3								1	
CO4	3								1	

Detailed Syllabus:

DC Circuits: Kirchhoff's Voltage & Current laws, Superposition Theorem, Star – Delta Transformations.

AC Circuits: Complex representation of Impedance, Phasor diagrams, Power & Power Factor, Solution of Single Phase Series & Parallel Circuits. Solution of Three Phase circuits and Measurement of Power in Three Phase circuits.

Magnetic Circuits: Fundamentals and Solution of Magnetic Circuits, Concepts of Self and Mutual Inductances, Coefficient of Coupling.

Single Phase Transformers: Principle of Operation of a Single Phase Transformer, EMF equation, Phasor diagram, Equivalent Circuit, Determination of Equivalent Circuit Parameters, Regulation and Efficiency of a single phase transformer. Principle of operation of an Auto Transformer.

DC Machines: Principle of Operation, Classification, EMF and Torque equations, Characteristics of Generators and Motors, Speed Control Methods and Starting Techniques.

Three Phase Induction Motor: Principle of Rotating Magnetic Field, Principle of Operation of 3-φ I.M., Torque-Speed Characteristics of 3-φ I.M., Starting Methods and Applications of Three Phase Induction Motors.

Measuring Instruments: Moving Coil and Moving Iron Ammeters and Voltmeters, Dynamometer Type Wattmeter and Induction Type Energy Meter.

Reading:

1. Edward Hughes, Electrical Technology, 10th Edition, ELBS, 2010.
2. Vincent Del Toro, Electrical Engineering Fundamentals, 2nd Edition, PHI, 2003.
3. V.N. Mittle, Basic Electrical Engineering, TMH, 2000.

CE101	ENGINEERING MECHANICS	ESC	4 – 0 – 0	4 Credits

Pre-requisites: None.

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

CO1	Determine the resultant force and moment for a given system of forces
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction
CO3	Calculate the motion characteristics of a body subjected to a given force system
CO4	Determine the deformation of a shaft and understand the relationship between different material constants
CO5	Determine the centroid and second moment of area

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3			2						
CO2	3			2						
CO3	3			2						
CO4	3			2						
CO5	3			2						

Detailed syllabus:

Introduction - Specification of force vector, Formation of Force Vectors, Moment of Force – Cross product – Problems, Resultant of a general force system in space, Degrees of freedom - Equilibrium Equations, Kinematics – Kinetics – De' Alemberts principle, Degree of Constraints – Freebody diagrams.

Spatial Force systems - Concurrent force systems - Equilibrium equations – Problems, Problems (Vector approach) – Tension Coefficient method, Problems (Tension Coefficient method), Parallel force systems - problems, Center of Parallel force system – Problems.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Problems on Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of sections, Method of members, Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Mechanics of Deformable Bodies - Stress & Strain at a point- Normal and shear stresses, Axial deformations – Problems on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Stepped shaft due to axial loading, Poisson's Ratio – Bulk Modulus - Problems, change in dimensions and volume.

Centroid & Moment of Inertia - Centroid & M.I – Arial & Mass M.I – Radius of Gyration, Parallel axis– Perpendicular axis theorem – Simple Problems.

Dynamics of Particles - Rectilinear Motion – Kinematics Problems, Kinetics – Problems, Work & Energy – Impulse Moment, Direct Central Impact – coefficient of restitution, Curvilinear Motion – Projectile Motion, Work & Energy in Curvilinear motion.

Dynamics of Rigid Bodies - Rigid body rotation – Kinematics - Kinetics, Problems – Work & Energy in Rigid body rotation, Plane Motion – Kinematics, Problem – Instantaneous center of rotation.

Reading:

1. J.L.Meriam and L.G. Kraige, Engineering Mechanics, 7th Ed, John Wiley & Sons, 2012.
2. Timoshenko and Young, Engineering Mechanics, 3rd Ed, McGraw Hill Publishers, 2006.
3. Gere and Timoshenko, Mechanics of Materials, 2nd Ed, CBS Publishers, 2011.

CE102	ENVIRONMENTAL SCIENCE AND ENGINEERING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO2	Estimate the population - economic growth, energy requirement and demand.
CO3	Analyse material balance for different environmental systems.
CO4	Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO5	Identify the major pollutants and abatement devices for environmental management and sustainable development

Mapping of Course Outcomes (COs) and the Program Outcomes (POs)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3				3		3		2	
CO2	3				3		3		2	
CO3	3				3		3		2	
CO4	3				3		3		2	

Detailed Syllabus:

Nature and scope of Environmental Problems: Environment and society, environmental disturbances, role of technology, sustainable development, quantification of environmental issues.

Population and Economic growth: Economic growth and industrialization urbanization, Resource consumption, Renewable and nonrenewable resources, Energy requirement and development.

Global Atmospheric systems: Concept of climate change, green house effect, global energy balance, global warming, carbon cycle, Intergovernmental Panel for Climate Change (IPCC) emission scenarios, impact of climate change.

Mass balance and Environmental chemistry: Mass and Energy balance, Particle dispersion, oxygen demand, carbon emission, enthalpy in environmental systems, chemical equilibria.

Ecology and Biodiversity: Energy flow in ecosystem, food chain, nutrient cycles, eutrofication, value of biodiversity, biodiversity at global, national and local levels, threats for biodiversity, conservation of biodiversity

Water Pollution: water pollutants, effects of oxygen demanding waste on water, water quality in lakes, reservoirs and groundwater, contaminant transport, self cleaning capacity of streams and water bodies, water quality standards, principles of water and wastewater treatment.

Air Pollution: Overview of emissions, pollutant standard index, toxic air pollutants, vehicle emissions, indoor air quality, principles of air pollution control.

Solid and Hazardous Waste: Characteristics of Solid and Hazardous Waste, Collection and transfer system, recycling, composting, waste to energy conversion, landfills.

Environmental Management: Sustainable development, Environmental Impact Assessment (EIA), Environmental Ethics, Legal aspects.

Reading:

1. J.G. Henry and G.W. Heinke, Environmental Science and Engineering, Pearson Education, 2004
2. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education, 2004.

ME101	BASIC MECHANICAL ENGINEERING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand basics of thermodynamics and components of a thermal power plant
CO2	Identify engineering materials, their properties, manufacturing methods encountered in engineering practice
CO3	Understand basics of heat transfer, refrigeration and internal combustion engines
CO4	Understand mechanism of power transfer through belt, rope, chain and gear drives
CO5	Understand functions and operations of machine tools including milling, shaping, grinding and lathe machines

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3			2					1	
CO2	3			2					1	
CO3	3			2					1	
CO4	3			2					1	
CO5	3			2					1	
CO6	3			2					1	

Detailed Syllabus:

Introduction: Introduction to Thermodynamics - Concept of a System – Types of Systems, Thermodynamic Equilibrium, Properties, State, Process and Cycle, Zeroth Law, Energy Interactions - Heat and Work, Types of Work, Work interactions in a closed System for various processes

First and Second Laws of Thermodynamics: First Law: Cycle and Process, Specific Heats (c_p and c_v), Heat interactions in a Closed System for various processes, Limitations of First Law, Concept of Heat Engine (H.E.) and Reversed H.E. (Heat Pump and Refrigerator), Efficiency/COP, Second Law: Kelvin-Planck and Clausius Statements, Carnot Cycle, Carnot Efficiency, Statement of Clausius Inequality, Property of Entropy, T-S and P-V Diagrams

Thermal Power Plant: Thermal Power Plant Layout – Four Circuits, Rankine Cycle, Boilers: Fire Tube vs Water Tube; Babcock & Wilcox, Cochran Boilers, Steam Turbines : Impulse vs Reaction Turbines, Compounding of Turbines: Pressure Compounding, Velocity Compounding, Pressure-Velocity Compounding, Condensers: Types – Jet & Surface Condensers, Cooling Towers

Manufacturing Processes: Engineering Materials: Classification, Properties of Materials, Manufacturing Processes: Metal Casting, Moulding, Patterns, Metal Working: Hot Working and Cold Working, Metal Forming: Extrusion, Forging, Rolling, Drawing

Internal Combustion Engines and Refrigeration: IC Engines: 2 - Stroke and 4 - Stroke Engines, S.I. Engine and C.I. Engine: Differences, P-V and T-S Diagrams

Refrigeration System and Refrigerants: Principle and working of standard vapor compression refrigeration system and Brief description of Refrigerants

Heat Transfer: Heat Transfer: Modes; Thermal Resistance Concept, Conduction: Composite Walls and Cylinders, Combined Conduction and Convection: Overall Heat Transfer Co-efficient, Simple Numerical Problems: Heat Transfer

Welding: Welding: Gas Welding and Arc Welding, Soldering, Brazing

Power Transmission: Transmission of Mechanical Power: Belt Drives – Simple Numerical Problems, Gear Drives – Simple Numerical Problems

Basics of Automotive Vehicle: Lay out of Automobile Transmission; Brakes – Types, Clutch, Differential

Machine Tools and Machining Processes: Machine Tools Machine Tools: Lathe Machine, Lathe Operations, Milling Machine-Types, Milling Operations, Shaper and Planer Machines: Differences, Quick-Return Motion Mechanism, Drilling Machine: Operations, Grinding Machine: Operations

Reading:

1. Mathur, M.L., Mehta, F.S., and Tiwari, R.P., Elements of Mechanical Engineering, Jain Brothers, New Delhi, 2011.
2. Roy, K.P., and Hazra Chowdary, S.K.., Elements of Mechanical Engineering, Media Promoters and Publishers Pvt. Ltd., 2002.
3. Rudramoorthy, R.., Thermal Engineering, Tata McGraw Hill Book Company, New Delhi, 2003.
4. Hazra Chowdary., S.K. and Bose, Workshop Technology, Vol. I and II, Media Promoters and Publishers Pvt. Ltd., 2002.

ME102	ENGINEERING GRAPHICS	ESC	2 – 0 – 3	4 Credits

Pre-requisites: None.

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

CO1	Draw Orthographic projections of Lines, Planes, and Solids
CO2	Construct Isometric Scale, Isometric Projections and Views
CO3	Draw Sections of various Solids including Cylinders, cones, prisms and pyramids
CO4	Draw projections of lines, planes, solids, isometric projections and sections of solids including Cylinders, cones, prisms and pyramids using AutoCAD

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3					1	3
CO2				3					1	
CO3				3					1	
CO4				3					1	

Detailed Syllabus:

Introduction: Overview of the course, Examination and Evaluation patterns.

Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons, Scales.

Orthographic projection of points: Principles of Orthographic projection, Projections of points.

Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.

Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.

Isometric views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects.

Auto-CAD practice: Introduction to Auto-CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES tool bar, Standard Tool bar, LAYERS

Reading:

1. N.D. Bhat and V.M. Panchal, Engineering Graphics, Charotar Publishers 2013
2. E. Finkelstein, “AutoCAD 2007 Bible”, Wiley Publishing Inc., 2007

CS101	PROBLEM SOLVING AND COMPUTER PROGRAMMING	ESC	4 – 0 – 0	4 Credits

Pre-requisites: None.

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

CO1	Develop algorithms for mathematical and scientific problems
CO2	Explore alternate algorithmic approaches to problem solving
CO3	Understand the components of computing systems
CO4	Choose data types and structures to solve mathematical and scientific problem
CO5	Develop modular programs using control structures
CO6	Write programs to solve real world problems using object oriented features

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3					2			1	
CO2	3					2			1	2
CO3	3					2			1	
CO4	3					2			1	
CO5	3					2			1	
CO6	3					2			1	

Detailed Syllabus:

Problem solving techniques – algorithms.

Introduction to computers - Basics of C++ - Number representation, Basic data types - int, float, double, char, bool, void.

Flow of Control - Conditional statements - If-else, Switch-case constructs, Loops - while, do-while, for.

Functions - user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion.

Arrays - Single, Multi-Dimensional Arrays, initialization, accessing individual elements, passing arrays as parameters to functions.

Pointers and Dynamic Arrays - Multidimensional Dynamic Arrays, creation and deletion of single and multi-dimensional arrays.

C Strings, Standard String Class

I/O Streams, stream flags, stream manipulators, formatted I/O, binary I/O, Character I/O, File I/O - Opening, closing and editing files.

Structures and Classes - Declaration, member variables, member functions, access modifiers, inheritance, function overloading, overriding, redefinition, virtual functions, operator overloading, polymorphism - compile time and runtime binding.

Reading:

1. Walter Savitch, Problem Solving with C++, Sixth Edition, Pearson, 2007.

   Cay Horstmann, Timothy Budd, Big C++, Wiley, Indian Edition, 2006.

PH102	PHYSICS LABORATORY	BSC	0 – 0 – 3	2 Credits

Pre-requisites: None.

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

CO1	Use CRO, signal generator, spectrometer, polarimeter and GM counter for making measurements
CO2	Test optical components using principles of interference and diffraction of light
CO3	Determine the selectivity parameters in electrical circuits
CO4	Determine the width of narrow slits, spacing between close rulings using lasers and appreciate the accuracy in measurements

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3					2			2	
CO2	3					2			2	
CO3	3					2			2	
CO4	3					2			2	

Detailed Syllabus:

1. Determination of Wavelength of Sodium light using Newton's Rings.
2. Determination of Wavelength of He-Ne laser – Metal Scale.
3. Measurement of Width of a narrow slit using He- Ne Laser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of capacitance by using R-C circuit.
6. Determination of resonating frequency and bandwidth by LCR circuit.
7. Measurement of half-life of radioactive source using GM Counter.
8. Diffraction grating by normal incidence method.

Reading:

1. Physics Laboratory Manual.

CY102	CHEMISTRY LABORATORY	BSC	0 – 0 – 3	2 Credits

Pre-requisites: None.

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

CO1	Synthesize polymers
CO2	Analyze ores and bleaching powder
CO3	Estimate the Hardness of water in terms of Calcium and Magnesium ions
CO4	Determine salt content using chromatographic techniques
CO5	Standardize solutions using titration, conductivity meter, pH-meter, potentiometer and colorimeter
CO6	Verify the Freundlich adsorption isotherm

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3		2		2		2	
CO2	3	3	3		2		2		2	
CO3	3	3	3		2		2		2	
CO4	3	3	3		2		2		2	
CO5	3	3	3		2		2		2	
CO6	3	3	3		2		2		2	

Detailed Syllabus:

Cycle 1

1. Standardization of potassium permanganate.
2. Determination of MnO2 in Pyrolusite.
3. Determination of Iron in Haematite.
4. Determination of available Chlorine in bleaching powder and of Iodine in Iodized salt.
5. Determination of hardness of water and of calcium in milk powder.
6. Chemistry of blue printing.
7. Preparation of phenol formaldehyde resin.

Cycle 2

1. Conductometric titration of an Acid vs Base.
2. pH-metric titration of an Acid vs Base.

3. Potentiometric titration of Fe^{2+} against $K_2Cr_2O_7$.
4. Colorimetric titration of potassium permanganate.
5. Determination of rate of corrosion of mild steel in acidic environment in the absence and presence of an inhibitor.
6. Determination of salt content by Ion-exchange.
7. Separation of Ions by paper chromatography.
8. Verification of Freundlich adsorption isotherm.

Reading:

1. Valentin, W. G. “A Course of Qualitative Chemical Analysis” Read Books Design, 2010; ISBN: 1446022730, 9781446022733.
2. G. Svehla: Vogel's Qualitative Inorganic Analysis. J. Mendham, R. C. Denny, J. D. Barnes, M. J. K. Thomas: Vogel’s Text Book of Quantitative Chemical Analysis.
3. G. N. Mukherjee: Semi-Micro Qualitative Inorganic Analysis (CU Publications) Vogel’s Text Book of Practical Organic Chemistry (5th Edition).
4. N. G. Mukherjee: Selected Experiments in Physical Chemistry.

CS102	PROBLEM SOLVING AND COMPUTER PROGRAMMING LABORATORY	ESC	0 – 0 – 3	2 Credits

Pre-requisites: None.

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

CO1	Design and test programs to solve mathematical and scientific problems
CO2	Develop and test programs using control structures
CO3	Implement modular programs using functions
CO4	Develop programs using classes

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3					2			1	
CO2	3					2			1	
CO3	3					2			1	
CO4	3					2			1	

Detailed Syllabus:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (int pointers, char pointers).
6. Programs on structures.
7. Programs on classes and objects.
8. Programs on inheritance and polymorphism.

Reading:

1. Walter Savitch, Problem Solving with C++, 6th Edition, Pearson, 2008.
2. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

ME103	WORKSHOP PRACTICE	ESC	0 – 0 – 3	2 Credits

Pre-requisites: None.

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

CO1	Study and practice on machine tools and their operations
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO3	Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
CO4	Apply basic electrical engineering knowledge for house wiring practice

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3						
CO2				3						
CO3				3						
CO4				3						

Detailed Syllabus:

Fitting Trade: Preparation of T-Shape Work piece as per the given specifications, Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding, and Practice marking operations.

Plumbing: Practice of Internal threading, external threading, pipe bending, and pipe fitting, Pipes with coupling for same diameter and with reducer for different diameters and Practice of T-fitting, Y-fitting, Gate valves fitting.

Machine shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools), Demonstration of different operations on Lathe machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting and Study of Quick return mechanism of Shaper.

Power Tools: Study of different hand operated power tools, uses and their demonstration and Practice of all available Bosch Power tools.

Carpentry: Study of Carpentry Tools, Equipment and different joints, Practice of Cross Half lap joint, Half lap Dovetail joint and Mortise Tenon Joint

House Wiring: Introduction to House wiring, different types of cables. Types of power supply, types of motors, Starters, distribution of power supply, types of bulbs, parts of tube light, Electrical wiring symbols, Stair case wiring: Demo and Practice (2 switches with one lamp control) and Godown wiring

Foundry Trade: Introduction to foundry, Patterns, pattern allowances, ingredients of moulding sand and melting furnaces. Foundry tools and their purposes, Demo of mould preparation and Practice – Preparation of mould by using split pattern.

Welding: Introduction, Study of Tools and welding Equipment (Gas and Arc welding), Selection of welding electrode and current, Bead practice and Practice of Butt Joint, Lap Joint.

Reading:

1. Raghuwanshi B.S., Workshop Technology Vol. I & II, Dhanpath Rai & Sons.
2. Kannaiah P. and Narayana K.L., Workshop Manual, 2nd Edn, Scitech publishers.
3. John K.C., Mechanical Workshop Practice. 2nd Edn. PHI 2010.
4. Jeyapoovan T.and Pranitha S., Engineering Practices Lab Manual, 3rd Edn. Vikas Pub.2008.

MA151	MATHEMATICS – II	BSC	4 – 0 – 0	4 Credits

Prerequisites: Mathematics – I.

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

CO1	Solve linear differential equations using Laplace transforms
CO2	Evaluate multiple integrals and improper integrals
CO3	Convert line integrals to area integrals
CO4	Convert surface integrals to volume integrals
CO5	Determine potential functions for irrotational force fields

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3			2		3				2
CO2	3			2		3				
CO3	3			2		3				
CO4	3			2		3				
CO5	3			2		3				

Detailed Syllabus:

Laplace Transformation: Laplace transform - Inverse Laplace transform - properties of Laplace transforms - Laplace transforms of unit step function, impulse function and periodic function - convolution theorem - Solution of ordinary differential equations with constant coefficients and system of linear differential equations with constant coefficients using Laplace transform.

Integral Calculus: Fundamental theorem of integral calculus and mean value theorems; Evaluation of plane areas, volume and surface area of a solid of revolution and lengths. Convergence of Improper integrals – Beta and Gamma integrals – Elementary properties – Differentiation under integral sign. Double and triple integrals – computation of surface areas and volumes – change of variables in double and triple integrals.

Vector Calculus : Scalar and Vector fields; Vector Differentiation; Level surfaces - directional derivative - Gradient of scalar field; Divergence and Curl of a vector field - Laplacian - Line and surface integrals; Green's theorem in plane; Gauss Divergence theorem; Stokes' theorem.

Reading:

1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, 2008.
2. Erwyn Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

MA201	MATHEMATICS - III	BSC	4 – 0 – 0	4 Credits

Prerequisites: Mathematics -II

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine Fourier series expansion of functions
CO2	Evaluate improper integrals involving trigonometric functions
CO3	Solve finite difference equations using Z transforms
CO4	Solve PDEs using variables separable method.
CO5	Evaluate improper integrals using residue theorem.

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1								2
CO2	3	1								2
CO3	3	1								2
CO4	3	1								2
CO5	3	1								2

Detailed Syllabus:

Fourier series: Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions

Fourier Transforms: Complex form of Fourier series - Fourier transformation and inverse transforms - sine, cosine transformations and inverse transforms - simple illustrations.

Z-transforms: Inverse Z-transfroms – Properties – Initial and final value theorems – convolution theorem - Difference equations – solution of difference equations using z-transforms

Partial Differential Equations: Solutions of Wave equation, Heat equation and Laplace's equation by the method of separation of variables and their use in problems of vibrating string, one dimensional unsteady heat flow and two dimensional steady state heat flow including polar form.

Complex Variables: Analytic function - Cauchy Riemann equations - Harmonic functions - Conjugate functions - complex integration - line integrals in complex plane - Cauchy's theorem (simple proof only), Cauchy's integral formula - Taylor's and Laurent's series expansions - zeros and singularities - Residues - residue theorem, evaluation of real integrals using residue theorem, Bilinear transformations, conformal mapping.

Reading:

1. R. K. Jain & S. R. K. Iyengar: Advanced Engineering Mathematics, Narosa Publishing House, 2008
2. Erwyn Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition.
3. B. S. Grewal: Higher Engineering Mathematics, Khanna Publications, 2009.

BT201	BIOCHEMICAL THERMODYNAMICS	PCC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the laws of thermodynamics
CO2	Apply power and refrigeration cycles for bioprocesses
CO3	Understand the degrees of freedom and phase & chemical reaction equilibria
CO4	Calculate thermodynamic parameters involved in biochemical reactions
CO5	Differentiate between ideal and non-ideal solutions

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1							
CO2	2		3							
CO3	3	2	1							
CO4	3	2	1	2						
CO5	3	1	3							

Detailed Syllabus:

Concepts in Engineering Thermodynamics: First Law of Thermodynamics and Other Basic Concepts, Calculation of Work, energy and property changes in reversible processes, Second Law of Thermodynamics, Thermodynamics of Flow Process, Thermodynamic Properties of Fluids, Volumetric Properties of Real Gases, Maxwell's relationships and their applications Residual Properties Estimation of Thermodynamic Properties using Equation of State , Power cycles and refrigeration cycles.

Solution Thermodynamics: Partial Properties, Concepts of Chemical Potential and Fugacity, Ideal and Non Ideal Solutions, Gibbs – Duhem Equation, Excess Properties of mixture; Activity Coefficients, Activity Coefficient Correlations.

Phase and Chemical Reaction Equilibria: Criteria for phase equilibrium ,Vapor – Liquid equilibrium calculations for binary mixtures, Liquid – Liquid Equilibria and Solid- Liquid Equilibria, Introduction to Chemical Reaction Equilibrium, Equilibrium criteria for homogeneous chemical reactions; Evaluation of equilibrium constant and effect of pressure and temperature on equilibrium constant; Calculation of equilibrium conversions and yields for single and multiple chemical reactions.

Biochemical Thermodynamics: Energetics of Metabolic Pathways; Energy Coupling (ATP & NADH) Stoichiometry and energetic analysis of Cell Growth and Product Formation – -elemental Balances, Degree of reduction concepts; available -electron balances; yield coefficients; Thermodynamics of microbial growth.; Oxygen consumption and heat evolution in aerobic cultures; thermodynamic efficiency of growth, Energy balance equation for free cell culture ; Reaction thermodynamics. pH dependence of a Biochemical Reaction, Unfolding of a protein as a function of Temperature.

Reading:

1. J.M. Smith, H.C. van Ness and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, McGraw Hill, 2005
2. 1. Stanley I. Sandler, Chemical, Biochemical, and Engineering Thermodynamics, 4th Edition, Wiley, 2006.
3. J.A Roels, Kinetics and Energetics in Biotechnology, Elsevier, 2003
4. Robert A. Alberty, Biochemical Thermodynamics: Applications of Mathematica 1st Edition, Wiley-Interscience, 2007.

BT202	BIOCHEMISTRY	PCC	4 – 0 – 0	4 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify bio-molecules
CO2	Understand complex biochemical pathways within living cells
CO3	Understand the physiological functioning of the cells
CO4	Understand catabolic and anabolic metabolism
CO5	Determine the kinetic parameters of enzymatic reactions

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3			2	2					
CO2	3	2	2		3					
CO3	3	2	2	2	2					
CO4	3	2	2	2	3					
CO5	1	2	3							

Detailed Syllabus:

Introduction to Biochemistry: Chemical foundations of Biology - pH, acids, bases, buffers, weak bonds and covalent bonds.

Amino acids and Peptides: Classification of amino acids, Structure and properties of amino acids, Peptide bond and peptide

Proteins: Structure and Classification of Proteins. Primary structure, Secondary structure, Tertiary structure and Quaternary structure, aggregated proteins, Structural importance in function, Denaturation and Renaturation.

Enzymes and Enzyme Kinetics: Enzymes as biological catalysts, classification, Examples of enzymes catalyzed reactions, Michealis Menten approach to enzyme kinetics, mechanism of enzyme action

Nucleic acids: Structure of nucleic acids, Structure of DNA, specialized secondary structures, Principle kinds of RNA and their structures

Carbohydrates: Structure and stereochemistry of monosaccharides- Reactions of monosaccharides-Structures and functions of polysaccharides- glycoproteins Lipids: Structure of Fats and Oils, Phospholipids, membrane lipids, Prostaglandins Vitamins: Introduction, classification and functions of vitamins, disease of vitamins deficiency, conversion of vitamins from precursor: β-carotenes to vitamin-A, argosterol to D3. Analytical techniques in biochemistry for small molecules and macro- molecules for quantification.

Reading:

1. David L. Nelson and Michael M. Cox: Lehninger Principles of Biochemistry, Palgrave Macmillan, Freeman, Low Price Edition, 4th Edition, 2007.
2. Mary K. Campbell and Shawn O. Farrell: Biochemistry, Thomson Brooks/Cole, Indian Edition, 5th Edition, 2007.
3. Robert K. Murray, Daryl K. Granner and Victor W. Rodwell: Harper's Illustrated Biochemistry, McGraw Hill Lange, International Edition, 27th Edition, 2006.
4. Lubert Stryer, Jeremy M. Berg, and John L. Tymoczko: Biochemistry, W. H. Freeman & Co, 5th Edition, 2002.

BT203	MICROBIOLOGY	PCC	4 – 0 – 0	4 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the diversity of microorganisms
CO2	Demonstrate the interaction of microorganisms with their environment
CO3	Analyze how microorganisms cause diseases
CO4	Select appropriate methods for control of the growth of microorganisms
CO5	Understand the principles of bacterial genetics

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2		2	2	2				
CO2	3			2		3		1		2
CO3	3	2		2		2		3		3
CO4					3	3	2	1		
CO5	3	2		2	2					

Detailed Syllabus:

Scope and History of Microbiology: Microbiology as a field of Biology - groups of microorganisms - Distribution in the nature - applied areas of Microbiology – Microscope - Spontaneous generation versus Biogenesis - fermentation - germ theory of disease - laboratory techniques and pure cultures - protection against Infection: Immunity - widening horizons.

Characterization, Classification, Identification and Examination of Microorganisms: Morphological, chemical, cultural, metabolic, antigenic, genetic, pathogenicity and ecological characteristics - past and present state of Bacterial taxonomy - Microscope and Microscopy - preparation of Light-Microscope examinations

Bacteria, Fungi, Protozoa and Viruses:- Bacteria: Size, shape and arrangement - structures external to the cell wall - the cell wall - structures internal to the cell wall - spores and cysts

Cultivation of Bacteria: Nutritional requirements - nutritional types – Media - physical conditions required for growth - Choice of media and conditions of Incubation – reproduction and growth – quantitative measurement of growth – Natural microbial population (Mixed cultures) - Selective methods – methods of isolation, maintenance and preservation of pure cultures – cultural characteristics.

Bacterial Genetics: Study of microbial genetics - inheritance of characteristics and variability - phenotypic changes due to environmental alterations – genotypic changes - bacterial recombination - bacterial conjugation, transduction, and transformation.

Fungi, Algae and Protozoa: Yeasts and Molds - Importance of fungi – distinguishing characteristics of fungi - morphology, reproduction and physiology – cultivation of fungi - classification of fungi - Occurrence, characteristics of Algae - biological and economic importance – lichens – Protozoa.

Viruses: Viruses of Bacteria – Bacteriophages - Discovery and significance – general characteristics, morphology and structure - classification and nomenclature - bacteriophages of *Escherichia coli* - Structure, composition and classification of viruses of animals and plants.

Control of Microorganisms: Fundamentals of control - physical agents - chemical agents – antibiotics

Introduction to Applied Microbiology: Microbiology of soil - biogeochemical roles of microorganisms – Distribution of Microorganisms in the aquatic environment – Microbiology of domestic water and wastewater - Chemical and microbiological characteristics - treatment procedures.

Reading:

1. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton: Prescott, Harley, and Klein's Microbiology, McGraw Hill Higher Education, International Edition, 7th Edition, 2007.
2. Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark: Brock Biology of Microorganisms, Pearson, 13th Edition, 2011
3. John L. Ingraham, Catherine A. Ingraham: Introduction to Microbiology, A case History Approach, Thomson Brooks/Cole, 3rd Edition, 2004

CH235	FLUID MECHANICS AND HEAT TRANSFER	ESC	4 – 0 – 0	4 Credits

Prerequisites: Basic Mechanical Engineering, physics

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine pressure drop for flow in closed channels.
CO2	Understand fluid – solid operations.
CO3	Select fluid moving machinery, valves and fittings.
CO4	Understand heat transfer with and without phase change.
CO5	Describe the construction and operation of heat exchangers.
CO6	State laws of radiation.

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3		3		2			3
CO2	3	1	3		3		2			3
CO3	3	1	3		3		2			3
CO4	3	1	3		3		2			3
CO5	3	1	3		3		2			3
CO6	3	1	3		3		2			3

Detailed Syllabus:

Fluid Mechanics: Unit systems - Fluid Statics and Its Applications - Fluid Flow Phenomena - Basic Equations of Fluid Flow - Incompressible Flow In Pipes and Channels - Flow of Compressible Fluids - Flow Past Immersed Bodies - Transportation and Metering of Fluids.

Heat Transfer: Heat Transfer by Conduction in Solids - Principles of Heat Flow in fluids - Heat Transfer to Fluids without Phase Change - Heat Transfer to Fluids with Phase Change - Heat-Exchange Equipment, Heat transfer by Radiation

Reading:

1. Warren L. McCabe, Jullian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, International Edition, 2005.
2. Coulson J. M and Richardson J. F, Chemical Engineering, 6th Edition, Elsevier, Vol. 1, 2000 and Vol. 2, 2003.
3. Frank P. Incropera and D. P. David, Fundamentals of Heat and Mass Transfer, 6th Revised Edition, John Wiley & Sons, 2007.

BT204	BIOCHEMISTRY LABORATORY	PCC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Estimate the concentration of macro-molecules
CO2	Identify and characterize macro-molecules
CO3	Separate micro and macro bio-molecules using TLC and Electrophoresis
CO4	Conduct reactions of proteins, carbohydrates and nucleic acids with organic and inorganic solvents.

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3						3		
CO2	2	3						3		
CO3		3			3			3		
CO4	2	3		2				3		

Detailed Syllabus:

Preparation of buffers, quantitative method for amino acid estimation using Ninhydrin, general Reactions of amino acids, protein estimation by Biuret and Lowry‟s methods, protein estimation by Bradford and spectroscopic methods, estimation of Carbohydrates by Anthrone and DNS methods, quantitative determination of Nucleic acids by DPA and Orcinol and Spectrophotometer methods, estimation of nucleic acids by absorbance at 260 nm, separation of amino acids by TLC method, separation of proteins by Electrophoresis method(SDS and NATIVE PAGE), separation of Nucleic acids by Electrophoresis method

Readings:

1. Laboratory Manual in Biochemistry by J.Jayaraman, New age International Publications.
2. Principles & Techniques of Practical Biochemistry 5th edition. K. Wilson & J.Walker, Cambridge University Press, 2000

BT205	MICROBIOLOGY LABORATORY	PCC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Study the morphology of microorganisms using compound microscope.
CO2	Isolate, culture and preserve microorganisms using aseptic techniques
CO3	Identify and characterize the given microorganism using biochemical tests
CO4	Study the growth characteristics of microorganisms
CO5	Perform physical and chemical aseptic techniques to control microbial growth
CO6	Estimate the concentration of bacteriophage using phage titration

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3					2		2		
CO2	3	2				2		2		
CO3	3	2		2				2		2
CO4	3	2		2				1		1
CO5	3	3		2		1				2
CO6	3	3		2				1		

Detailed Syllabus:

Compound Microscope, Preparation of culture Media, Identification of Microorganisms- Staining Techniques, Culturing of Microorganisms- Pure culture techniques, Isolation of Pure bacteria culture from soil, Determination of Bacterial Number with spectrophotometer, Control of microorganism- physical and chemical agents.

Reading:

1. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton: Prescott, Harley, and Klein's Microbiology, McGraw Hill Higher Education, International Edition, 7th Edition, 2007.

CH236	FLUID MECHANICS AND HEAT TRANSFER LABORATORY	ESC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the Electrical analogy in relation to heat conduction
CO2	Determine heat losses from cylindrical furnace
CO3	Determine temperature profiles in rod-double pipe heat exchanger, helical coil, heat pipe demonstration experiment.
CO4	Understand boiling Phenomena in liquids
CO5	Determine viscosity and surface tension of liquids
CO6	Determine friction in flow through pipes fittings and valves.

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		3						1	
CO2	3	2	3						1	
CO3	2		3						1	
CO4	2		3	1					1	
CO5	2		3	1					1	
CO6	3		3						1	

Detailed Syllabus:

Fluid Mechanics Laboratory: Measurement of viscosity and surface tension of liquids-Reynolds Experiment-Verification of Bernoulli's Principle – Friction in flow through smooth and rough pipes – Friction in pipe fittings and valves – Terminal settling velocities in viscous medium – Flow through packed bed- Flow through fluidized bed-Calibration of Orifice and Venturi meters – Characteristics of centrifugal pump.

Heat Trasnfer Laboratory: Electrical analogue for heat conduction – Natural Convection – Thermal Resistance in series – Heat losses from cylindrical furnace – Temperature profile in rod – Double pipe heat exchanger – Helical Coil –Heat pipe demonstration experiment – Boiling Phenomenon in liquids – Heat Exchanger – Tubular Heat Exchanger –Fin Tube Heat Exchanger –Plate Heat Exchanger.

Reading: Lab Manual

MA251	MATHEMATICS – IV	BSC	4 – 0 – 0	4 Credits

Prerequisites: Mathematics - III

Course Outcomes: At the end of the course the student will be able to:

CO1	Estimate chance of occurrence of events by normal distribution
CO2	Analyze the null hypothesis for large and small number of samples.
CO3	Construct a given curve for the data by least squares
CO4	Solve initial values problems
CO5	Solve differential equation at a singular point

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2								1
CO2	3	2								1
CO3	3	2								1
CO4	3	2								1
CO5	3	2								1

Detailed Syllabus:

Statistics and Probability: Probability laws – Addition and Multiplication theorems on probability - Baye's theorem –Expectation, Moments and Moment generating function of Discrete and continuous distributions, Binomial, Poisson and Normal distributions, fitting these distributions to the given data, Testing of Hypothesis - Z-test for single mean and difference of means, single proportion and difference of proportions - t-test for single mean and difference of means, F-test for comparison of variances,. Chi-square test for goodness of fit. – Correlation, regression.

Numerical Analysis: Curve fitting by the method of least squares. Fitting of (i) Straight line (ii) Second degree parabola (iii) Exponential curves. Calculation of dominant eigen value by iteration, Gauss Seidal iteration method to solve a system of equations and convergence (without proof). Numerical solution of algebraic and transcendental equations by Regula-Falsi method Newton-Raphson's method.

Lagrange interpolation, Newton's divided differences, Forward, backward and central differences, Newton's forward and backward interpolation formulae, Gauss's forward and backward interpolation formulae, Numerical differentiation at the tabulated points with forward backward and central differences. Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule and Romberg integration. Taylor series method, Euler's method, modified Euler's method, Runge-Kutta method of 2^{nd} & 4^{th} orders for solving first order ordinary differential equations.

Series Solution: Series solution of Bessel and Legendre's differential equations._Bessel function of first kind Recurrence formulae Generating function Orthogonality of Bessel functions Legendre polynomial rodrigue's formula Generating function Recurrence formula Orthogonality of Legendre polynomials.

Reading:

1. S.C.Gupta and V.K.Kapoor, *Fundamentals of Mathematical Statistics*, S.Chand & Co, 2006.
2. Jain, Iyengar and Jain, *Numerical methods for Scientific and Engineering Computation,* New Age International Publications, 2008.
3. Erwyn Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 8th Edition, 2008.
4. B.S.Grewal, *Higher Engineering Mathematics*, Khanna Publications, 2009.

BT251	MOLECULAR BIOLOGY AND GENETICS	PCC	4 – 0 – 0	4 Credits

Prerequisites: BT203-Microbiology, BT202-Biochemistry

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure of nucleic acids & proteins and their interactions.
CO2	Understand the mechanisms of central dogma of life.
CO3	Study the molecular mechanisms of gene regulation in prokaryotes and eukaryotes.
CO4	Demonstrate Mendelian inheritance
CO5	Calculate recombinant frequencies and construct pedigree analysis.
CO6	Study chromosomal aberrations in humans.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1		3	2					
CO2	3				2					3
CO3	3		2		3					
CO4	3			3						2
CO5	3	2			3					2
CO6	3			2	1	1				

Detailed Syllabus:

Genome Anatomies: Central Dogma, Anatomy of Eukaryotic Genome, unusual chromosomal types, Eukaryotic Organelle genomes, Anatomy of Prokaryotic Genome, Repetitive DNA content of Genomes, Organization of Human genome, Role of DNA-binding proteins, Methods for studying DNA-binding proteins, interactions between DNA and DNA binding proteins, RNA-binding motifs.

Genome Replication: DNA Replication mechanisms, DNA repair processes, issues relevant to genome Replication, topological problem, Variations on semi-conservative theme, replication process, diverse function of DNA Topoisomerase, Regulation of Eukaryotic Genome Replication,

Initiation of Transcription: first step in Gene Expression, Accessing Genome, DNA methylation and gene expression, Assembly of Transcription Initiation Complexes of Prokaryotes and eukaryotes, Regulation of Transcription Initiation, Cis and Trans, Regulation of RNA polymerase I initiation

Translation I**:** The information problem, Synthesis and Processing of RNA: RNA content of cell,

Translation II**:** The Machinery and the chemical nature of Protein, Synthesis and processing of mRNAs, Synthesis and processing of Non-coding RNAs, Process of pre-RNA by chemical modification, turnover of mRNAs. Regulation of Gene activity in Eukaryotes, Genetic Recombination between Homologous DNA Sequences, role of tRNA in protein synthesis, role of ribosome in protein synthesis, Post translational processing of proteins.

Mendelian Genetics**:** Principles, Segregation, Independent Assortment, Dominance Relations and Multiple Alleles, Probability in Mendelian Inheritance, Sex Determination and Sex Linkage, Variants and Genetic dissection, Parallel behavior of autosomal genes and chromosomes, lethal alleles, several genes affecting same character, Penetrance and Expressivity.

Linkage**:** Linkage symbolism, Linkage of Genes on the X Chromosome, Linkage maps, Crossing Over, Chromosomal mapping, Human Chromosomes, Chromosome Variation in Number, Change in Chromosome Structure, Extra Chromosomal Inheritance, Interference, Calculating Recombinant Frequencies.

Reading:

1. Bruce Alberts, Molecular Biology of the Cell, 5th Edition, Garland Science, 2007.
2. David Freifelder, Molecular Biology, 2nd Edition, Narosa Publishing House, Reprint 2004
3. T. A. Brown, Genomes 2, 2nd Edition, Garland Science, 2006
4. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Molecular Biology of the Gene, 6th Edition, CSHL Press, 2008.
5. Strickberger M.W., Genetics, 3rd Edition, Prentice Hall India, 2008

BT252	CELL BIOLOGY	PCC	3 – 0 – 0	3 Credits

Prerequisites: CY-101 and BT-202.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the cell theory and cellular compartmentalization
CO2	Understand the structure and function of the plasma membrane and cell organelles.
CO3	Understand the molecular mechanisms of cell cycle.
CO4	Relate the importance of cell cycle on cancer development
CO5	Understand the role of apoptotic cell death in cellular development.
CO6	Study the signal transduction process in a cellular system

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3			1	1					
CO2	3			1	1					
CO3	3			1	1					
CO4	3	2		1						
CO5	2			1						
CO6	2			1						

Detailed Syllabus:

Unit-I

Cell structure and function: Discovery of cells & Basic properties of cell, Cell theory; Cell complexity – Cell size & shape, Different classes of cells; Prokaryotic & Eukaryotic cell

Unit-II

Intracellular Compartments: Structure and functions of Nucleus, Endoplasmic Reticulum, Golgi Complex, Mitochondria, Lysosomes, Peroxisomes, Plastids and

Unit-III

Cell Membranes: Introduces membrane components, phospholipid bilayers, Membrane proteins and their interaction in real membranes, Basics of membrane transport systems (both active and passive).

Unit-IV

Cell division: Molecular Mechanics of Mitosis & Meiosis, Checkpoint cell cycle control, Activation and control of cyclin dependent kinase activity, Chromosomal replication

Unit-V

Cell signaling: Intracellular signaling and types of signal receptors, Chemoreceptors of Bacteria (Attractants & Repellents), Signal Transduction by hormones - Steroid / Peptide hormones, Concept of Secondary messengers, cAMP, cGMP, Protein Kinases, G Proteins, Receptors & Non - receptors associated tyrosine kinases.

Unit-VI

Cell differentiation: General Characteristics of Cell Differentiation, Differentiation in Unicellular & Multicellular Organism, Cytoplasmic determinants, Nucleoplasmic Interactions, Embryonic and adult stem cells and its Biological Importance.

Unit-VII

Cancer biology basics, Characteristics of Cancer Cells, Types of Tumors, Molecular Basis of Cancer – Proto oncogene, Tumor Suppressor gene, Telomerase, apoptosis, angiogenesis, Metastasis, chemical carcinogens, cancer therapy

Reading:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Dennis Bray, Karen Hopkin, Keith Roberts, Peter Walter: *Essential Cell Biology*, Garland Science, 2009.
2. G. Karp, *Cell and Molecular Biology*, 6th Edition, Wiley, 2009.
3. Thomas D. Pollard, William C. Earnshaw and Jennifer Lippincott-Schwartz: *Cell Biology: With Student Consult Online Access*, Saunders College Publishing, 2nd Edition, 2007.

BT253	BIOPROCESS CALCULATIONS	PCC	4 – 0 – 0	4 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the material and energy balances of bioprocesses.
CO2	Perform material and energy balances on biochemical processes/equipment without and with reactions.
CO3	Perform unsteady state material and energy balances
CO4	Draw the flow diagram and solve the problems involving recycle, purge and bypass in a process or unit.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		2			3	3		3	
CO2			3	2			1		1	
CO3			3	2			1		1	
CO4	3		3							2

Detailed Syllabus:

Steady-state material balances: General material balance equations; procedure for material balance calculations; material balances involving multiple sub-systems; simplifications for steady-state processes without chemical reaction; material balance problems with chemical reactions.

Material balance for various unit operations: Concept of limiting; excess reactants; fractional conversion; percentage of conversion; percentage yield; excess air calculations; material balances involving simultaneous equations; material balances involving recycle; by-pass; and purge streams; stoichiometry of microbial growth and product formation.

Recycle by-pass and Purge: material balances involving recycle; by-pass; and purge streams, Uses of recycle and purge streams, Problems involving recycle and purge streams.

Steady-state energy balances: General energy balance equations; enthalpy calculation procedures; enthalpy change in non-reactive processes; steam tables; procedure for energy balance calculations without reaction; energy balance worked examples without reaction; enthalpy change due to reaction. Solving simultaneous material and energy balances.
Heat of reaction for processes with biomass production; energy balance equation for cell culture; fermentation energy balances worked examples.

Introduction to unsteady-state material and energy balances: Unsteady-state material and energy balance equations; solving differential equations; unsteady-state mass balances; unsteady-state energy balances; unsteady-state material and energy balances on non-reactive process; heat of mixing and solution; balances on reactive processes; integrated balances.

Reading:

1. Himmelblau, D.H, Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall India, 2003.
2. Bhatt B.I, and Vora S.M, Stoichiometry, 4th Edition, Tata McGraw-Hill, 2005.
3. Hougen, O.A, Watson, K.M and Ragatz R.A, Chemical Processes Principles (Part-1): Material and Energy Balances, 2nd Edition, Asia Publication House, 2001.
4. Pauline M. Doran, Bioprocess Engineering Principles, Elsevier, South Asia Edition, 2005.

CH285	MASS TRANSFER	ESC	4 – 0 – 0	4 Credits

Prerequisites: MA101: Mathematics - I, MA151: Mathematics - II

Course Outcomes: At the end of the course the student will be able to:

CO1	Calculate diffusional mass transfer rates for gases and liquids.
CO2	Calculate mass transfer rates in gas-liquid systems.
CO3	Describe mass transfer equipment.
CO4	Understand mass transfer operations absorption, distillation, extraction, drying.

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			2							
CO2			3							
CO3			2							
CO4			2							

Detailed Syllabus:

Mass Transfer Operations**,** Molecular Diffusion in Fluids**;** Diffusion in Solids, Mass Transfer Coefficients**,** Interphase Mass Transfer**,** Gas Absorption**,** Distillation, Liquid Extraction**,** Adsorption and Ion Exchange**,** Drying

Reading:

1. Treybal R. E. – Mass Transfer Operations – 3rd Edition – International Student Edition McGraw Hill International, 1981.

2. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall Inc., 1993.

3. Warren L. McCabe, Julian C. Smith and Peter Harriott, Unit Operations of Chemical Engineering, 6th Edition, McGraw Hill, Inc, 2002.

BT254	MOLECULAR BIOLOGY AND GENETICS LABORATORY	PCC	0 – 0 – 3	2 Credits

Prerequisites: BT205-Microbiology Lab., BT204-Biochemistry Lab.

Course Outcomes: At the end of the course the student will be able to:

CO1	Demonstrate safe laboratory practices and handle the equipment safely
CO2	Isolate nucleic acids from biological samples.
CO3	Estimate the quality and quantity of nucleic acids using Gel-electrophoresis and spectrophotometer.
CO4	Determine the molecular weight of a given nucleic acid fragment
CO5	Demonstrate blotting and hybridization techniques
CO6	Demonstrate manual sequencing of nucleic acids

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3				2	2	3		3
CO2	2	3		3	2					
CO3		3	1	3	2					
CO4	2	3		2						
CO5	2	3			3					
CO6	2	3		2	3					

Detailed Syllabus:

Isolation of Plasmid by Alkali Lysis Method, Isolation of Genomic DNA from Bacteria by High Salt Method, Molecular weight determination of Nucleic acid, Manual Sequencing, DNA Elution from Agarose Gel, Isolation of Genomic DNA from Blood Cells by High Salt Method, Isolation of genomic DNA from Plant Tissue, Isolation of RNA from Yeast, Southern Blotting, Southern Hybridization

Reading:

1. Laboratory manual
2. Molecular cloning: A Laboratory Manual (3rd Edition) by Joseph Sambrook and David Russell, CSHL Press, 2004.

BT255	INSTRUMENTAL ANALYSIS LABORATORY	PCC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine pKa of the given amino acid using a spectrophotometer
CO2	Estimate trace element using a flame photometer
CO3	Determine melting temperature of DNA
CO4	Estimate the turbidity of the given sample

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3		1				2		
CO2	2	3		1				2		
CO3	2	3		1				2		
CO4	2	3		1				2		

Detailed Syllabus:

Determination of pKa value of an amino acid using UV-Visible Spectrophotometer, Determination of the stability of proteins using Differential Scanning Calorimeter, Determination of the melting temperature(Tm) of the Genomic DNA using UV-Visible Spectrophotometer, Determination of K_m and V_{max} of α-Amylase using Visible Spectrophotometer, Determination of alkali and alkaline earth metals using a Flame Photometer, Determination of turbidity of the given samples using Turbidimeter, Determination of alkali and alkaline earth metals in the given biological samples using a Flame Photometer, Determination of the melting temperature(Tm) of the Plasmid DNA using UV-Visible Spectrophotometer, Demonstration of a batch bioreactor, Demonstration of a packed bed bioreactor, Demonstration of a gradient thermal cycler, Demonstration of a micro plate reader

Reading:

Laboratory manual

CH286	MASS TRANSFER LABORATORY	ESC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine efficiency of steam distillation
CO2	Plot mutual solubility curve for acetone-methyl-iso-butyl-ketone and water
CO3	Determine the overall plate efficiency of sieve plate distillation
CO4	Verify Rayleighs equation for batch distillation.
CO5	Determine HETP and HTU for given packing for distillation of benzene-acetone mixture under total reflux.
CO6	Determine the critical moisture content in drying

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2			3							
CO3			3							
CO4			3							
CO5			3							
CO6			3							

Detailed Syllabus:

Steam Distillation, Batch Distillation, Distillation in Packed Tower, Distillation in Plate Column, Diffusivity coefficient determination, Mutual solubility data, Tie-line data, Batch Drying, Mass Transfer in Packed Tower, Mass Transfer in Spray Tower, Ion-Exchange Apparatus, V.L.E. – Data.

Reading:

1. Treybal R. E. – Mass Transfer Operations – 3rd Edition – International Student Edition McGraw Hill International, 1981.

BT301	IMMUNOLOGY	PCC	4 – 0 – 0	4 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand innate and adaptive immune responses.
CO2	Understand the role of primary and secondary lymphoid organs.
CO3	Understand antigen and antibody interactions
CO4	Understand the mechanism of immunization
CO5	Understand the role of immune system in organ transplantation, autoimmune disorders and Cancer

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2		2						2
CO2	3	2		1						2
CO3	3	3		3						2
CO4	3	3	2	3						3
CO5	3	3	3	3						3

Detailed Syllabus:

UNIT I

Introduction to Immune System, Types Of immunity: Innate & Adaptive Immunity, Cells of Immune system, Organs of Immune system: Primary lymphoid organs: Structure and Functions, Secondary lymphoid organs: Structure and Functions

UNIT II

Immunogen, Haptens & Adjuvants, Epitope, Immunoglobulin Structure, Immunoglobulin Isotypes: Structure and Functions, Monoclonal Antibodies: Hybridoma Technology and Applications, Recombinant & Chimeric Antibodies, Humanized & Bispecific Antibodies, Immunotoxins, Polyclonal antibodies, Abzymes, Organization and Expression of Immunoglobulin genes: Antibody Diversity: Somatic variation theory, Germ line theory, Tonegawa's bombshell: Immunoglobulin genes rearrange, Immunoglobulin Light chain (Kappa, Lambda) rearrangement, Immunoglobulin Heavy chain rearrangement, Immunoglobulin Class Switching

UNIT III

B-cell Maturation, B Lymphocyte activation by TI antigens: Toll like receptors, MHC: Structure and Functions, B Lymphocyte activation by TD antigens, T Lymphocyte development, T Lymphocyte activation and differentiation, Cell mediated cytotoxic responses.

UNIT IV

Complement system, Hypersensitivity reactions, Cytokines, Immunological tolerance, Autoimmune disorders

UNIT V

Transplantation, Graft rejection & Immunosuppresive Therapy, Vaccines: Types of Vaccines, Tumor Immunology

Reading:

1. Kuby Immunology, 6^{th} Edition, -R.A. Goldsby, Thomas J. Kindt, Barbara, A. Osbarne. (Freeman), 2007.
2. Immunology- A Short Course, 4^{th} Edition, -Eli Benjamini, Richard Coico, Geoffrey Sunshine. (wiley-Liss) 2002.
3. Fundamentals of Immunology, William Paul. Wiley publishers, 2004.
4. Immunology, by Roitt, Freeman Publishers, 2010.

BT302	BIOPROCESS ENGINEERING	PCC	4 – 0 – 0	4 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the roles and responsibilities of a bioprocess engineer.
CO2	Understand sterilization techniques and estimate the sterilization time
CO3	Understand the rheology of fermentation fluids and determine the power requirement in bioreactors
CO4	Develop the design equations for bioreactors and calculate the oxygen demand for cell growth.
CO5	Understand the scale up concepts for bioprocesses.
CO6	Identify sensors and instruments needed for measurement and control.

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3		2						
CO2	3	3		3						
CO3		3	2	3						
CO4	2	3		3						
CO5	1	3	3	3						
CO6	1	3	3	3						

Detailed Syllabus:

Introduction: Role of a bioprocess engineer, Kinetics of microbial growth, substrate utilization and product formation; Simple structured models, Design of fermentation media.

Sterilization: Media sterilization; kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilization, sterilization of air and filter design. Radiation and chemical sterilization.

Batch, fed-batch and continuous processes: Operation of batch, continuous and fed-batch processes and industrial applications, Comparison of batch, fed-batch and continuous processes.

Rheology of fermentation fluids: Newtonian and non Newtonian fluids, Aeration and agitation, power requirement for gassed and ungassed systems, time calculation for mixing.

Mass transfer in bioreactors: Theories of mass transfer, metabolic oxygen demand, measurement of K_La, Maximum cell concentration.

Instrumentation in bioreactors: On-line and off-line measurement various types of microbial and enzyme reactors, Bioreactor Considerations for Animal Cell Culture and plant cell culture.

Fermentation: Structured and Unstructured Models. Optimization of Fermentation media.

Reading:

1. Bioprocess Engineering Principles. By Paulin M. Doran. Elsevier Science & Technology Books.2008.
2. Biochemical Engineering Fundamentals, Second Edition, James E.Bailey, David F. Ollis. McGrawHill. 2004.
3. Bioprocess Engineering Basic Concepts 2nd Edition, Michael Shuler, Fikret Kargi. Prentice-Hall India.2006.
4. Bioprocess Engineering: Kinetics, Mass Transport, Reactors and Gene Expression by Wolf. R. Vieth . A Wiley-Interscience Publication, 2009.
5. "Principles of fermentation technology" P F Stanbury and A Whitaker, Pergamon press, 2005.

BT303	GENETIC ENGINEERING	PCC	4 – 0 – 0	4 Credits

Prerequisites: BT203-Microbiology, BT202-Biochemistry, BT251-Molecular Biology and Genetics

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand basic and advanced techniques in Genetic Engineering.
CO2	Select appropriate host and vector system for cloning and expression.
CO3	Understand the cloning strategies and expression of recombinant molecules.
CO4	Understand the gene regulation mechanism in bacteria and eukaryotic hosts.
CO5	Apply genetic engineering principles for biotechnological and biomedical applications.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2		2	1					
CO2		3	3	3	2					
CO3		3	3	3	2					
CO4	3	3		1						
CO5	1	2	3	3		2				

Detailed Syllabus:

Basic Techniques: Agarose gel electrophoresis, Nucleic acid blotting, transformation of *E. coli,* Advance Techniques in gene expression and analysis, PCR, RT-PCR, Real Time PCR, etc…, Nucleic acid sequences as diagnostic tools, micro array, gene chip, Hybridization - Radio labeling, FISH - Fluorescent in situ hybridization, mFISH, gene tagging, DNA finger printing.

Cutting and joining DNA molecules: various restriction enzymes, ligases, joining DNA molecules, Cloning Vectors: Plasmids and Phage Vectors, Cosmids, Phasmids and other advanced vectors.

Cloning strategies and DNA libraries**:** cDNA cloning, genomic libraries, screening of libraries and recombinant clone selection, hybridization with differential expression and subtractive techniques, Differential display.

Sequencing and Mutagenesis**:** Basic DNA sequencing, whole genome sequencing, analyzing sequence data, chromosome walking, short gun sequencing, changing genes – site directed mutagenesis, reverse mutagenesis, cassette mutagenesis. Molecular markers: RFLP, RAPD, AFLP, gene knockout gene mapping.

Cloning**:** Introducing DNA into bacterial cells, cloning in Gram negative bacteria other than *E.coli*, Gram positive bacteria, Saccharomyces cerevisiae and other fungi, gene transfer to animal and plant cells, DNA mediated transformation, gene transfer by viral transduction, Agrobacterium mediated transformation, Directed DNA transfer to plants, In planta transformation, plant viruses as vectors. Stability of transgene, inheritance, patterns of integration.

Advances and applications**:** of Transgenic and Recombinant DNA Technology: Inducible expression system, Prokaryotic and eukaryotic expression systems, transgenic animals and plants, new drugs and new therapies for genetic diseases, gene therapy and gene therapy models, molecular pharming.

Reading:

1. Old RW and Primrose SB .Sixth edition, “Principles of gene manipulation ", BlackWell Scientific Publications, 2001.
2. Bernard R. Glick and Jack J. Pesternak. Third edition, “Molecular Biotechnology: Principles and Applications of recombinant DNA”, American Society for Microbiology, 2003.

BT304	IMMUNOLOGY LABORATORY	PCC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Perform single and double diffusion techniques for antigen – antibody interactions
CO2	Separate immunoglobulins using immunoelectrophoresis
CO3	Detect the given sample using DOT-ELISA test
CO4	Estimate the concentration of the antigen sample using quantitative precipitin assay.
CO5	Perform antibody-HRP conjugation reaction

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3		2						2
CO2	3	3		3	2					
CO3		3	2	3	3					
CO4	2	3		3	3					
CO5	1	3	3	3	3					

Detailed Syllabus:

Quantitative precipitin assay, Immunoprecipitation, Ouchterlony double diffusion, Radial immunodiffusion, Immunoelectrophoresis, Rocket immunoelectrophoresis, Countercurrent immunoelectrophoresis, Antibody-HRP conjugation, Immunoglobulin G isolation, Latex agglutination, Dot ELISA.

Reading:

1. Kuby Immunology, 6th Edition, -R.A. Goldsby, Thomas J. Kindt, Barbara, A. Osbarne. (Freeman), 2007.
2. Immunology- A Short Course, 4th Edition, -Eli Benjamini, Richard Coico, Geoffrey Sunshine. (wiley-Liss) 2002.
3. Fundamentals of Immunology, William Paul. Wiley publishers, 2004.
4. Immunology, by Roitt, Freeman Publishers, 2010.

BT305	BIOPROCESS AND BIOREACTION ENGINEERING LABORATORY	PCC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Estimate M-M constants
CO2	Find the effect of pH and temperature on enzyme activity
CO3	Estimate the monod parameters in batch, fed-batch and continuous cultures
CO4	Estimate residence time distributions in batch and continuous bioreactors.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	1							
CO2	2	3								
CO3	2	3	1							
CO4	2	3	1							

Detailed Syllabus:

Growth kinetics of bacteria in Fed-Batch Reactor, Enzyme Immobilization, Microbial death Kinetics, Residence time distribution, fluidized bed bioreactor for cell cultivation, determination of mixing time and power number in chemostat, effect of temperature, pH substrate concentration on enzyme activity, inhibition kinetics and estimation of biomass.

Reading:

1. Bioprocess Engineering Principles. By Paulin M. Doran. Elsevier Science & Technology Books.2008.

BT306	**GENETIC ENGINEERING LABORATORY**	**PCC**	**0 – 0 – 3**	**2 Credits**

Prerequisites: BT206-Molecular Biology and Genetics lab

Course Outcomes: At the end of the course the student will be able to:

CO1	Demonstrate basic safe laboratory practices and handle equipment safely
CO2	Perform restriction digestion of DNA with enzymes
CO3	Amplify DNA fragment using PCR
CO4	Prepare competent cells and perform transformation
CO5	Perform blue-white screening to select recombinant clones
CO6	Clone and express GFP in *E.coli*

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3				2	3			3
CO2		3	3							
CO3		3	3		2					
CO4		3	1							
CO5		3	3							
CO6		3	3							

Detailed Syllabus:

Restriction Digestion of DNA fragment with Restriction enzymes, Amplification of DNA fragment by PCR, Cloning of Lambda Phage DNA fragment in a pUC 18 Plasmid, DNA Ligation, Green Florescence Protein GFP Cloning and Expression, Transformation of cloned plasmid in to bacterial host cells – blue white Screening, RAPD, RFLP, AFLP, invitro transcription

Reading:

1. Molecular cloning: A Laboratory Manual (3rd Edition) by Joseph Sambrook and David Russell, CSHL Press, 2004.

SM335	ENGINEERING ECONOMICS AND ACCOUNTANCY	HSC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Prepare accounting records and summarize and interpret the accounting data for managerial decisions
CO2	Understand the macro-economic environment of the business and its impact on enterprise
CO3	Understand cost elements of the product and its effect on decision making
CO4	Understand the concepts of financial management and smart investment

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1								1	3	2
CO2								1	3	2
CO3								1	3	2
CO4								1	3	2

Detailed Syllabus:

Engineering Economics: Introduction to Engineering Economics – Fundamental concepts – Time value of money – Cash flow and Time Diagrams – Choosing between alternative investment proposals – Methods of Economic analysis. The effect of borrowing on investment- Various concepts of National Income – Significance of National Income estimation and its limitations, Inflation –Definition – Process and Theories of Inflation and measures to control, New Economic Policy 1991 – Impact on industry.

Accountancy: Accounting Principles, Procedure – Double entry system – Journal – Ledger, Trail Balance – Cash Book – Preparation of Trading, Profit and Loss Account – Balance sheet.

Cost Accounting – Introduction – Classification of costs – Methods of costing – Techniques of costing – Cost sheet and preparation of cost sheet- Breakeven Analysis – Meaning and its application, Limitations.

Reading:

1. Henry Malcom Stenar, Engineering Economic Principles, McGraw Hill, 2005.
2. K K Dewett, Modern Economic Theory, Siltan Chand & Co., 2005.
3. Agrawal AN, Indian Economy, Wiley Eastern Ltd, New Delhi, 2012.
4. Jain and Narang, Accounting Part-I, Kalyani Publishers, 2012.
5. Arora, M.N., Cost Accounting, Vikas Publications, 2013.

BT351	BIOREACTION ENGINEERING	PCC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the kinetics and mechanism of chemical and biochemical reactions
CO2	Classify bioreactors
CO3	Estimate Monod's parameters
CO4	Develop models for bioreactors and structured models for microbial growth
CO5	Design batch, continuous flow, and fed batch reactors for enzymatic reactions
CO6	Understand scale up concepts for bioreactors

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3			1	3					
CO2	3			1	3					
CO3	3			1	3					
CO4	3			2	3					
CO5	3			2	3					
CO6	3			1	3					

Detailed Syllabus:

Introduction**:** From Bioprocess design to system biology, Types of reaction, order of reaction. The effect of temperature on reaction rate. Rate equations and Reaction mechanisms; Interpretation of batch reactor data, constant volume batch reactor, integral method of analysis of data for reversible and irreversible reactions.

Bioreactor systems**:** Definitions, Differences and similarities between chemical and bioreactors; Classification of bioreactors; Reactor configurations; Description of a conventional bioreactor with all aspects; Design and construction criteria of a bioreactor; Residence time distributions, concentration, and temperature distributions; Models of non-ideal reactors, Imperfect mixing.

Design of Bioreactors**:** Design equations for enzyme reactors, batch growth of microorganisms, Design equation of a plug flow reactor; Design of CSTR with washout concept; Stirred tank reactors with recycle of biomass; Continuous stirred tank fermenter in series without and with recycle of biomass; Estimation of kinetic parameters.

Modelling of growth kinetics and design of fermentation processes: Model structure and complexity, a general structure for kinetic models, unstructured growth kinetics. Simple structured models, Mechanistic models, morphologically structured models, the stirred tank bioreactor, the plug flow reactor. Dynamic analysis of continuous stirred tank bioreactors.

Reading:

1. Bioreaction Engineering Principles , Second Edition, Jens Nielsen , John Villadsen , Gunnar Lidén .Kluwer Academics /Plenum publishers. 2002
2. Chemical Reaction Engineering; third Edition, Octave Levenspiel A Wiley- interscience Publication .2004
3. Bioprocess Engineering Principles. Paulin M. Doran. Elsevier Science & Technology Books.2006
4. Biochemical Engineering Fundamentals, Second Edition, James E.Bailey, David F. Ollis.McGrawHill. 1989.

BT352	BIOPROCESS INSTRUMENTATION AND CONTROL	PCC	4 – 0 – 0	4 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify instruments for the measurement of pressure, temperature, fluid flow and liquid level.
CO2	Understand the dynamic behavior of bioprocesses
CO3	Analyze different components of a control loop
CO4	Understand the closed loop control system
CO5	Analyze stability of feedback control system
CO6	Classify biosensors and transducers used in bioprocesses.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	3	1		1				
CO2	2	2		1		1				
CO3	3	2		1						
CO4	3	2		1						
CO5	3	2		1						
CO6	2	1	2	1	2	1	1			

Detailed Syllabus:

Process instrumentation: Principles of measurements and classification of process control instruments, measurements of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity and consistency, ph, concentration, electrical and thermal conductivity, humidity of gases, composition by physical and chemical properties

Bioprocess Instrumentation: Monitoring and control of bioreactors, Biochemical Reactor Instrumentation, physical, chemical and bio-chemical parameters, Introduction to flow, pressure, temperature, pH, foam, DO, redox and level measurements, sensors for medium and gases. Online and offline monitoring

Closed loop control systems: Development of Block diagram, Controllers and Final Control Elements, positioners, valve body, valve plugs, Valve characteristics, final control elements. Transfer functions for controllers and final control element, proportional, derivative, integral control; proportional reset (integral) (PI); proportional rate derivative (PD); proportional reset & rate controller (PID), actuators, numerical.

Transient Response and stability of Closed Loop Systems: Block diagram reduction for servo and regulator problem, Transient response of I and II order processes for set point changes and load changes with proportional, PI, PD and PID controllers, numerical, Concepts of stability, stability criteria, Routh test for stability, Root-locus method, Bode plots and stability criteria, tuning of controllers, numericals.

Biosensors: Types, Transducers in biosensors- calorimetric, optical, potentiometric / amperometric, conductometric/ resistometric, piezoelectric, semi conductor, mechanical and molecular electronics based, molecular wires and switches, development of molecular arrays as memory stores, design for a biomolecular photomic computers- information processing

Reading:

1. Donald R. Coughanowr (2009), Process Systems Analysis and Control, Mcgraw-Hill,
2. Eckman, D.P (2007) Industrial Instrumentation. Wiley.
3. Shuler and Kargi (2002), Bioprocess engineering. Prentice Hall.
4. Bailey and Ollis (2006), Biochemical engineering fundamentals. McGraw Hill
5. Tarun K Ghosh (2004) Biotechnology and bioprocess engineering: Proceedings, VII international biotechnology symposium. Delhi.
6. George Stephanopoulous (2009) Chemical process control, Prentice Hall of India

BT353	DOWNSTREAM PROCESSING IN BIOTECHNOLOGY	PCC	4 – 0 – 0	4 Credits

Prerequisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Understand separation techniques used in downstream process
CO2	Design and optimize downstream processes
CO3	Understand the requirements for successful operation of downstream processes
CO4	Understand the principles of major unit operations used in downstream processing of biopharmaceuticals.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		3	2		1				
CO2	2		3							
CO3	3				2			1		
CO4	3	2			2					

Detailed Syllabus:

Scope of Downstream Processing: Importance of Down Stream Processing (DSP) in biotechnology, characteristics of products, criteria for selection of bio-separation techniques. Role of DSP methods in bioprocess economics

Cell disruption methods: Various cell disruption methods, need for cell disruption for intracellular products, cell disruption equipment. Applications in bio-processing.

Solid- Liquid separation: Centrifugation: Principles of centrifugation, centrifuge effect, various centrifuges viz; basket centrifuge, tabular centrifuge, disc-bowl centrifuge, scale –up of centrifuges. Extraction methods.

Concentration of products
Membrane separation processes: Basic principles of membrane separation, membrane characteristics, different types of membranes, criteria for selection of membranes.

Chromatographic separation and electrophoresis methods: Principles of chromatographic separation methods, different types of chromatographic methods, viz; adsorption chromatography, ion – exchange chromatography, gel chromatography, affinity chromatography etc. Applications in bio-processing. Principles of electrophoresis and electrophoresis mobility, Applications

Drying**:** Various types of drying methods, Freeze drying technique and its advantages over other methods. Applications in bio-processing.

Reading:

1. Product Recovery in Bioprocess technology, BIOTOL series, Butterworth –Heinemann, 2006
2. Principles of fermentation technology by Peter F Stan bury, Allan Whitaker and Stephen J Hall, Pergamon Publications.2007
3. Comprehensive Biotechnology Vol 2 Ed: M.Moo –young (1985)
4. Principles of Downstream processing, by Ronald & J.Lee, Wiley Publications, 2007

BT354	BIOPROCESS INSTRUMENTATION AND CONTROL LABORATORY	PCC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Calculate the response of a dial thermometer
CO2	Determine the time constant of a thermocouple
CO3	Determine the dynamics of two capacity liquid level process without interaction and with interaction.
CO4	Evaluate the dynamics of a stirred tank
CO5	Determine the performance of controllers for a flow process, pressure process, level process, temperature process, heat exchanger system.

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	3	1		1				
CO2	2	2		1		1				
CO3	3	2		1						
CO4	3	2		1						
CO5	3	2		1						

Detailed Syllabus:

Dial Thermometer-Time constant calculation, Interacting and Non-Interacting liquid level system, Time constant of a liquid in glass thermometer, Heat transfer dynamics in a stirred tank, computer controlled flow process analyzer (P, PD, PI, PID Controls), level process analyzer, pressure process analyzer, temperature process analyzer, computer controlled heat exchanger.

Reading:

Lab Manual

BT355	DOWNSTREAM PROCESSING LABORATORY	PCC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Extract intra and extra cellular proteins from biological samples.
CO2	Perform cell destruction using a sonicator and enzymatic methods
CO3	Fractionate proteins using precipitation methods
CO4	Separate proteins using chromatographic techniques
CO5	Analyze the purity of proteins using electrophoresis

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		2							
CO2	2	1	3							
CO3	2	3		2						
CO4	3		3	2						
CO5		3	2			1				

Detailed Syllabus:

Extraction of Intra cellular Proteins by cell disruption methods, Centrifugation methods, Sonication methods, Precipitation methods, Lyophilization, Ion exchange chromatography, Gel filtration chromatography, Affinity chromatography, Tangential filtration methods, NATIVE electrophoresis, Storage methods for isolated products

Reading:

1. Principles of Protein Purification by Thomson, Wiley International Edition, 2007.
2. Practical Biochemistry by Wilson & Walker, Cambridge publications, 2006
3. Practical Biochemistry by Singh & Jain, Narosa Publications, 2007
4. Chromatographic Techniques by Amersham Pharmacia hand book,2008

ME435	INDUSTRIAL MANAGEMENT	ESC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic principles, approaches and functions of management and apply concepts to specific situations.
CO2	Understand marketing management process and apply marketing mix in formulation of marketing strategies during the life cycle of product.
CO3	Identify and utilize various techniques for improving productivity using work study.
CO4	Apply the concepts and tools of quality engineering in the design of products and process controls.
CO5	Understand and use appropriate methods/tools of inventory classification and control in industry.
CO6	Identify activities with their interdependency so as to optimize time vs costs utilizing the techniques of project management/CPM.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1									3	
CO2									3	
CO3								3		
CO4				3						
CO5					3					
CO6								2		

Detailed Syllabus:

Introduction, Evolution of industry and professional management, Functions of management, Organization structures, Hawthorne Experiments and informal organizational structures, Motivational theories and leadership styles

Marketing management process, 4P's of marketing mix, Target marketing, Product life cycle and marketing strategies

Productivity and its role in the economy, Techniques for improving productivity, Method study, Principles of motion economy, Stop watch time study, Work sampling

Dimensions of quality, Process control charts, Acceptance sampling, Taguchi's Quality Philosophy, Quality function deployment, Introduction to TQM

Purpose of inventories, Inventory costs, ABC classification, Economic Order Quantity (EOQ), P and Q systems of inventory control
Project activities & Network diagrams, Feasibility analysis, Critical path method, PERT

Reading:

1. Koontz H and Weihrich H, *Essentials of Management*, 7th Ed., McGraw-Hill, New York 2007.
2. Kotler P, *Marketing Management*, 13th Ed., Prentice Hall of India/Pearson, New Delhi 2009.
3. Chase, Shankar, Jacobs and Aquilano, *Operations and Supply Management*, 12th Ed., Tata McGraw Hill, New Delhi 2010.

BT401	BIOINFORMATICS	PCC	3 – 1 – 0	4 Credits

Prerequisites: BT251-Molecular Biology and Genetics

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the types of biological databases available in open source domain.
CO2	Compare and contrast, biological databases
CO3	Review algorithms for pairwise, multiple sequence alignments and phylogenetic analysis.
CO4	Analyse secondary and tertiary structure of proteins using bioinformatic tools.
CO5	Understand the principles of protein modeling.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3			1	3			2		
CO2	3			1	3			2		
CO3	3			1	3			2		
CO4	3			2	3			2		
CO5	3			2	3			2		

Detailed Syllabus:

Introduction to Bioinformatics -History & Overview and applications, emerging areas of Bioinformatics, Biological Databases: Definition, Purpose, Formats, Content, Access - PDB, Genbank, Swissprot, NRL3D, PIR. Nucleic Acids, gene families, and DNA motifs, Protein Motifs and Patterns, Protein families. Nucleotide Sequence Analysis, DNA Analysis-Strategies for sequencing genomes- Systematic approach, random approach, EST based approach.

Introduction to Whole Genomic analysis, Elements of DNA Sequences, ORF finding, DNA Motifs and Patterns, Micro-satellite Repeat patterns, Gene Structure (promoter elements, splicing, termination, etc) Gene Identification: Gene identification methods: grail, genscan etc… Proteins- Types, Functions and applications

Protein Sequence Analysis -Physico-chemical properties of Amino acids, Protein sequence motifs, Signal and membrane Proteins

Sequence Alignments and Statistics- Introduction to identity, similarity, Homology, Sequence Alignment methods, Alignment programs, Pairwise sequence alignment, Heuristic alignment concept and tools (BLAST- all flavors), mutation matrix, global vs local alignment, Dot plots, PAM and BLOSUM matrices, Multiple sequence Alignment- algorithms, Phylogenetic studies, dendrograms, phylograms, cladograms

Overview of Protein structure - Principles & characterization, Secondary structure elements, Domains, Folds, Motifs Overview of Protein Secondary Structure Prediction Methods, Introduction to Molecular Modeling concepts and Applications, overview of Bioinformatics applications -Automated gel reading, Primer Design, Restriction Endonuclease mapping.

Reading:

1. Arthur Lesk; Introduction to Bioinformatics, Oxford University Press, latest edition, 2002
2. Richard Durbin; Sean R. Eddy; Anders Krogh; Graeme Mitchison; Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, Cambridge University Press, latest edition, reprint 2008
3. David W. Mount; Bioinformatics: Sequence and Genome Analysis; CSHL Press; 1st edition, 2001
4. Andreas D. Baxevanis, Bioinformatics, A Practical Guide to the Analysis of Genes and Proteins. Wiley-Interscience, 3rd edition 2004

BT402	BIOPROCESS PLANT DESIGN MODELLING AND SIMULATION	PCC	4 – 0 – 0	4 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the Modelling Principles
CO2	Formulate Balance Equations
CO3	Understand and analyse Batch Operation, Semicontinuous or Fed Batch Operation
CO4	Develop Enzyme and growth kinetic models
CO5	Understand Bioreactor Modelling
CO6	Develop models for biological systems

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		3			2				
CO2	3		3		3					
CO3	3		3						2	
CO4	3		3							
CO5	3		3		3					
CO6	3		3		3					

Detailed Syllabus:

Unit-I. Modelling principles, use of models for understanding, design and optimization of bioreactors, general aspects of the modelling approach, general modelling procedure, simulation tools, uncertainty, and scenario and sensitivity analysis.

Unit-II Formulation of balance equations, types of mass balance equations, balancing procedure, continuous stirred tank bioreactor, tubular reactor, river with eddy current, component balances for reacting systems, constant volume continuous stirred tank reactor, semi-continuous reactor with volume change, steady-state oxygen balancing in fermentation, inert gas balance to calculate flow rates, stoichiometry, elemental balancing and the yield coefficient concept.

Unit-III Information for bioreactor modelling, batch operation, semi continuous or fed batch operation, continuous operation, summary and comparison, biological kinetics, michaelis-menten equation, other enzyme kinetic models, deactivation, sterilization, modelling of mutualism kinetics, kinetics of anaerobic degradation.

Unit-IV Bioreactor modelling, the batch fermenter, the chemostat, the fed batch fermenter, biomass productivity, modelling of tubular plug flow bioreactors, gas absorption with bioreaction in the liquid phase,liquid-liquid extraction with bioreaction in one phase, steady-state gas balance for the biological uptake rate, determination of $k_l a$ using the sulfite oxidation reaction determination of $k_l a$ by a dynamic method, model for oxygen gradients in a bubble column bioreactor , model for a multiple impeller fermenter.

Unit-V Simulation examples of biological reaction
Processes using berkeley madonna, batch fermentation (batferm), chemostat fermentation (chemo), fed batch fermentation (fedbat), kinetics of enzyme action (mmkinet), repeated fed batch culture (repfed), lineweaver-burk plot (lineweav), steady-state chemostat (chemosta), variable volume fermentation (varvol and varvold), penicillin fermentation using elemental balancing (penferm), fluidized bed recycle reactor (fbr).

Reading:

1. I. J. Dunn, E. Heinzle, J. Ingham, J. E. Pfenosil “Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples” WILEY-VCH Verlag GmbH & Co. KGaA, Weinheitn ,2003
2. J.R. Leigh, Modeling and Control of fermentation Processes, Peter Peregrinus, London, 2000
3. Syam S. Sablani et al. Hand book of food and bioprocess modelling techniques, Taylor & Francis Group, LLC,2006

BT403	BIOINFORMATICS LABORATORY	PCC	0 – 0 – 3	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Write simple PERL programs to manipulate and analyze DNA sequences
CO2	Retrieve data from open source biological databases
CO3	Use open source tools for bioinformatic data analysis
CO4	Construct protein models
CO5	Analyse protein structure, function and interaction using bioinformatic tools.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2			3					
CO2	3				3					
CO3	3				3					
CO4	3				3					
CO5	3				3					

Detailed Syllabus:

PERL Practice, Biological Databases, Pair wise sequence alignments, Multiple sequence alignments, ORF/Gene finding, Phylogenetic Tree construction, Protein Structure visualization, Protein modeling, docking studies with VLife MDS

Reading:

1. Bioinformatics exercises developed by Paul Craig, Department of chemistry, Rochester Institute of Technology.
2. Website tutorials @ NCBI, PDB

BT404	MODELING AND SIMULATION OF BIOPROCESS LABORATORY	PCC	0 – 0 – 3	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Model and simulate batch, CSTBR, PBR.
CO2	Apply SuperPro Designer software to simulate a biochemical process
CO3	Apply sensitivity, design and optimization tools in SuperPro Designer software.
CO4	Carry material and energy balances for bioprocesses.
CO5	Perform economic analysis for the waste water treatment system
CO6	Simulation of biochemical processes

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		3						3	
CO2		3	3		3				2	
CO3	3		3		3					
CO4	3	2	3							
CO5			3		3			2	3	
CO6	3		3		3					

Detailed Syllabus:

Flow sheeting of the chemical process using Superpro Designer, Design of a Heat exchanger using Superpro Designer, Design of a Distillation column using Superpro Designer, Calculation of volume of a bioreactor using Superpro Designer, Design of pressure valves and compressors using Superpro Designer, Design of a evaporator using Superpro Designer, Design of a absorption column using Superpro Designer, Design of a extractor using Superpro Designer, Design of a dryer using Superpro Designer, Design of a filter using Superpro Designer, Design of wastewater treatment plant using Superpro Designer, Design of Bioreactors using Superpro Designer.

Reading:

1. Syam S. Sablani et al. Hand book of food and bioprocess modelling techniques, Taylor & Francis Group, LLC,2006

BT41	SEMINAR	PCC	0 – 0 – 3	1 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Acquire knowledge on topics outside the scope of curriculum.
CO2	Communicate with group of people on different topics.
CO3	Collect and consolidate required information on a topic.
CO4	Prepare a seminar report.

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3	3		
CO2									2	3
CO3								3		
CO4							3	3	1	3

Detailed Syllabus: Seminar topic (related to biotechnology or allied sciences)

Reading: Recent literature survey related to the seminar topic published in the peer reviewed National and International Journals

BT449	PROJECT WORK PART-A	PRC	0 – 0 – 3	2 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Carry out literature survey as a team and select a problem statement
CO2	Draw flow sheet of the selected bioprocess
CO3	Perform mass balance calculations for each unit operation and bioprocess.
CO4	Apply modern software tools including prediction and modelling methods.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3		3	3					
CO2			3							
CO3	3		3				2			
CO4	1	1		3	3					

Detailed Syllabus: Project Topic

Reading: Recent literature survey related to the project topic published in the peer reviewed National and International Journals

BT451	BIOETHICS, BIOSAFETY AND IPR ISSUES	PCC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic issues of biosafety, bioethics and IPR
CO2	Follow good laboratory procedures and practices
CO3	Justify the design of confinement facilities at different Biosafety levels
CO4	Understand the social and ethical issues related to plant, animal and modern biotechnology.
CO5	Review international agreements and protocols for Biosafety.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2					3	3			2
CO2	2					3	3			2
CO3	2					3	3			2
CO4	2					3	3			2
CO5	2					3	3			2

Detailed Syllabus:

Introduction to Biosafety: Historical Background, Introduction to Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety Levels, Biosafety Levels of Specific Microorganisms, Recommended Biosafety Levels for Infectious Agents and Infected Animals, Biosafety guidelines – Government of India

Definition of GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture, Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication, Overview of National Regulations and relevant International Agreements including Cartagena Protocol

Introduction to Intellectual Property, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs, IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies

Agreements and Treaties, History of GATT & TRIPS Agreement, Madrid Agreement; Hague Agreement, WIPO Treaties; Budapest Treaty; PCT, Indian Patent Act 1970 & recent amendments, Basics of Patents and Concept of Prior Art, Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition, Specifications: Provisional & complete; Forms & fees, Invention in context of “prior art”

Patent databases: Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENTScope(WIPO), IPO, etc.), Patent filing procedures, National & PCT filing procedure; Time frame& cost; Status of patent applications filed, Precautions while patenting – disclosure/non-disclosure, Financial assistance for patenting - Introduction to existing schemes, Patent licensing and agreement, Patent infringement-meaning, scope, litigation, case studies

Bioethics: Necessity of bioethics, Origin and Evolution of ethics into bioethics, Ethical reasoning and the justification of moral beliefs, Different paradigms of bioethics - National and International

Reading:

1. Diane O. Fleming; Debra A. Long; Biological Safety: Principles and Practices, ASM Press; 4th edition, 2006
2. 2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information, 2007
3. Nancy Ann Silbergeld Jecker; Albert R. Jonsen; Robert A. Pearlman; Bioethics: Introduction to History, Methods, and Practice; Jones & Bartlett Publishers; II edition, 2007
4. Lim Li Ching; Terje Traavik; Biosafety First: Holistic Approaches to Risk and Uncertainty in Genetic Engineering and Genetically Modified Organisms; Tapir Academic Press, 2007
5. 21st Century Complete Guide to Biosafety and Biosecurity (CD-ROM): by U.S. Government, Publisher: Progressive Management, 2004
6. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., latest edition, 2007
7. Bonnie Steinbock; The Oxford Handbook of Bioethics (Oxford Handbooks): Oxford University Press, USA; 1st edition, 2007.

BT452	BIOSTATISTICS	PCC	3 – 0 – 0	3 Credits

Prerequisites: Mathematics –I, Mathematics-IV

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the mathematical basis and foundations of probability and statistics
CO2	Apply statistical methods to solve biological problems
CO3	Use basic and modern statistical software to analyse the biological and clinical data

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3				3					1
CO2	3								2	
CO3		2			3			2		

Detailed Syllabus:

Unit-I

Introduction to bio statistics and organization of data: Graphical and pictorial presentation of data, measurers of central tendency and dispersion, sampling techniques, sample size, coefficient of variation, means error, relative error, precision and accuracy.

Unit-II

Probability and Regression: Definition and probability distributions, normal, binominal and polynomial distributions, continuous data distribution, probit and logit analysis. Linear regression and correlation, method of least squares, curve fitting, multiple regression and correlation, significance of correlation and regression.

Unit-III

Parametric and Non-parametric tests: Testing hypothesis, types of errors, tests of significance based on normal distribution, test of significance for correlation coefficients. Data characteristics and nonparametric procedures, chi square test, sign test, Wilcoxon sign rank test, goodness of fit.

Unit-IV

Experimental design: Randomization, completely randomized and latin square designs, factorial design, cross over and parallel designs, bioavailability and bioequivalence. Bioassay, dose effect, relationships, LD_{50} ED_{50} probability calculations. Statistical quality control.

Reading:

1. Daniel Wayne W., Biostatistics: A Foundation for Analysis in the Health Sciences, 9th Ed., John Wiley & Sons, 2008.
2. Rosner Bernard, Fundamentals of Biostatistics, 7th Ed., Brooks/Cole, 2011.
3. Motulsky H, Intuitive Biostatistics, 2nd Ed., Oxford University Press, 2009.

BT499	PROJECT WORK PART-B	PRC	0 – 0 – 6	4 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Demonstrate safe laboratory practices and handle the equipment safely to ensure personal, product and environmental safety
CO2	Design processes for sustainable energy and environment
CO3	Design process equipments and bioprocess plants.
CO4	Apply advanced bimolecular engineering tools to solve biomedical problems

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3	3			
CO2						2	3			
CO3			3							
CO4				2	3					

Detailed Syllabus: Project Topic

Reading: Recent literature survey related to the project topic published in the peer reviewed National and International Journals

Department Elective Courses

BT311	INDUSTRIAL MICROBIOLOGY AND ENZYME TECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Sketch a process flow diagram for the production of bioproducts
CO2	Identify the process and critical unit operations involved in the production of beer, vinegar, SCP, Yeast and insecticides
CO3	Review the manufacturing processes for industrial alcohols and organic acids
CO4	Understand importance of enzymes and the principles of enzyme technology.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	3	2	2					
CO2	1		3	2		1	1			
CO3	1		3			1	1		2	
CO4	2			2	1				1	

Detailed Syllabus:

Unit 1**:**
Introduction: Scope of Biotechnology and Industrial Microbiology, Some microorganisms commonly used in an Industrial Microbiology, Industrial Media and the Nutrition of Industrial Organisms, Criteria for the Choice of Raw Materials Used in Industrial Media, Extraction of Fermentation products

Unit 2**:**
Production of Beer, Production of wines and spirits, Production of Vinegar, Production of industrial alcohol

Unit 3**:**
Single Cell Protein production, Yeast Production, Production of Microbial Insecticides, Production of Fermented Foods

Unit 4**:**
Production of Organic Acids, Production of amino acids, Production of exo polysaccharides, Production of antibiotics, Production of recombinant proteins, Production of biofertilizers, Production of vaccines

Unit 5**:**

Enzyme Technology, Immobilized enzymes and their uses, Enzyme Kinetics, Cellulases for Biomass Conversion, Enzyme Engineering, Industrial enzymes, Production and extraction of enzymes: Carbohydrate active enzymes, Proteases, Lipases, Nucleic acid enzymes.

Reading:

1. Nduka Okafor: Modern Industrial Microbiology and Biotechnology, Science publishers, Enfield, New Hampshire 03748, USA, 2007.
2. Julio Polaina and Andrew P. MacCabe: Industrial Enzymes- Structure, Function and Applications, Springer, Dordrecht, The Netherlands, 2007.

BT312	FERMENTATION TECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the chronological development of the fermentation industry
CO2	Understand working principle of various Bioreactors.
CO3	Understand Stoichiometry of Cell growth and product formation
CO4	Calculate Stoichiometric coefficients,Yield coefficients
CO5	Understand the Bath culture, Continuous culture, Multistage system, Feedback systems.
CO6	Model Solid-state Fermentation

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		1	1		1				
CO2	2		3						1	
CO3	2		1							
CO4	2		1							
CO5			3	2						
CO6			2		3					

Detailed Syllabus:

UNIT-I: Introduction to fermentation technology: Interaction between Chemical Engineering. Introduction to fermentation processes, the chronological development of the fermentation industry, the component parts of a fermentation process, Microbial culture selection for fermentation processes.

UNIT-II: Gaden's Fermentation classification, Design and operation of fermenters, Basic concepts for selection of a reactor, Rheology of fermenter, Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor, Scale up of Bioreactor.

UNIT-III: Bath culture, Continuous culture, Multistage system, Feedback systems, Comparison of batch and continuous culture in industrial process, Biomass productivity, Metabolite productivity Continuous brewing, Continuous culture and biomass production, Comparison of batch and continuous culture investigative tools, Fed-batch culture, Variable volume fed-batch culture, Fixed volume fed-batch culture, Cyclic fed-batch culture, Application of fed-batch culture, Examples of the use of fed-batch culture

UNIT-IV: Production of industrially important microbial products - Case studies: Production of beer, alcohol, enzymes, S.C.P and antibiotics from industrial strains

Reading:

1. Bailey, J.E. and Ollis D.F., Biochemical Engineering Fundamentals, Mcgraw Hill Higher Education; 2nd edition, 2001
2. Stanbury, P.E., Whitaker, A., Hall, S., Principles of Fermentation Technology 2nd edition, Butterworth-Heinemann, 2002
3. Pirt, S. J., Principles of Microbe and Cell Cultivation. Wiley, John & Sons, Reprint, 2005
4. Moo-Young, M., Comprehensive Biotechnology, Vol. 1–4, Pergamon Press, Reprint, 2004

BT313	ANALYTICAL METHODS IN BIOTECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the working principles of analytical instruments.
CO2	Analyze error, repeatability, precision and accuracy of instruments
CO3	Determine the structure of biomolecules using instrumental methods
CO4	Separate biomolecules using membrane and chromatographic techniques.
CO5	Understand the application of radioactivity in the analysis of biomolecules

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2				3					
CO2					3					
CO3					3					
CO4		3								
CO5		3								

Detailed Syllabus:

Photometry and spectrophotometry: The Beer-Lambert Law, percentage transmittance and absorbance, photoelectric colorimeters; spectrophotometers-types, UV visible, IR, atomic absorption, NMR and mass spectrophotometers.

Chromatography: Partition chromatography-mobile and stationary phases-paper chromatography-solvent systems-development of Rf value-ascending and descending techniques, two dimensional chromatography-thin layer chromatography. Column chromatography preparation of columns-gradient elution-analysis of fraction and elution profiles-ion exchange chromatography-preparation and activation of ion exchange materials-affinity chromatography separation of macromolecules-gas chromatography and high performance liquid chromatography (HPLC).

Electrophoresis-paper and gel electrophoresis-immuno electrophoresis-enzyme linked immuno absorbent assay (ELISA)-isoelectric focusing-two dimensional electrophoresis-capillary electrophoresis. Dialysis-separating membranes-factors affecting dialysis-gel filtration ultra-filtration-application of filtration techniques. Differential centrifugation-preparation of cellular organelle and other materials: disintegration of cells, density gradient centrifugation; analytical ultracentrifuge-determination of molecular weight.

Radio isotope techniques-radioactive disintegration-radioactive isotopes used in biology detection

of radioactivity-Geiger counters- -labelling of biological material with radioactive isotope-scintillation counting-liquid scintillation counters-autoradiography.

Reading:

1. Gurudeep R.Chatwal, Sham K.Anand, Instrumental Methods of Chemical Analysis, 5th edition, Himalaya Publishing House, 2012.

2. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Fundamentals of Analytical Chemistry, 8th edition, Brooks Cole; 2003.

3. Hobart H. Willard, Lynne L. Merrit, Jr. John A. Dean, Frank A. Settle Jr., Instrumental Methods of Analysis, 7th Edition, CBS Publishers, 1988.

BT314	PLANT BIOTECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Comprehend the concepts of Plant tissue culture techniques
CO2	In vitro study of plant secondary metabolites.
CO3	Understand the technology of plant transformation
CO4	Study of conventional and molecular marker breeding techniques.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1					3					
CO2		3								
CO3					3					
CO4					3					

Detailed Syllabus:

Unit 1

Introduction to Plant Biotechnology, Plant agriculture: The impact of biotechnology, Special features and organization of Plant cells, Plant growth hormones: biosynthesis and signaling pathways, Physiology, Transpiration, Movement of water and ions, translocation of phloem, Photomorphogenesis, Photoperiodism, Florigen, Vernalization.

Unit 2

Plant Tissue Culture, Media, culture conditions, Callus, cell suspension culture, Anther, protoplast, embryo and meristem cultures, Totipotency, regeneration methods of plants in cultures, Somatic hybrids and cybrids, Applications of cell and tissue culture, Production of Secondary metabolites, Engineering considerations for production of phytochemicals.

Unit 3

Successful gene transfer mechanism, Direct and Indirect methods, Agrobacterium mediated gene transfer, Applications of Transgenic plants, Insecticidal, herbicidal and viral resistance, Other applications of Transgenic plants

Unit 4

Transgenic Plant Analysis, Initial screens, Definitive molecular characterization, Field Testing of Transgenic Plants, Environmental risk assessment, Why transgenic plants are so controversial, IPR in PBT.

Reading:

1. Adrian Slator, Nigel W. Scott and Mark R. Fowler; Plant Biotechnology: the genetic manipulation of plants; Oxford University Press;2008
2. C. Neal Stewart, Plant Biotechnology and Genetics: Principles, techniques and applications; John Wiley and Sons, Inc., Publication, 2008.
3. P.S. Srivastava, Alka Narula and Sheela Srivastava, Plant Biotechnology and Molecular Markers; Springer Science, 2005.
4. H.S. Chawla, Introduction to Plant Biotechnology; Science Publishers, 2004

BT315	BIOFUELS	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify potential biomass sources for renewable energy generation.
CO2	Understand the production process for lipid based biofuels.
CO3	Understand the production process of biomethane and biohydrogen
CO4	Differentiate first and second generation biofuels

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3					3			
CO2		3					3			
CO3			3				3			
CO4	3						3			

Detailed Syllabus:

Historical Development of Bioethanol as a Fuel, Starch as a Carbon Substrate for Bioethanol Production, The Promise of Lignocellulosic Biomass, Thermodynamic and Environmental Aspects of Ethanol as a Biofuel, Effects on emissions of greenhouse gases and other pollutants, Ethanol as a First-Generation Biofuel: Present Status and Future Prospects

Chemistry, Biochemistry, and Microbiology of Lignocellulosic Biomass, Biomass as an Energy Source: Traditional and Modern Views, Structural and Industrial Chemistry of Lignocellulosic Biomass, Lignocellulose as a chemical resource, Physical and chemical pretreatment of lignocellulosic biomass, Biological pretreatments, Acid hydrolysis to saccharify pretreated lignocellulosic biomass,

Cellulases: Biochemistry, Molecular Biology, and Biotechnology, Enzymology of cellulose degradation by cellulases, Cellulases in lignocellulosic feedstock processing, Molecular biology and biotechnology of cellulase production, Hemicellulases: New Horizons in Energy Biotechnology, A multiplicity of hemicellulases, Hemicellulases in the processing of lignocellulosic biomass, Lignin-Degrading Enzymes as Aids in Saccharification, Commercial Choices of Lignocellulosic Feedstocks for Bioethanol Production, Biotechnology and Platform Technologies for Lignocellulosic Ethanols

Biotechnology of Bioethanol Production from Lignocellulosic Feedstocks, Traditional Ethanologenic Microbes, Yeasts, Bacteria, Metabolic Engineering of Novel Ethanologens, Comparison of industrial and laboratory yeast strains for ethanol production, Improved ethanol production by naturally pentose-utilizing yeasts, Assembling Gene Arrays in Bacteria for Ethanol Production, Metabolic routes in bacteria for sugar metabolism and ethanol formation, Genetic and metabolic engineering of bacteria for bioethanol production, Candidate bacterial strains for commercial ethanol production, Trends for Research with Yeasts and Bacteria for Bioethanol Production, “Traditional” microbial ethanologens, “Designer” cells and synthetic organisms

Biochemical Engineering and Bioprocess Management for Fuel Ethanol, Biomass Substrate Provision and Pretreatment, Wheat straw — new approaches to complete saccharification, Switchgrass, Corn stover, Softwoods, Sugarcane bagasse, Other large-scale agricultural and forestry, biomass feedstocks, Fermentation Media and the “Very High Gravity” Concept, Fermentation media for bioethanol production, Highly concentrated media developed for alcohol fermentations,

Fermentor Design and Novel Fermentor Technologies, Continuous fermentations for ethanol production, Fed-batch fermentations, Immobilized yeast and bacterial cell production designs,

Contamination events and buildup in fuel ethanol plants, Simultaneous Saccharification and Fermentation and Direct Microbial Conversion, Downstream Processing and By-Products, Ethanol recovery from fermented broths, Continuous ethanol recovery from fermentors, Solid by-products from ethanol fermentations

Genetic Manipulation of Plants for Bioethanol Production, Engineering resistance traits for biotic and abiotic stresses, Bioengineering increased crop yield, Optimizing traits for energy crops intended for biofuel production, Genetic engineering of dual-use food plants and dedicated energy crops

Vegetable oils and chemically processed biofuels, Biodiesel composition and production processes, Biodiesel economics, Energetics of biodiesel production and effects on greenhouse gas emissions, Issues of ecotoxicity and sustainability with expanding biodiesel production, Fischer-Tropsch Diesel: Chemical Biomass–to–Liquid Fuel Transformations

Radical Options for the Development of Biofuels, Biodiesel from Microalgae and Microbes, Biohydrogen, The hydrogen economy and fuel cell technologies, Bioproduction of gases, Production of H2 by photosynthetic organisms, Emergence of the hydrogen economy, Microbial Fuel Cells: Eliminating the Middlemen of Energy Carriers Biofuels as Products of Integrated Bioprocesses

Reading:

1. David M. Mousdale, Biofuel-Biotechnology, Chemistry, and sustainable Development, 1st Ed., CRC Press Taylor & Francis Group, 2008.
2. Ayhan Demirbas, Green Energy and Technology, Biofuels, Securing the Planet’s Future Energy Needs, 1st edition, Springer, 2009.

BT316	BIOFERTILIZER TECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the importance of biofertilizers
CO2	Select suitable production technology for biofertilizers
CO3	Identify the standards and quality control measures to be followed for mass production of biofertilisers

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3	3		1	2
CO2			3			2				
CO3		1		2		3	3			

Detailed Syllabus:

Biofertilizer: Concept of biofertilizer: kinds and beneficial effects on crops.Production technology of biofertilizers: Isolation, authentication and maintenance of the cultures of *Rhizobium*, *Azotobacter*, *Azospirillum*, Cyanobacteria, Phosphate solubilizing bacteria, celluloytic microbes and mycorrhizal fungi; Screening, selection and use of effective strains of *Rhizobium* and other microorganisms in the production of biofertilizers; Collection and processing of suitable carrier material for biofertilizer production., Screening and selection of *Azolla*, suitable for use as biofertilizer, application and quality control of biofertilizer, Contribution of biofertilizers on organic matter build-up of soils. Interactions of biofertilizers with chemicals interactions of biofertilizers with chemical fertilizers and pesticides applied in soil.

Reading:

1. Hamdi. Y.A. 2002. Application of nitrogen fixing systems in soil improvement and management. F AO soils bulletin 49. Rome. Italy.
2. Malik. K.A. Naqvi, S.II.M. and Aleem, M.I.H. 2005. Nitrogen and the environment, NIAB. Faisalabad. Pakistan.
3. Subba Rao, N.S. 2004. Current Development in Biological Nitrogen Fixation. Oxford and IBH Pub. Co. Pvt. Ltd. New Delhi.
4. Subba Rao, N.S. 2004. Biofertilizers in Agriculture. Oxford and IBH Pub. Co. Pvt. New Delhi.
5. Subba Rao. N.S. J 2007. Advances in Agricultural Microbiology. Oxford and 1BH. Pub. Co., New Delhi.

BT361	ANIMAL BIOTECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basics of animal cell culture
CO2	Apply aseptic techniques for cell culture
CO3	Design cell culture media for cell growth and product development
CO4	Characterize the animal cell using biochemical and molecular biology techniques
CO5	Apply the principles of genetic engineering to modify animal cell for research and industrial use.
CO6	Understand the concept of transgenic animal and animal breeding

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2		3			2			1
CO2		3		3	2		2			
CO3				2	2	2	3			
CO4	1	2		3	2					
CO5		3		3			2			1
CO6		3		3		2				

Detailed Syllabus:

Unit 1

Historical background, advantages and limitations Essential Equipments, General Safety Measures, Aseptic Techniques, Risk Assessment. Cryopreservation.

Unit 2

Media for culturing cells and tissues; natural and defined media, serum free and serum based media. Isolation of Cells and Tissues, primary and secondary cell cultures, development and maintenance of cell lines.

Unit 3

Characteristics of animal cells Morphological studies: Chromosome analysis, DNA content, RNA and Protein, Enzyme Activity, Antigenic Markers. Transformation: Immortalization, Aberrant Growth, Tumorigenicity. Transformation Assay, Cell counting, Cell Proliferation and Viability assay.

Unit 4

Recombinant Vaccine for animal health, Animal Breeds, Embryonic Stem Cell method, Transgenic Animal Production: Microinjection method, Retroviral vector method, importance and applications of transgenic animals.

Reading:

1. Animal Cell Culture & Technology, 2nd Edition, Author: Michael Butler, Mike Butler, M. Butler
2. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications 6th Edition, Author: R. Ian Freshney, Freshney

BT362	ENVIRONMENTAL BIOTECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the biological treatment techniques for waste water
CO2	Understand the principle of industrial waste management
CO3	Describe the use of biotechnological processes to protect the environment
CO4	Contrast approaches to anaerobic digestion of wastes and solve related problems

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3	3		3	3			2
CO2			2			2	2			3
CO3	1					3	3			1
CO4			2	3		2	2			

Detailed Syllabus:

Biological Treatment of Wastewater – Aerobic System Biological processes for domestic and industrial waste water treatments; Aerobic systems - activated sludge process, trickling filters, biological filters, rotating biological contractors (RBC), Fluidized bed reactor (FBR), expanded bed reactor, Inverse fluidized bed biofilm reactor (IFBBR) packed bed reactors air-sparged reactors.

Biological Treatment of Wastewater, Anaerobic System Anaerobic biological treatment – contact digesters, packed column reactors, UASB.

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.

Metal Biotechnology Mining and Metal biotechnology – with special reference to Copper & Iron. Microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects.

Hazardous Waste Management: Introduction - Xenobiotic compounds, recalcitrance. hazardous wastes - biodegradation of Xenobiotics . Biological detoxification - market for hazardous waste management, biotechnology application to hazardous waste management - examples of biotechnological applications to hazardous waste management – cyanide detoxification - detoxification of oxalate, urea etc. - toxic organics - phenols.

Reading:

1. Biodegradation & Bioremediation (2009), Martin Alexander, Academic press.
2. Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology, McMillan Publications, 2009.
3. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 2007.
4. Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London, 2009.

BT363	MEDICAL BIOTECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Review the clinical applications of gene and cellular therapy
CO2	Understand the concept of tissue engineering and organ transplantation
CO3	Review the clinical applications of recombinant technology
CO4	Understand the theory of gene silencing and antisense therapy
CO5	Study the principles of immunotherapy and vaccine development
CO6	Study the principles of transgenics

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	2	3						
CO2	2	3		3						
CO3			3	3	2					
CO4	2	2	3	3	2					
CO5	1	3		3			1			1
CO6				3			2			1

Detailed Syllabus:

UNIT-I

History of Gene therapy, Types of Gene therapy: *In vivo* & *Ex vivo*; Somatic & Germline Gene therapy, Introduction to Suicide Gene therapy: Suicide genes; bystander effect, Vectors for Gene therapy: viral & non-viral, Introduction to cellular therapy, Methodologies involved in cellular therapy, Clinical applications of cellular therapy.

UNIT-II

Stem cells: Introduction, types, Therapeutic applications of stem cell therapy, Concept of Tissue engineering, Clinical applications of Tissue engineering.

UNIT-III

Introduction to Recombinant therapy, Techniques involved in Recombinant therapy, Clinical applications of recombinant technology, Preface to Immunotherapy, Examples and applications of immunotherapy, Vaccines: Types of Vaccines, Clinical applications of Recombinant vaccines

UNIT-IV

Concept of Gene silencing, Gene silencing techniques, Clinical applications of Gene silencing, Method of Antisense therapy, Clinical applications of Antisense therapy.

UNIT-V

Tissue and Organ Transplantation, Graft rejection & Immunosuppresive Therapy, Introduction to Transgenics, Clinical and therapeutic applications of Transgenics

Reading:

1. Bernhard O. Palsson, Sangeeta N. Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
2. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics, 1st Edition, 21st Century Medicine, Springer, 2008.
3. Judit Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone; 1st Edition, 2009.

BT411	BIONANOTECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic principles of nanotechnology
CO2	Study the application of nanotechnology to physical, chemical and material sciences
CO3	Apply the concepts of nanotechnology for biosensors, drug delivery and gene therapy.
CO4	Study physical, chemical and biological methods for synthesis of nano materials
CO5	Understand the application of nanotechnology for design of biomolecular devices

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1		2		2				
CO2	1	2		2	2	1				
CO3	2	1	1	2	2				1	
CO4	3	1		1	1		1			
CO5	2	2	2	1	2	1	1			

Detailed Syllabus:

UNIT-I. Introduction to Nanoworld, Nanoscience and Nanotechnology, Nanoparticles, Nanowires, Thin films and multilayers, Applications of nanotechnology in Biotechnology, Nanotubes, Applications of nano tubes.

UNIT-II. Applications of nanotechnology in Physical sciences, Applications of nanotechnology in chemical sciences. Applications of nanotechnology in material sciences.

UNIT-III .Introduction to nanobiotechnology, Biomolecules as nanostructures, Biosensors, Types of biosensors and applications, BNT in separation of cells and cell organelles, BNT in drug delivery, BNT in gene therapy.

UNIT-IV. Synthesis of nanostructures, Natural in inorganic, Natural in organism, chemical and physical methods., Sol Process, Micelle, Chemical Precipitation, Hydrothermal Method, Pyrolysis, Bio-based Protocol, Chemical Vapor Deposition, Sputtering etc. Functionalization of nanoparticles for biological applications.

UNIT-V. Recent trends in Nanobiotechnology, Applications of nanobiotechnology: Drugs-Photodynamic therapy, Molecular motors, neuroelecronic interphases, Development of nano luminiscent tags, Biosynthesis of designer compounds: Designer biopolymers, Procollagen, DNA Polynode, RNA topoisomerase, Protein –magnetic materials.

Reading:

1. M.Ratner and D.Ratner,Nanotechnology –a gentle introduction to the next big idea, Pearson education , Latest edition.2007.
2. Nanobiotechnology: Concepts, Applications and Perspectives *by Christof M. Niemeyer, Chad A. Mirkin.*Wiley, John & Sons*.2004. 1st Edition.*
3. L.E.Foster, Nanotechnology-Science, Innovation and opportunity, Person education inc, Latest edition. 2007

BT412	BIOMATERIALS TECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify and understand the properties of biomaterials
CO2	Understand the concept of biocompatibility
CO3	Assess biocompatibility of materials using in vivo and in vitro techniques
CO4	Understand the concepts for developing new materials for tissue engineering and bio-implant applications

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2		2							
CO2	3	1		3						
CO3	2	2	3	3						2
CO4	2	3	3	2		2	2			2

Detailed Syllabus:

Unit-I

Introduction to basic concepts of Materials Science; Salient properties of important material classes; Property requirement of biomaterials.

Unit-II

Concept of biocompatibility; Structure and properties of biological cells & tissues; cell material interactions and foreign body response; Assessment of biocompatibility of biomaterials, *in vitro* biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation using ALP assay; Biomnuneralisation using Osteocalcin assay)

Unit-III

In vivo testing and histocompatibility assessment; genotoxicity assessment (Physical damage to DNA by biomaterial eluates); important biometallic alloys: Ti-based, stainless steels, Co-Cr-Mo alloys; Bioinert, Bioactive and bioresorbable ceramics;

Unit-IV

Processing and properties of different bioceramic materials with emphasize on hydroxyapatite; synthesis of biocompatible coatings on structural implant materials; Microstructure and properties of glass-ceramics; biodegradable polymers.

Unit-V

Design concept of developing new materials for bio-implant applications. Biomaterial applications in tissue engineering and regenerative medicine.

Reading:

1. Buddy D. Ratner, *Biomaterials Science*: An Introduction to Materials in Medicine 2nd Edition, Academic Press, 2004
2. Sujatha V. Bhat, Biomaterials, 2nd Edition , Narosa Publishing house,2010
3. Fredrick H. Silver Medical Devices and Tissue engineering: An integrated approach 1st edition , chapman and Hall Publications,1993

BT413	BIOTRANSFORMATION AND BIOCATALYSIS	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the process of biotransformation
CO2	Classify enzymes
CO3	Understand the applications of biocatalysis
CO4	Review commonly used enzyme preparations
CO5	Understand the methods for immobilization

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		2	2						
CO2	3		2	2						
CO3	2	2		3	1		1			
CO4	3		2	2						
CO5	3		2	3	1					

Detailed Syllabus:

Introduction, History of Industrial Biotransformations, Biocatalysis, Advantages and Disadvantages of Biocatalysis,

Enzyme Classification, Nomenclature, Classes, Enzyme Properties, Commonly used Enzyme Preparations, Isolated Enzymes vs. Whole Cell Systems, Immobilization; Modified and Artificial Enzymes. Mechanistic Aspects of Enzyme Catalysis, Coenzymes, Enzyme Sources, Retrosynthetic Biocatalysis, Optimization of Biocatalysys,

Biocatalytic Applications, Hydrolytic reactions, Mechanistic and Kinetic Aspects, Reduction reactions, Oxidation Reactions, Addition and Elimination Reactions, Transfer Reactions, Halogenation and Dehalogenation Reactions.

Special Techniques, Biotransformations at Industrial Scale. Quantitative Analysis of Industrial Biotransformation.

Reading:

1. Andreas Liese, Karsten Seelbach, Christian Wandrey, *Industrial Biotransformations*, 2nd Ed., Wiley-VCH; 2006.
2. Kurt Faber, *Biotransformations in Organic Chemistry: A Textbook*, 6th Ed., Springer; 2011.
3. Andreas S. Bommarius, Bettina R. Riebel-Bommarius, *Biocatalysis: Fundamentals and Applications*, 1st Ed., Wiley-VCH; 2004.

BT461	DRUG AND PHARMACEUTICAL BIOTECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Understand principles of biotechnology in pharmaceutical product development.
CO2	Identify the challenges faced in development of biologicals and drugs.
CO3	Apply advanced biotechnology methods in novel drug development
CO4	Review the production processes for antibiotics, vitamins, alkaloids and steroids

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	3	2						
CO2	1	2	3	2						
CO3	2	3		3	2					1
CO4	2	2	2	3	1	1	1			

Detailed Syllabus:

Introduction: Introduction to Pharmaceutical biotechnology, Introduction to pharmacokinetic concepts, biological /research advances and approved biologicals for pharmaceutical uses. And introduction to pharmacogenomics.

Enzymes: Enzyme fermentors and medium, enzyme extraction and purification of oxidoreductases, oxidases, hydrolases, penicillin amidases, transferases and applications of enzymes in therapeutics, clinical analysis and pharma industry.

Antibiotics: Antibacterial, antifungal and antiviral antibiotics, screening of antibiotics procedures, inoculum and medium for commercial production of penicillin and cephalosporin, fermentation process, isolation and purification.

Vitamins, ergot alkaloids, steroid and other metabolites: Different sources, isolation and purification, commercial production in bioreactors.

Microbes: Single cell protein production, microbial fermentation ,choice of substrate ,microbes in organic acid production, enzyme production, antibiotic ,ergotin,vitamin and glycerin production, microbes in medicine., Mutant selection of microbe strain for high yield.

Gene therapy and diagnostic aids: Disease prevention by vaccines (DNA vaccines), disease diagnosis probes, monoclonal antibodies, disease treatment products from recombinant organisms ,interferons, antisense nucleotides as therapeutic agents, drug delivery(Viral delivery and therapeutic strategies, nonviral delivery, Gene delivery to skin, use of liposomes as drug delivery system), disease targets, augmentation therapy, and gene therapy in cancer treatment .in HIV infection...

Reading:

1. Purohit,Kulkarni,Saluja—Pharmaceutical biotechnology, Agrobios publishers,2003
2. Templeton and Lasic –Gene therapy,Marcel and Dekkn publishers, 2000
3. Pharmaceutical biotechnology:drug discovery and clinical applications by Kayser,Wiley publishers, 1st edition 2007
4. Murray Moo-Young (Ed)-Comprehensive biotechnology Vol.3. (Permagon Press) 2004
5. Pharmaceutical biotechnology edition2 by crommel, Freeman publishers,2004

BT462	DRUG DESIGN AND DEVELOPMENT	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the concept of structure-function relationship of lead molecules in drug discovery
CO2	Understand the target identification in drug discovery
CO3	Apply the proteomics and genomics techniques in drug design
CO4	Understand the methods of drug delivery
CO5	Design new drugs using computational methods

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1				3					
CO2		2			3					
CO3		2		2	1					
CO4		2		2	1					
CO5		2	2	2	1					

Detailed Syllabus:

Unit 1

Stages of drug discovery, identification, validation and diversity of drug targets, Structure and function of different enzymes, ion channels and receptors. Molecular recognition in Ligand- Protein Binding. Biostructure – Based and Ligand – Based Drug Design. Functional selectivity of receptors. Forces involved in Drug- Receptor Interaction. Principles and fractional occupancy, Drug-Receptor occupation, Schild analysis. Receptor polymorphism; Cell signaling and signal transduction pathways.

Unit 2

Stereochemistry in Drug Design, Peptides and Peptidomimetics. Drug delivery systems for proteins and peptides with special reference to oral & nasal routes. Delivery consideration of Biotechnological products: Stability profile, Barriers to peptides and protein delivery, Delivery of protein and peptide drugs, Site specific protein modification, Toxicity profile characterization.

Unit 3

High-Throughput Screening, Pharmacogenomics, Proteomics, Array technology and Recombinant DNA technology of drugs. Disease targets for gene therapy. Monoclonal antibodies for diseases such as Diabetes, Cancer and neurodegenerative disorders. Biomarkers and its targets: Biosensors and Devices: Introduction and it's Applications.

Unit 4

Computation approaches for the quantification of Molecular diversity and design of compound libraries, physicochemical concept of in drug design. Indroduction QSAR, SAR versus QSAR, History and development of QSAR, Types of physicochemical parameters, experimental and theoretical approaches for the determination of physicochemical parameters. 3D-QSAR approaches. Computer aided prediction of drug toxicity and metabolism.

Reading:

1. Textbook of Drug Design and Discovery, Fourth Edition, Author: PovlKrogsgaard-Larsen, Ulf Madsen, Kristian Stromgaard.
2. Modern methods of drug discovery:1st edition. Hillisch, A., and Hilgenfeld, R. E. J. Wood.
3. Modern Biopharmaceuticals: Design, Development and Optimization, 1st edition, Editor(s): JörgKnäblein. Wiley – VCH, 2005.

BT463	MOLECULAR MODELING AND DRUG DESIGN	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand, design and model small molecules using computer aided drug design tools
CO2	Apply modeling techniques to model drug receptor interactions
CO3	Calculate the total energy of molecules and forces between them.

Mapping of the Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				1	3					
CO2			2		3					
CO3	2				3					

Detailed Syllabus:

Introduction to Molecular Modeling, Single molecule calculation, assemblies of molecules, Reaction of the molecules, Drawbacks of mechanical models as compared to graphical models, Co-ordinate systems two – matrix, potential energy surface.

Quantum Mechanics, Postulates of quantum mechanics, electronic structure calculations, *abinitio*, semi-empirical and density functional theory calculations, molecular size versus accuracy. Approximate molecular orbital theories. Empirical Force Field Models, Molecular Mechanisms, energy calculations, Bond stretch, angle bending, torsional term, Electrostatic interaction- Van der waals interactions, Miscellaneous interaction.

Analog based Drug Design, Introduction to QSAR, lead module, linear and nonlinear modeled equations, biological activities, physicochemical parameter and molecular descriptors, molecular modeling in drug discovery. Structure Based Drug Design, 3D pharmacophores, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies. Applications on the design of new molecules, 3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching, combinatorial libraries.

Molecular Dynamics, Introduction, Molecular Dynamics using simple models. Dynamics with continuous potentials, Constant temperature and constant dynamics, Conformation searching, Systematic search. Protein folding, Comparative protein modeling, Modeling by Homology, the alignment, construction of frame work ,selecting variable regions, side chain placement and refinement, validation of protein models –Ramchandran plot, threading and ab initio modeling.

Reading:

1. Andrew Leach. Molecular modeling: principles and applications. 2nd ed. Pearson Education. 2001.
2. Atkins and Friedman. Molecular quantum mechanics. Oxford University Press. 4th ed. 2005.
3. Alan Hinchliffe, Molecular Modelling for Beginners, 2nd edition, wiley, 2008
4. Hans-Dieter, Holtje, wolfgangsippl, Didier Rognan, GerdFolkers, Molecular Modelling, 3rd edition wiley-vch, 2008.
5. Chemical Applications of Molecular Modelling by Jonathan Goodman.
6. J.M.Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
7. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

BT464	TISSUE ENGINEERING	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure and organization of tissues and culture of cells
CO2	Understand the underlying mechanisms in cell attachment, cell adhesion and cell surface markers
CO3	Understand the construction of scaffolds and other transplant engineering biocompatible materials for tissue engineering
CO4	Understand the immunological response in organ transplantation.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3		2						
CO2	2	3		3	2					
CO3			3		2		2			
CO4	2	2		3			2			

Detailed Syllabus:

Unit-I

Introduction to tissue engineering, Cells as therapeutic Agents with examples, Cell numbers and growth rates. Tissue organization, Tissue Components, Tissue types, Functional subunits. Tissue Dynamics, Dynamic states of tissues, Homeostasis in highly prolific tissues and Tissue repair. Angiogenesis.

Unit-II

Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process Cell division - mitotic cell cycle, Cell death -biological description of apoptosis. Coordination of cellular fate processes – soluble signals, types of growth factors and chemokines, sending and receiving a signal, processing a signal, integrated responses, soluble growth factor receptors, Malfunctions in soluble signaling.

Unit-III

Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Direct Cell-Cell contact - Cell junctions in tissues, malfunctions in direct cell-cell contact signaling. Response to mechanical stimuli.

Unit-IV

Measurement of cell characteristics – cell morphology, cell number and viability, cell-fate processes, cell motility, cell function. Cell and tissue culture - types of tissue culture, media, culture environment and maintenance of cells in vitro, cryopreservation. Basis for Cell Separation, characterization of cell separation, methods of cell separation.

Unit-V

Biomaterials in tissue engineering - biodegradable polymers and polymer scaffold processing. Growth factor delivery, Stem cells. Gene therapy. Bioreactors for Tissue Engineering In vivo cell & tissue engineering case studies: Artificial skin, artificial blood vessels. In vivo cell & tissue engineering case studies: Artificial pancreas, artificial liver. In vivo cell & tissue engineering case studies: Regeneration of bone, muscle. In vivo cell & tissue engineering case studies: Nerve regeneration.

Reading:

1. "Tissue Engineering", Bernhard O. Palsson, Sangeeta N. Bhatia, Pearson Prentice Hall Bioengineering.
2. Nanotechnology and Tissue engineering - The Scaffold", Cato T. Laurencin, Lakshmi S. Nair, CRC Press.

BT465	GENOMICS AND PROTEOMICS	DEC	3 – 0 – 0	3 Credits

Prerequisites: Biochemistry, Molecular Biology

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand organization and structure of prokaryotic, eukaryotic and organellar genomes
CO2	Study molecular markers, DNA sequencing and bioinformatic tools for genome analysis
CO3	Analyse gene expression using northern blotting, RT-PCR and micro array
CO4	Comprehend the techniques of protein separation, sequencing, identification and protein-protein interactions
CO5	Understand the clinical and biomedical applications of proteomics

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2		1						
CO2	3	2		2	1					
CO3	3	2		2	1					
CO4	3	2		2	1					
CO5	3	2		2	1	1	1			

Detailed Syllabus:

UNIT I**:** Introduction, prokaryotic, eukaryotic & organellar genomes, genome sizes, introns and exons, methods of preparing genomic DNA, recombinant DNA technology, DNA cloning basics, polymerase chain reaction, southern blotting.

UNIT II**:** Molecular markers, hybridization and PCR based, single nucleotide polymorphisms (SNPs), DNA sequencing: Sanger dideoxy method, automated DNA sequencing, shotgun sequencing-contig assembly.

UNIT III: Gene identification, databases, sequence analysis, gene annotation, detecting open reading frames, software programs for finding genes, using homology to finding genes, human genome project, phylogenetic trees, genome evaluation.

UNIT IV: Analysis of gene expression, northern blotting, RNAse protection assay, RT-PCR, primer extension analysis, SI-nuclease assay, comparing transcriptomes, subtractive hybridization, SAGE, reporter genes, high-throughput analysis of gene expression, DNA microarrays and expression profiling, fluorescence in situ hybridization (FISH). Application of genomics.

UNIT V: Introduction and scope of proteomics, protein separation techniques: ion-exchange, size-exclusion and affinity chromatography techniques, polyacrylamide gel electrophoresis, isoelectric focusing, two-dimensional polyacrylamide gel electrophoresis, mass-spectrometry based method for protein identification.

UNIT VI: Protein sequencing, protein-protein interaction, immunoprecipitation, yeast two hybrid system, phage display method, protein engineering, protein chips and functional proteomics, protein structure analysis, proteome database, clinical and biomedical application of proteomics.

Reading:

1. S. B. Primrose, Richard M. Twyman. *Principles of gene manipulation and genomics*. Blackwell Publishing.
2. Anthony J. F. Griffiths: *Introduction to genetic analysis*. W.H. Freeman and Co., 2008
3. Mount (2003). *Bioinformatics: Sequence and Genome Analysis*. CBS
4. Sandor and Suhai. *Genomics and Proteomics: Functional and Computational Aspect*. Kluwar Academic Publisher.
5. Daniel C. Liebler, *Introduction to Proteomics: Tools for the new biology*, Published by Humana Press. (2002).
6. Stephen R. Pennington, Michael J. Dunn *Proteomics: From Protein sequence to Function*. BIOS Scientific Publisher LTD 2001.

BT466	STEM CELL TECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: Basic Biology and Cell Biology

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify stem cells
CO2	Understand the construction of connective tissues
CO3	Understand the process of isolation and identification of stem cells
CO4	Apply the concept of haematopoiepic stem cell therapy
CO5	Review the human stem cell research in India

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2		2						1
CO2	2	3		3						
CO3		3		2	2					
CO4		2	3	3	2		1			1
CO5		3		3			2			2

Detailed Syllabus:

Cell types and sources, Human tissue culture media, Culturing of cell lines-monolayer and suspension types of cultures, Biology and characterization of cultured cells, Maintenance and management of cell lines.

Bioreactor design on tissue engineering – Hollow fibre systems, Micro carrier based systems.
Isolation and identification of stem cells, Culturing and subculturing human neurospheres, Differentiation of human – Neurospheres into neurons, Astocytes and Oligodentrocytes, Immunolabelling procedures, stem cells and cloning.

Type of stem cell transplantation – Autologous, Allogeneic, Syngeneic, Nuclear transplantation, Therapeutic transplantation, Transfection methods – Lipofection, Electroporation, Microinjection, Embryonic stem cell transfer and Targeted gene transfer.
Neural stem cells for Brain/Spinal cord repair, Miracle stem cell heart repair, stem cell and future of regeneration medicine.
Haematopoietic stem cell therapy for autoimmune disease, Prenatal diagnosis of genetic abnormalities using fetal CD 34+ stem cells, Embryonic stem cell – A promising tool for cell replacement therapy, Germ-line therapy.

Human stem cell research in India, Human embryonic stem cell ethics and Public policy.

Reading:

1. Stem Cells Handbook, Editor: Stewart Sell ,Humana Press; 2003
2. Stem Cell Biology ,Editors: Daniel R. Marshak, Richard L. Gardner and David Gottlieb Cold Spring Harbor Laboratory Press, Cold Spring Harbor NY, USA; 2001
3. Adult Stem Cells,Editor: Kursad Turksen, Humana Press; Jan. 2004
4. Human Embryonic Stem Cells,Editors: Arlene Chiu, Mahendra S. Rao, Humana Press; 2003
5. Neural Stem Cells: Methods and Protocols, Tanja Zigova, Paul R Sanberg, Juan R Sanchez-Ramos,HumanaPress;2002
6. Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential Ann Kiessling and Scott C. Anderson,Jones and Bartlett Publishers, 2003
7. Neural Stem Cells For Brain and Spinal Cord Repair,Editors: Tanja Zigova, Evan Y.Snyder, Paul R. Sanberg, Humana Press; 2002
8. Stem Cells and the Future of Regenerative Medicine, Committee on the Biological and Biomedical Applications of Stem Cell Research, Board on Life Sciences, National Academies

BT467	IMMUNO TECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic concept of immune system.
CO2	Analyse antigen-antibody interaction
CO3	Design recombinant antibody for immuno-therapy
CO4	Understand the use of vaccine to manipulate immuno response
CO5	Understand the immuno response against cancer and infectious organisms
CO6	Study about immuno diagnostic kits.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2				2	1			
CO2	2	3		3						
CO3		2	3	3			1			
CO4		2	3	3			1			
CO5		2		3	2		2			
CO6	1		3				2			

Detailed Syllabus:

Unit 1:
Concept of innate immunity and adaptive immunity. Structure, Function and Classification of Immunoglobulins. Concept of epitopes. Isotype, Allotype and Idiotype.

Unit 2:
Cells and Organs of the Immune System, Haematopoiesis, Antigen recognition by T cells, Antigen processing and presentation. MHC molecules. T cell cloning, MHC class II molecules in T cell cloning, Immunity to virus.

Unit 3: Basic concepts of Ag-Ab interactions, polyclonal and monoclonal antibody, Hybridoma Techniques and monoclonal antibody production, Phage display technology and Antibody Engineering. Purification and characterization of monoclonal antibodies.

Unit 4:
Principles and strategy for developing vaccines, Immuno diagnosis of infectious diseases, Tumor Immunology, Recent advances in immunotechnology: Manipulation of the Immune Response.

Reading:

1. A.K. Chakravarty, Immunology and Immunotechnology, 1st Edition, Oxford Higher Education, 2006.
2. Kuby Immunology, 6th Edition, Barbara A. Osborne, Richard A. Goldsby, Thomas J. Kindt.
3. Immunotechnology: Principles, Concepts and Applications, 1st edition, Anthony Moran, James Gosling.

BT468	IPR MANAGEMENT IN BIOTECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basics of IPR and marketing regulations
CO2	Understand the role of IPR in pharma sector.
CO3	Understand risk management in IP commercialization.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							2		3	2
CO2						2	2		3	2
CO3			2			3	2		3	

Detailed Syllabus:

Intellectual Property System: Definition of IPR, different forms of IP, Patents, Trademarks, Copyright, Registered Design, Plant Breeder's Right, Domain names, Traditional knowledge, Geographical indication – their characteristics and application.

IP management Framework: Developing an IP strategy, Establishment of IP Management Framework, Developing IP policy and implementation plan, quantitative and qualitative IP valuation

IPR in pharma sector: Agreement and Treaties, GATT and TRIPS agreement, Madrid Agreement, Hague Agreement, Doha declaration.

IP commercialization**:** IP commercialization structure, direct exploitation, licence, Risk of IP commercialization, Type of Risks and risk management.

Reading:

1. Biotechnology intellectual property management manual. Spruson & Ferguson, 2008.
2. Kankanala C., Genetic patent law and strategy, 1st ed, Manupatra Information, 2007.
3. Derek Bosworth, Elizabeth Webster, The management of intellectual property, 1st ed., Edward Eglar, 2006.

BT469	METABOLIC REGULATION AND ENGINEERING	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the overview of cellular metabolism and connection between metabolic pathways.
CO2	Understand the metabolic pathway regulation at transcription and translation level.
CO3	Differentiate regulatory mechanisms involved in biosynthesis of primary and secondary metabolites
CO4	Apply the concept of auxotrophic mutations for the synthesis of primary and secondary metabolites
CO5	Understand the concept of bioconversions and its applications
CO6	Understand the concepts for developing heterologous pathways for production of value added compounds

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3		2						
CO2	2	3		3	1					
CO3	3			3		2				
CO4	3			3		2				
CO5	2			3		1	2			
CO6		2	3	2					1	

Detailed Syllabus:

Unit-I

Basic concepts of Metabolic Engineering – Overview of cellular metabolism – Different models for cellular reactions, induction – Jacob Monod model and its regulation, Differential regulation by isoenzymes, Feedback regulation.

Unit-II

Synthesis of primary metabolites: Amino acid synthesis pathways and its regulation at enzyme level and whole cell level, Alteration of feedback regulation, Limiting accumulation of end products.

Unit-III

Biosynthesis of secondary metabolites: Regulation of secondary metabolite pathways, precursor effects, prophase, idiophase relationship, Catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites, applications of secondary metabolites.

Unit-IV

Bioconversions: Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Co metabolism, Product inhibition, mixed or sequential bioconversions, Conversion of insoluble substances.

Unit-V

Regulation of enzyme production: Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation, Feedback repression, Catabolite Repression, optimization and control of metabolic activities. Pathway manipulations: The modification of existing - or the introduction of entirely new - metabolic pathways

Reading:

1. G. Stephanopoulos, A. Aristidou and J. Nielsen, Metabolic Engineering Principles and Methodologies, Academic Press, 1998
2. Daniel I. C. Wang, Malcolm D. Lilly, Arthur E. Humphrey, Peter Dunnill, Arnold l.Demain, Fermentation and Enzyme Technology,1st edition John Wiley& Sons, Reprint, 2005
3. Christina Smolke, The Metabolic Pathway Engineering Handbook (Two Volume) Set 1st edition CRC press, 2009.

Open Electives

CE390	**Environmental Impact Analysis**	**OPC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None.

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

CO1	Identify the environmental attributes to be considered for the EIA study.
CO2	Formulate objectives of the EIA studies.
CO3	Identify the suitable methodology and prepare Rapid EIA.
CO4	Prepare EIA reports and environmental management plans.
CO5	Plan the methodology to monitor and review the relief and rehabilitation works.

Mapping of the Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1					3	2		3
CO2	3	1					3	2		3
CO3	3	1					3	2		3
CO4	3	1					3	2		3
CO5	3	1					3	2		3

Detailed Syllabus:

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

EIA Methodologies**:** Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System,Integrated Impact Assessment.

Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal.

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.

Reading:

1. Jain, R.K., Urban, L.V., Stracy, G.S., *Environmental Impact Analysis*, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal, R. R., *Environmental Impact Assessment*, New Age International Publishers, 2002
3. Rau, J.G. and Wooten, D.C., *Environmental Impact Assessment,* McGraw Hill Pub. Co., New York, 1996.
4. Anjaneyulu.Y., and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

EE390	LINEAR CONTROL SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze linear and non-linear systems for steady state errors, absolute stability and relative stability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2									2
CO2	2									2
CO3	2									2
CO4	2									2

Detailed syllabus:

Introduction - control system, types, feedback and its effects-linearization

Mathematical Modelling of Physical Systems. Block diagram Concept and use of Transfer function. Signal Flow Graphs- signal flow graph, Mason's gain formula.

Time Domain Analysis of Control Systems - BIBO stability, absolute stability, Routh-Hurwitz Criterion.

P, PI and PID controllers. Root Locus Techniques - Root loci theory, Application to system stability studies.

Frequency Domain Analysis of Control Systems - polar plots, Nyquist stability criterion, Bode plots, application of Bode plots.

Reading:

1. B.C. Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pub. Co. 2008.

ME390	AUTOMOTIVE MECHANICS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Analyze operation and performance indicators of transmission systems, internal combustion engines and after treatment devices.
CO2	Understand operation of engine cooling system, lubrication system, electrical system and ignition system.
CO3	Understand fuel supply systems in an diesel and petrol vehicles
CO4	Analyze current and projected future environmental legislation and its impact on design, operation and performance of automotive power train systems.
CO5	Understand operation and performance of suspension, steering and braking system.
CO6	Understand layout of automotive electrical system and importance of electronic

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		3				3			3
CO2	3		3				3			3
CO3	3		3				3			3
CO4	3		3				3			3
CO5	3		3				3			3
CO6	3		3				3			3

Detailed syllabus

Introduction: Layout of an automotive chassis, engine classification.

Cooling Systems: Air cooling, air cleaners, Water cooling: Thermosyphon and pump circulation systems, Components of water cooling systems- Radiator, thermostat etc.

Engine Lubrication: Petroils system, Splash system, Pressure lubrication and dry sump system

Ignition System: Battery, Magneto and Electronic, Engine Starting drives

Fuel supply system: Components in fuel supply system, types of feed pumps, air cleaners, fuel and oil filters, pressure and dry sump systems.

Engine testing and Performance: Performance parameters, constant and variable speed test, heat balance test, performance characteristics. Engine Emissions: SI and CI engine emissions, emission control methods

Automotive electrical and electronics: Electrical layout of an automobile, ECU, sensors, windscreen wiper, Electric horn.

Transmission: Clutch- Single and multiplate clutch, semi & centrifugal clutch and fluid flywheel, Gear box: Sliding mesh, constant mesh and synchromesh gear box, selector mechanism, over drive, Propeller shaft and Differential.

Suspension System: Front and rear suspension, shock absorbers, Rear Axles mountings, Front Axle. Steering Mechanism: Manual and power steering systems, Braking System: Mechanical, Hydraulic and Air braking systems.

Engine service: Engine service procedure.

Reading:

1. S. Srinivasan, Automotive Mechanics, Tata McGraw-Hill, 2004.
2. K.M.Gupta, Automobile Engineering, Vol.1 and Vol.2, Umesh Publications, 2002
3. Kirpal Singh, Automobile Engineering, Vol.1 and Vol.2, Standard Publishers, 2003.
4. William H.Crouse and Donald L. Anglin, Automotive Mechanics, Tata McGraw-Hill, 2004
5. Joseph Heitner, Automotive Mechanics, East-West Press, 2000.

ME391	ROBUST DESIGN	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand stages in engineering design and concept of robust design.
CO2	Develop quality loss functions and S/N ratios for S, N and L type objective functions.
CO3	Identify control and noise factors for a given product or process.
CO4	Conduct experiments using DOE concepts to decide the optimal setting of parameters
CO5	Apply quality loss function approach for fixing the component tolerances.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		1							2
CO2	3		1							2
CO3	3		1							2
CO4	3		1							2
CO5	3		1							2

Detailed syllabus

Introduction: Taguchi's quality philosophy, causes of performance variation, concept of robust design, stages in product/process design, need for experimentation, QFD, process flow analysis, cause and effect diagram.

Design of Experiments**:** Principles of experimentation, Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & Anova, Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data.

Parameter Design**:** Loss function, average quality loss, S/N ratios, objective functions, selection of control & noise factors and their levels, strategy for systematic sampling of noise, classification of control factors, inner-array and outer-array design, data analysis, selection of optimum levels/values for parameters.

Tolerance Design: Experiments, selection of tolerances to be tightened, fixing the final tolerances.

Reading:

1. Taguchi G, Chowdhury S and Taguchi S, Robust Engineering, TMH, 2000.
2. Ross PJ, Taguchi Techniques for Quality Engineering, TMH, 2005.

ME392	ENTREPRENEURSHIP DEVELOPMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand entrepreneurship and entrepreneurial process and its significance in economic development.
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.
CO4	Develop a framework for technical, economic and financial feasibility.
CO5	Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
CO6	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3						2		3	3
CO2	3						2		3	3
CO3	3						2		3	3
CO4	3						2		3	3
CO5	3						2		3	3
CO6	3						2		3	3

Detailed syllabus

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site.

Planning a Small Scale Enterprsies**:** Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.

Operational Issues in SSE**:** Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws.

Performance appraisal and growth strategies**:** Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:

1. G.G. Meredith, R.E.Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013.

EC390	COMMUNICATION SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design tradeoffs and performance of communications systems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3	3		1	2
CO2			3			2				
CO3		1		2		3	3			
CO4		1		2		3	3			

Detailed syllabus

Signal Analysis**:** Communication Process, Sources of Information, Communication Channels, Modulation Process, Types of Communication, Random Process, Gaussian Process, Correlation Function, Power Spectral Density, Transmission of Random Process through an LTI Filter.

Noise Analysis: External Noise, Internal Noise, White Noise, Narrow Band Noise, Representation of Narrow Band noise In phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.

Amplitude (Linear) Modulation: Linear Modulation Schemes, Generation of AM, Envelope Detector, DSB-SC Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiver, SSB Signal Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Modulator and Demodulator, Carrier Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in SSB and DSB receivers using coherent detection, Noise in AM Receiver using Envelope detection, Threshold Effect.

Angle (Exponential) Modulation: Types of Angle Modulation, Relation between FM and PM, Narrow Band FM, Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and Indirect methods, FM Demodulation using Slope

Circuit, Frequency Discriminator, Interference in Angle Modulation, Noise in FM Receiver, FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodulation.

Pulse Modulation: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, Digital Multiplexer Hierarchy, DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Comparison of the Noise Performance of AM,FM,PCM and DM.

Information Theory: Uncertainty, Information, Entropy, Source Coding Theorem, Data Compaction, Mutual information, Channel Capacity, BSC Channel, Information Capacity Theorem, Bandwidth - Power Tradeoff, Huffman Coding.

Reading:

1. S. Haykin, Communication Systems, 4th Edn, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3rd Edn, Oxford University Press, Chennai, 1998.
3. Leon W.Couch II., Digital and Analog Communication Systems, 6th Edn, Pearson Education inc., New Delhi, 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems – 4th Edn, MGH, New York, 2002.

EC391	MICROPROCESSOR SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Develop basic understanding of microprocessor architecture.
CO2	Design Microprocessor and Microcontroller based systems.
CO3	Understand C, C++ and assembly language programming
CO4	Understand concept of interfacing of peripheral devices and their applications

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2		3			2			1
CO2		3		3	2		2			
CO3				2	2	2	3			
CO4	1	2		3	2					

Detailed syllabus

Microcomputer Organization: CPU, Memory, I/O, Operating System, Multiprogramming, Multithreading, MS Windows

80386 Micro Processors : Review of 8086,salient features of 80386,Architecture and Signal Description of 80386,Register Organization of 80386,Addressing Modes,80386 Memory management, Protected mode, Segmentation, Paging, Virtual 8086 Mode, Enhanced Instruction set of 80386, the Co- Processor 80387

Pentium & Pentium-pro Microprocessor: Salient features of Pentium microprocessor, Pentium architecture, Special Pentium registers, Instruction Translation look aside buffer and branch Prediction, Rapid Execution module, Memory management, hyper-threading technology, Extended Instruction set in advanced Pentium Processors

Microcontrollers: Overview of micro controllers-8051 family microcontrollers, 80196 microcontrollers family architecture, instruction set, pin out, memory interfacing.

ARM Processor Fundamentals: Registers, current Program Status Registers, Pipeline Exceptions, Interrupts and Vector Table, Architecture Revisions, ARM Processor families, ARM instruction set, Thumb Instruction set-Exceptions Handing, Interrupts, Interrupt Handling schemes, firmware, Embedded operating systems, Caches-cache architecture, Cache policy, Introduction to DSP on the ARM, DSP on the ARM7TDMI,ARM9TDMI.

Case study-Industry Application of Microcontrollers

Reading:

1. Barry B.Brey: Intel Microprocessor Architecture, Programming and Interfacing-8086/8088,80186,80286,80386 and 80486, PHI,1995.
2. Muhammad Ali Mazidi and Mazidi: The 8051 Microcontrollers and Embedded systems, PHI, 2008
3. Intel and ARM Data Books on Microcontrollers.

CH390	Nanotechnology and Applications	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Understand the properties of Nano-materials and applications
CO2	Apply chemical engineering principles to Nano-particle production
CO3	Solve the quantum confinement equations.
CO4	Characterize Nano-materials.
CO5	Scale up the production Nanoparticles for Electronics and Chemical industries.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3									
CO2			3							
CO3				3						
CO4									3	
CO5			3							

Detailed Syllabus:

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano-sizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.

Fabrication of Nanomaterials: Top Down Approach Grinding, Planetory milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface charges, Zeta Potential and pH.

Carbon Nanomaterials: Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C_{60}, bucky onions, nanotubes, nanocones

Quantum mechanics: Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots

Nanomaterials characterization: Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application: Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy.

Applications: Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials.

Nano inorganic materials of $CaCO_3$ synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices,

Nanobiology: Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts

Reading:

1. Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007
2. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore Introduction to Nanoscience and Nanotechnology CRC Press
5. Davies, J.H. 'The Physics of Low Dimensional Semiconductors: An Introduction', Cambridge University Press, 1998.

CH391	Industrial Safety and Hazards	OPC	3 – 0 – 0	3 Credits

Prerequisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze the effects of release of toxic substances.
CO2	Select the methods of prevention of fires and explosions.
CO3	Understand the methods of hazard identification and preventive measures.
CO4	Assess the risks using fault tree diagram.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3	3			
CO2						3	3			
CO3						3	3			
CO4						3	3			

Detailed syllabus:

Introduction-Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk , Public Perceptions ,The Nature of the Accident Process ,Inherent Safety.
Industrial Hygiene- Anticipation and Identification, Hygiene Evaluation, Hygiene Control.
Toxic Release and Dispersion Models- Parameters Affecting Dispersion, Neutrally Buoyant Dispersion Models, Dense Gas Dispersion, Toxic Effect Criteria, Effect of Release Momentum and Buoyancy, Release Mitigation.
Fires and Explosions- The Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram
Hazards Identification- Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews.
Risk Assessment- Review of Probability Theory, Event Trees, Fault Trees.
Safety Procedures: Process Safety Hierarchy, Managing Safety, Best Practices, Procedures—Operating, Procedures—Permits, Procedures—Safety Reviews and Accident Investigations.

Reading:

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall,2011.

2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Vol. 6, Elsevier India, 2006.

CS390	OBJECT ORIENTED PROGRAMMING	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand fundamental concepts in object oriented approach.
CO2	Analyze design issues in developing OOP applications.
CO3	Write computer programs to solve real world problems in Java.
CO4	Analyze source code API documentations.
CO5	Create GUI based applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3				2					2
CO2	3				2					2
CO3	3				2					2
CO4	3				2					2
CO5	3				2					2

Detailed Syllabus:

Object- oriented thinking, History of object-oriented programming, overview of java, Object-oriented design, Structure of java program. Types and modifiers, Classes, declaring objects in classes, Methods, constructors, garbage collection, Method overloading, passing objects as parameters, Inheritance, various forms and types of inheritance, Multilevel hierarchy, use of super, method overriding, Applications of method overriding, abstract classes, Packages with examples

Interfaces and implementation, Exception handling, types, throwing, creating own exceptions, Multithreading and concepts, its usage and examples, Input/output streams, String operations and examples, Collection classes-array, stack collection, bitset collection, Utility classes-string tokenizer, bitset, date, Applets- methods, creation, designing and examples, Event handling- event classes, Event listener interfaces, AWT classes, working with frames, AWT controls-layout manager, user interface components, Graphics programming

Reading:

1. Timothy Budd, “Understanding object-oriented programming with Java”, Pearson,
2. Herbert Schildt, “ The complete reference Java 2”, TMH,

BT390	GREEN TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

(This course is not offered to Biotechnology)

Pre-requisites: Chemistry

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

CO1	Address smart energy and green infrastructure
CO2	Build models that simulate sustainable and renewable green technology systems
CO3	Understand the history, global, environmental and economical impacts of green technology
CO4	Address non-renewable energy challenges

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1		1		1	2			
CO2	1	1		1	3	2	1			
CO3	2	1		1		1	2			
CO4	2	1		1		1	2			

Detailed Syllabus:

Biomass Energy, basic concepts, sources of biomass energy, uses of biomass energy, science and engineering aspects of biomass energy, production of biomass electricity, transmission of biomass electricity, storage of biomass electricity.

Energy transformation from source to services; Energy sources, sun as the source of energy; biological processes; photosynthesis; food chains, classification of energy sources, quality and concentration of energy sources; fossil fuel reserves - estimates, duration; theory of renewability, renewable resources; overview of global/ India's energy scenario.

Environmental effects of energy extraction, conversion and use; sources of pollution from energy technologies, Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends – process/product innovation-, technological/ environmental leap-frogging; Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity.

First and second laws of thermodynamics and their applications – Thermodynamic processes - Irreversibility of energy – Entropy. Properties of steam and classification of steam engines. Carnot cycle - Rankine cycle, Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil, Shale, Nuclear energy Option.

Biomass fuels, market barriers of biomass fuels, biomass fuel standerdization, biomass fuel life cycle, Sustainability of biomass fuels, economics of biomass fuels, Fuel stoichiometry and analysis: Fuel stoichiometry relations; Estimation of air required for complete combustion; Estimation of minimum amount of air required for a fuel of known composition; Estimation of dry flue gases for known fuel composition; Calculation of the composition of fuel & excess air supplied, from exhaust gas analysis; Dew point of products; Flue gas analysis (O_2, CO_2, CO, NOx, SOx).

Biomass as a major source of energy in India: Fuel-wood use in rural households. Consequences for ecosystems. Future energy scenario in rural areas. Utilization of biomass in industrial and semi-industrial settings. Future utilization of biomass in India. Future of landscape management: optimal management.

Reading:

1. Ayhan Demirbas, Green Energy and Technology, Biofuels, Securing the Planet's Future Energy Needs, 1st Edition, Springer, 2009.

2. Jay Cheng, Biomass to Renewable Energy Processes, 1st Edition, CRC press, 2009.

3. Samir K. Khanal, Rao Y. Surampally, 1st edition, American Society of Civil Engineers, 2010.

SM390	MARKETING MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand concepts and scope of marketing and market oriented strategic planning
CO2	Analyze macro level environment
CO3	Identify factors influencing consumer behavior in competitive global business environment
CO4	Identify tools and techniques for marketing management through integrated marketing communication systems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2								3	3
CO2	2								3	3
CO3	2								3	3
CO4	2								3	3

Detailed Syllabus:

Importance of Marketing, Scope of Marketing, Core Marketing concepts company orientation towards market place-production concept, Product concept, selling concept and Marketing concept.

Market oriented Strategic planning – Defining corporate Mission and Vision Statement at Corporate level and at Business unit level. Assigning resources to Strategic Business units through B.C.G Matrix and G.E Model.

Analyzing Macro environment-Demographic environment. Economic Environment, Technical Environment, Social-Cultural Environment and political – Legal Environment.

Components of Marketing information systems- Internal Records, Marketing intelligence, Marketing research and Marketing Decision support system.

Consumer Behavior- Buying Decision process and the factors influencing consumer Behavior- Psychological factors, social factors, cultural factors and personal factors.

Importance of Market segmentation, Target market selection and positioning.

Importance of new product development process and the various stages involved.

The concept of product lifecycle and the various strategies used by the marketer in each stage.

Product characteristics and classification, Product mix and product line decisions Branding Decisions, Building Brand Equity.

Importance of Pricing, Factors influencing pricing decisions. Various pricing methods-cost based and demand based methods.

Role of Marketing channels-Channel functions and channel levels channel Design and channel Management Decisions, Managing Retailing. Wholesaling and logistics. Importance of Electronic channels.

Importance of integrated Marketing communication. Advantages and Disadvantages of Various promotional tools- Advertising, Sales promotion, personal selling, publicity and public Relations and Direct marketing.

Reading:

1. Philip Kotler, Marketing Management, PHI, 14th Edition, 2013.
2. William Stonton & Etzel, Marketing Management, TMH, 13th Edition, 2013.
3. Rama Swamy & Namakumari, Marketing Management, McMillan, 2013.

MA390	NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Solve nonlinear differential equations by numerical methods.
CO2	Determine the convergence region for a finite difference method.
CO3	Solve elliptic PDE by finite difference method
CO4	Solve a parabolic PDE by finite difference method
CO5	Solve a hyperbolic PDE by finite difference method

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3									2
CO2	3									2
CO3	3									2
CO4	3									2
CO5	3									2

Detailed Syllabus:

Ordinary Differential Equations: Multistep (explicit and implicit) methods for initial value problems, Stability and Convergence analysis, Linear and nonlinear boundary value problems, Quasi-linearization, Shooting methods

Finite difference methods: Finite difference approximations for derivatives, boundary value problems with explicit boundary conditions, implicit boundary conditions, error analysis, stability analysis, convergence analysis.

Partial Differential Equations: Classification of partial differential equations, finite difference approximations for partial derivatives and finite difference schemes for Parabolic equations, Schmidt's two level, multilevel explicit methods, Crank-Nicolson's two level, multilevel implicit methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stability analysis.

Hyperbolic Equations: Explicit methods, implicit methods, one space dimension, two space dimensions, ADI methods.

Elliptic equations: Laplace equation, Poisson equation, iterative schemes, Dirichlet's problem, Neumann problem, mixed boundary value problem, ADI methods.

Reading:

1. M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern, 1984.
2. G.D. Smith, Numerical Solution of Partial Differential Equations, Oxford Univ. Press, 2004.
3. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Computational Methods for Partial Differential Equations, Wiley Eastern, 2005.

MA391	FUZZY MATHEMATICS AND APPLICATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Apply operations on Fuzzy sets
CO2	Solve problems related to Propositional Logic.
CO3	Apply Fuzzy relations to cylindric extensions.
CO4	Apply logic of Boolean Algebra to switching circuits.
CO5	Develop Fuzzy logic controllers

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3		2						
CO2	2	3		3	2					
CO3			3		2		2			
CO4	2	2		3			2			
CO5	2	2		3			2			

Detailed Syllabus:

Crisp set theory (CST): Introduction, Relations between sets, Operations on sets, Characteristic functions, Cartesian products of crisp sets, crisp relations on sets.

Fuzzy set theory (FST): Introduction, concept of fuzzy set (FS), Relation between FS, operations on FS, properties of standard operations, certain numbers associated with a FS, certain crisp sets associated with FS, Certain FS associated with given FS, Extension principle.

Propositional Logic (PL1): Introduction, Syntax of PL1, Semantics of PL1, certain properties satisfied by connectives, inference rules, Derivation, Resolution.

Predicate Logic (PL2): Introduction, Syntax of PL2, Semantics of PL2, certain properties satisfied by connectives and quantifiers, inference rules, Derivation, Resolution

Fuzzy Relations (FR): Introduction, Operations on FR, □-cuts of FR, Composition of FR, Projections of FR, Cylindric extensions, Cylindric closure, FR on a domain.

Fuzzy Logic (FL): Introduction, Three-valued logics, N-valued logics and infinite valued logics, Fuzzy logics, Fuzzy propositions and their interpretations in terms of fuzzy sets, Fuzzy rules and their interpretations in terms of FR, fuzzy inference, More on fuzzy inference, Generalizations of FL.

Switching functions (SF) and Switching circuits (SC): Introduction, SF, Disjunctive normal form, SC, Relation between SF and SC, Equivalence and simplification of circuits, Introduction of Boolean Algebra BA, Identification, Complete Disjunctive normal form.

Applications: Introduction to fuzzy logic controller (FLC), Fuzzy expert systems, classical control theory versus fuzzy control, examples, working of FLC through examples, Details of FLC, Mathematical formulation of FLC, Introduction of fuzzy methods in decision making.

Reading:

1. M. Ganesh, Introduction to Fuzzy Sets and Fuzzy Logic, PHI, 2001.
2. G.J. Klir and B.Yuan, Fuzzy sets and Fuzzy Logic–Theory and Applications, PHI, 1997.
3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1995.

PH390	MEDICAL INSTRUMENTATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand the origin of bio-potentials and their physical significance.
CO2	Understand anatomy and functioning of human heart and its common problems.
CO3	Analyze ECG, ENG and EMG signals and instrumentation.
CO4	Compare different techniques of measuring blood pressure, blood flow and volume.
CO5	Interpret the principle and operation of therapeutic and prosthetic devices.
CO6	Differentiate between the various techniques for measurement of parameters.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	2						3
CO2	3	1	3	2						3
CO3	3	1	3	2						3
CO4	3	1	3	2						3
CO5	3	1	3	2						3
CO6	3	1	3	2						3

Detailed Syllabus:

General Introduction: The cell, body fluids, Musculoskeletal system, respiratory system, gastrointestinal system, Nervous system, endocrine system and circulatory system.

Origin of Bio potentials: electrical activity of Excitable cells: the resting state, The active state, Volume conductor fields, Functional organization of the peripheral nervous system: Reflex are & Junctional transmission.

The Electroneurogram (ENG): The H-Reflex, The Electromyogram (EMG), The Electrocardiogram (ECG), heart and the circulatory system, Electro conduction system of the heart and heart problems, ECG waveform and Physical significance of its wave features, Electrical behavior of cardiac cells, The standard lead system, The ECG preamplifier, DC ECG Amplier, Defibrillator protection circuit, Electro surgery Unit filtering, Functional blocks of ECG system, Multichannel physiological monitoring system, Common problems encountered and remedial techniques.

Blood Pressure: indirect measurement of blood pressure, korotkoff sounds, auscultatory method using sphygmo manometer, Oscillometric and ultrasonic non invasive pressure measurement, Direct measurement of blood pressure H_2O manometers, electronic manometry, Pressure transducers,. Pressure amplifier designs, Systolic, diastolic mean detector circuits

Blood flow and Volume Measurement: indicator dilution methods, Transit time flow meter, DC flow meter, Electromagnetic flow meter AC electromagnetic flow meter, Quadrature suppression flow meter, Ultrasonic flow meter, Continuous-wave Doppler flow meter, Electric impedance plethysmography, chamber plethysmography, Photo plethysmography.

Pulse Oximetr: Principles of Operation, Absorption Spectrum, Sensor design, Pulse oximeter, Therapeutic and Prosthetic Devices.

Cardiac Pacemakers: Lead wires and electrodes, Synchronous Pacemakers, rate responsive pacemaking, Defibrillators, cardioverters, Electrosurgical unit, Therapeutic applications of laser, Lithotripsy Haemodialysis.

Reading:

1. John G Webster, Medical Instrumentation: Application and Design , John Wiley,3rd Ed. 2012.
2. Joseph J. Carr & John M. Brown , Introduction to biomedical Equipment Technology, 4th Ed., Prentice Hall India, 2001

PH391	ADVANCED MATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand the synthesis and properties of nanomaterials
CO2	Evaluate the usefulness of nanomaterials in medicine, biology and sensing
CO3	Understand modeling of composite materials by finite element analysis
CO4	Differentiate superconducting materials
CO5	Understand the characteristics and uses of functional materials

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3							3
CO2	3	2	3							3
CO3	3	2	3							3
CO4	3	2	3							3
CO5	3	2	3							3

Detailed Syllabus:

Nano Materials: Origin of nano technology, Classification of nano materials, Physical, chemical, electrical, mechanical properties of nano materials. Preparation of nano materials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon nana tubes (CNT).Synthesis, preparation of annotates, nana sensors, Quantum dots, nana wires, nano biology, nano medicines.

Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopeadiac implants, dental materials.

Composites: General characteristics of composites , composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion, composite modeling, finite element analysis and design.

Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, charge coupled devices (CCD), laser materials.

Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.

Smart materials: An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphous, liquid crystalline materials.

Surface Acoustic Wave (SAW) Materials and Electrets: Delay lines, frequency filters, resonators, Pressure and temperature sensors, Sonar transducers. Comparison of electrets with permanent magnets, Preparation of electrets, Application of electrets.

Reading:

1. T.Pradeep, Nano: The Essentials; TaTa McGraw-Hill,2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press
3. Krishan K Chawla, Composite Materials; 2nd Ed., Springer 2006.

CY390	INSTRUMENTAL METHODS IN CHEMICAL ANALYSIS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Characterize materials using ultraviolet and visible absorption and fluorescence techniques
CO2	Analyze materials, minerals and trace samples using atomic absorption, emission and X-ray fluorescence techniques
CO3	Analyze environmental, industrial, production-line materials by liquid, gas and size-exclusion chromatographic techniques.
CO4	Characterize interfaces and traces of surface adsorbed materials using electro-analytical techniques
CO5	Understand principles of thermogravimetry and differential thermal analyses.
CO6	Characterize chemical, inorganic and engineering materials using analytical techniques

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3							2
CO2	3	1	3							2
CO3	3	1	3							2
CO4	3	1	3							2
CO5	3	1	3							2
CO6	3	1	3							2

Detailed Syllabus:

UV-Visible Spectrophotometry and Fluorescence Beer-Lambert's law, limitations, Molecular fluorescence, influencing factors, basic instruments, standardization, quantitative methods, applications.

Atomic spectrometry, atomic absorption, X-ray fluorescence methods Flame atomic emission and absorption, flame emission photometer, flame absorption spectrometer, spectral interferences, quantitative aspects, X-ray fluorescence principle, Instrumentation, quantitative analysis.

Separation techniques Solvent extraction, Principle, Extraction of solutes, Soxhlet extraction

Chromatography methods Gas chromatography, High performance liquid chromatography, Size exclusion chromatography, Principle, Basic instrumentation, Capillary Electrophoresis: Principle and application.
Thermoanalytical methods Thermogravimetry, Differential thermal analysis, differential scanning calorimetry, Principle, Block diagram, Applications, Quantitative determinations.
Electroanalytical methods Coulometric methods, Polarography, Pulse voltammetric methods, Amperometry, Principles, Applications, Electrochemical sensors, Ion selective, Potentiometric and amperometric sensors, Applications.
Spectroscopic methods Molecular absorption, Woodward rules, applications, Infra red absorption, functional group analysis, qualitative analysis, 1H- and 13C-NMR spectroscopy, Principle, Basic instrumentation, terminology, Interpretation of data, Quantitative applications.
Mass spectrometry Principles, Instrumentation, Ionization techniques, Characterization and applications.

Reading:

1. Mendham, Denny, Barnesand Thomas, Vogel: Text book of Quantitative Chemical Analysis, Pearson Education, 6th Edition, 2007.
2. Skoog, Holler and Kouch, Thomson, Instrumental methods of chemical analysis, 2007.
3. Willard, Meritt and Dean, Instrumental methods of chemical analysis, PHI, 2005.

CY391	CHEMICAL ASPECTS OF ENERGY SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand traditional and alternative forms of energy
CO2	Understand energy production, storage, distribution and utilization.
CO3	Model environmental impacts of energy generation and conservation
CO4	Apply concepts of engineering design to energy challenges

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3	3			
CO2						3	3			
CO3						3	3			
CO4						3	3			

Detailed Syllabus:

Unit I: THERMOCHEMISTRY AND CHEMICAL KINETICS OF ENERGY SOURCES:
Chemistry of Fuels and Characteristics of a Good Fuel; Heats of Combustion of Fuels; Determination of Heats of Combustion by Bomb Calorimetry and Differential Scanning Calorimetry; Thermodynamics of Electrochemical Cells; Determination of Various Thermochemical Functions of Energy Materials by Electroanalytical Methods (Potentiometry, Coulometry and Voltammetry)
Rates of Combustion Processes; Determination of Ignition Point, Flash Point and Other Kinetic Parameters of Chemical Energy Sources

Unit-II: CHEMISTRY OF CONVENTIONAL AND NON-CONVENTIONAL ENERGY MATERIALS:
Chemical Composition of Finite Energy materials (Petroleum Products, Petroleum Refinery, Fractional Distillation and Petroleum Cracking; Natural Gas, Water Gas, Biomass and Goober Gas; Hydrogen as a Fuel and Its Controlled Combustion; Coal Carbonization and Gasification; Pulverization of Cellulose and Firewood

UNIT -III: ELECTROCHEMICAL ENERGY SYSTEMS:
Primary and Secondary batteries, Reserve batteries, Solid state and molten solvent batteries, Recent technological trends, Lithium ion batteries, Nanostructured electrode materials, Lithium and carbon based nanomaterials and nanocomposites, Solid-state Lithium ion batteries, Energy storage and backup. Fuel cells, Scientific prospects of fuel cells, Electrochemistry, In-situ and ex-situ electrochemical characterizations, Current-Voltage measurement, Current Interrupt measurements, Porosity, BET surface area analysis, Gas

permeability, Hydrogen as future fuel, Alkaline-, acid- and molten carbonate-fuel cells, Solid oxide fuel cells.

UNIT-IV: SOLAR ENERGY HARNESSING:
Fundamentals, Conversion into electrical energy, Photovoltaic and Photogalvanic energy storage, Semiconductor photoelectrochemical cells, Photoelectrochemical reactions, Regenerative photoelectrochemical cells, Basic problems, Photocorrosion and protection of semiconductor electrodes, Protective coatings, Coatings of metals and electrically conductive polymers, Electrodes with chemically modified surfaces.

UNIT-V: PHOTOCHEMICAL AND PHOTOELECTROCHEMICAL CLEAVAGE OF WATER:
Photochemistry and Photocatalysis of Splitting of Water Molecule; Chemically Modified Electrodes for Water Cleavage; Coordination Chemistry of Water Cleavage

UNIT-VI: ENVIRONMENTAL CONCERNS AND GREEN METHODS OF ENERGY SOURCES:
Quality of Chemical Energy Sources; Pollution Control and Monitoring of Energy Extraction from Materials; Nanochemical Methods in Energy Extraction; Modeling of Combustion and Other Energy Tapping from Materials

Reading:

1. Energy systems Engineering – Evaluation and Implementation, Francis Vanek, Louis Albright, Largus Argenent, Mc Graw-Hill, 2012.
2. Energy Systems and Sustainability: Power for a Sustainable Future, Bob Everett, Godfrey Boyle, Stephen Peake and Janet Ramage, Oxford Uni Press, 2012.
3. Lithium ion batteries – Advances and applications, Gianfranco Pistoria, Elsevier 2014.
4. Tomorrow's Energy: Hydrogen, Fuel cells, and the prospects for a cleaner planet, Peter Hoffmann, Byron Dorgan, MIT Press, 2012.
5. solar energy conversion Yuri V Pleskov, Springer-Verlag, 1990.
6. Solar energy conversion – Dynamics of interfacidal electron and excitation transfer, Piotrowiak, Laurie Peter, Heinz Frei and Tim Zhao, RSC 2013.

HS390	SOFT SKILLS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand corporate communication culture
CO2	Prepare business reports and proposals expected of a corporate professional
CO3	Employ appropriate speech in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Acquire corporate email, mobile and telephone etiquette

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3							2		3
CO2	3							2		3
CO3	3							2		3
CO4	3							2		3
CO5	3							2		3

Detailed Syllabus:

English Language Enhancement: Verbs and tenses, Phrasal verbs, Synonyms, Antonyms, Homonyms - Descriptive Words, Combining Sentences, Business Idioms, Indianisms in English.

Art of Communication, Communication process- Non-verbal Communication- Effective Listening.

Interpersonal and Intra Personal Communication Skills- Self-Awareness- Self-Esteem and Confidence- Assertiveness and Confidence- Dealing with Emotions-Team Concept- Elements of Teamwork- Stages of Team Formation- Effective Team-Team Player Styles- Leadership.

Campus to Company- Dressing and Grooming- The Corporate Fit- Business Etiquette- Communication; media etiquette- Group Discussions, Interviews, and Presentation Skills.

Interview Handling skills- Effective Resume-- Common Interview Mistakes- Body-language- Content Aid, Visual Aids- Entrepreneurial Skills Development.

Reading:

1. Robert M. Sherfield, Developing Soft Skills, Montgomery and Moody Fourth Edn. Pearson, 2009.
2. K.Alex, Soft Skills: Know Yourself & Know The world, S. Chand; 2009.

3. Robert Bramson, Coping with Difficult People, Dell, 2009

CE440	BUILDING TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.
Course Outcomes: At the end of the course the student will be able to:

CO1	Apply basic principles to develop stable, sustainable and cost-effective building plans.
CO2	Identify effective measures for fire proofing, damp proofing, and thermal insulation.
CO3	Adopt standard building provisions for natural ventilation and lighting.
CO4	Identify different materials, quality and methods of fabrication & construction.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		3					2		3
CO2	3		3					2		3
CO3	3		3					2		3
CO4	3		3					2		3

Detailed Syllabus:

Overview of the course, basic definitions, Buildings – Types, components, economy and design, Principles of planning of buildings and their importance.

Definitions and importance of Grouping and circulation; Lighting and ventilation; How to consider these aspects during planning of building

Termite proofing: Inspection, control measures and precautions, Lighting protection of buildings: General principles of design of openings, Various types of fire protection measures to be considered while planning a building.

General requirements and extra requirements for safety against fire, special precautions, Vertical transportation in building – types of vertical transportation, Stairs, different forms of stairs, planning of stair cases, Other modes of vertical transportation – lifts, ramps, escalators.

Prefabrication systems in residential buildings – walls, openings, cupboards, shelves etc., planning and modules and sizes of components in prefabrication.

Planning and designing of residential buildings against the earthquake forces, Principles, Seismic forces and their effect on buildings.

Air conditioning – process and classification of air conditioning, Dehumidification. Systems of air-conditioning, ventilation, functional requirements of ventilation.

Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics of building. Sound insulation – importance and measures.

Plumbing services – water supply system, maintenance of building pipe line, Sanitary fittings, principles governing design of building drainage.

Reading:

1. Building Construction - Varghese, PHI Learning Private Limited, 2008
2. Building Construction - Punmia, B C, Jain, A J and Jain A J, Laxmi Publications, 2005.
3. Building Construction by S.P. Arora and S.P. Bindra – Dhanpatrai and Sons, New Delhi, 1996.
4. Building Construction – Technical Teachers Training Institute, Madras, Tata McGraw Hill, 1992.
5. National Building code of India, Bureau of Indian Standards, 2005.

EE 440	NEW VENTURE CREATION	OPC	3–0– 0	3 Credits

Pre-requisites: None

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

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Understand conceptual frameworks for identifying entrepreneurial opportunities and for preparation of business plan
CO3	Explore opportunities for launching a new venture
CO4	Identify functional management issues of running a new venture

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3							2		3
CO2	3							2		3
CO3	3							2		3
CO4	3							2		3

Detailed syllabus:

ENTREPRENEUR AND ENTREPRENEURSHIP:
Entrepreneurship and Small Scale Enterprises (SSE) – Role in Economic Development, Entrepreneurial Competencies, Institution Interface for SSE.

ESTABLISHING THE SMALL SCALE ENTERPRISE:
Opportunity Scanning and Identification, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Ownership Structures and Organizational Framework.

OPERATING THE SMALL SCALE ENTERPRISES:
Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, Organizational Relations in SSE.

Reading:

1. Kuratko: New Venture Management : The Entrepreneur's Roadmap, Pearson Education India, 2008.
2. Holt, "Entrepreneurship: New Venture Creation", PHI(P), Ltd.,2001.
3. Lisa K. Gundry, Jill R. Kickul: Entrepreneurship Strategy: Changing Patterns in New Venture Creation, Growth, and Reinvention, Sage Publications, 2007.

ME440	ALTERNATIVE SOURCES OF ENERGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify renewable energy sources and their utilization.
CO2	Understand basic concepts of solar radiation and analyze solar thermal systems for its utilization.
CO3	Understand working of solar cells and its modern manufacturing technologies.
CO4	Understand concepts of Fuel cells and their applications
CO5	Identify methods of energy storage.
CO6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and hydrogen.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	1			3			3
CO2	3	1	3	1			3			3
CO3	3	1	3	1			3			3
CO4	3	1	3	1			3			3
CO5	3	1	3	1			3			3
CO6	3	1	3	1			3			3

Detailed Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems

Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems

Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles

Reading:

1. Sukhatme S.P. and J.K.Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources,Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Pro

EC440	ELECTRONIC MEASUREMENTS AND INSTRUMENTAION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Apply knowledge of instruments for effective use
CO2	Select suitable instruments for typical measurements.
CO3	Identify various transducers to measure strain, temperature and displacement.
CO4	Understand data acquisition system and general purpose interfacing bus.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3	3		3	3			2
CO2			2			2	2			3
CO3	1					3	3			1
CO4			2	3		2	2			

Detailed syllabus

Measurement And Error: Sensitivity, Resolution, Accuracy and precision, Absolute and Relative types of errors, Statistical analysis, Probability of and Limiting errors, Linearity.

Instruments: D’Arsonval movement and basic principles of Measurement of Voltage, Current and Resistance in instruments. Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.

Impedance Measurement: Kelvin Bridge; Megger; Maxwell, Hay and Shering Bridges. Q-meter; Noise and Interference reduction techniques in Measurement Systems.

Oscilloscopes: Block diagram, probes, Deflection amplifier and delay line, Trigger Generator, Coupling, Automatic Time Base and Dual Trace Oscilloscopes, Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital Storage Oscilloscopes.

Special instruments: Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer, FFT Analyzer.

Transducers (Qualitative Treatment Only): Classification and selection of Transducers, Introduction to strain, Load, force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements.

Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and various components of DAS.

General purpose Instrumentation Bus (GP-IB): Protocol, SCPI Commands and Applications to DSO and DMM.

Reading:

1. Oliver and Cage, Electronic Measurements and Instrumentation, McGraw Hill, 2009
2. Helfrick Albert D. and Cooper William D., Electronic Instrumentation & Measurement Techniques, PHI, 2008.
3. D.A. Bell, Electronic Instrumentation and Measurements, 3/e, Oxford, 2013.

MM440	MATERIALS FOR ENGINEERING APPLICATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Correlate processing, microstructure and properties of materials.
CO2	Understand behaviour of materials under various conditions.
CO3	Characterize modes of failure of engineering materials and design new materials with better properties and cost effective processes.
CO4	Identify suitable materials for engineering applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3							2
CO2	3	1	3							2
CO3	3	1	3							2
CO4	3	1	3							2

Detailed Syllabus:

Materials Science and Engineering Materials, Classification of Materials and Properties: Mechanical, Dielectric, Magnetic and Thermal

Metallurgical Aspects of Materials: Structure of Metals and Alloys, Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals, Significance of microstructural features

Heat Treatment: effect of cooling and heating rates and ageing materials for mechanical load bearing applications

Corrosion Resistant Materials: Some important Metals, Alloys, Ceramics and Polymers

Materials for Electrical Applications: Conductors, Dielectrics, insulators

Materials for Civil Engineering Applications

Materials for Biomedical applications: Steels, Ti and its alloys, Ni-Ti alloys, bioceramics, porous ceramics, bioactive glasses, calcium phosphates, collagen, thin films, grafts and coatings, biological functional materials Latex products

Reading:

1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, B H, 2005.
3. ASM Publication Vol. 20, Materials Selection and Design, ASM, 1997
4. Pat L. Mangonon: The Principles of Materials Selection and Design, PHI, 1999.

CH440	INDUSTRIAL POLLUTION CONTROL	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze the effects of pollutants on the environment.
CO2	Understand meteorological aspects of air pollution
CO3	Understand air pollution control methods
CO4	Select treatment technologies for water/wastewater/solid waste.
CO5	Design unit operations for pollution control.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3	3			
CO2						3	3			
CO3						3	3			
CO4						3	3			
CO5						3	3			
CO6										

Detailed Syllabus:

Introduction: Biosphere, hydrological cycle, nutrient cycle, consequences of population growth, pollution of air, water and soil.

Air pollution sources & effects: Classification and properties of air pollutants, emission sources, behavior and fate of air pollutants, effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, wind velocity and turbulence, plume behavior, dispersion of air pollutants, estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, ambient air sampling, stack sampling, analysis of air pollutants.

Air pollution control methods & equipment: Control methods, source correction methods, cleaning of gaseous effluents, particulate emission control, selection of a particulate collector, control of gaseous emissions, design methods for control equipment.

Water pollution: Water resources, origin of wastewater, types of water pollutants and there effects.

Waste water sampling, Analysis and Treatment: Sampling, methods of analysis, determination of organic matter, determination of inorganic substances, physical characteristics, bacteriological measurement, basic processes of water treatment, primary treatment, secondary treatment, advanced wastewater treatment, recovery of materials from process effluents.

Solid Waste Management: Sources and classification, public health aspects, methods of collection, disposal Methods, potential methods of disposal.

Hazardous Waste Management: Definition and sources, hazardous waste classification, treatment methods, disposal methods.

Reading:

1. Rao C.S. – Environmental Pollution Control Engineering- Wiley Eastern Limited, India, 1993.
2. Noel de Nevers- Air Pollution and Control Engineering- McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke - Environmental Science and Engineering, 2nd Edition, Prentice Hall of India, 2004.
4. Rao M.N. and Rao H.V.N - Air Pollution, Tata – McGraw Hill Publishing Ltd., 1993.
5. De A.K - Environmental Chemistry, Tata – McGraw Hill Publishing Ltd., 1999.

CH441	**FUEL CELL TECHNOLOGY**	**OPC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None.
Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fuel cell fundamentals.
CO2	Analyze the performance of fuel cell systems.
CO3	Understand construction and operation of fuel cell stack and fuel cell system.
CO4	Apply the modeling techniques for fuel cell systems

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3	3			
CO2						3	3			
CO3			3		3					
CO4						3	3			

Detailed syllabus

Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.

Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.

Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling

Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal , Using renewable fuels for SOFCs

Reading:

1. Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, 2003.

2. Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.
3. F. Barbir, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, 2013.
4. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications

CS440	Management Information Systems	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business problems.
CO3	Analysis of computing systems and telecommunication networks for business information systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1			3				2	2
CO2	3	1			3					2
CO3	3	1			3					2
CO4	3	1			3		3		3	2
CO5	3	3			3			3		2

Detailed syllabus

Organization and Information Systems, Foundation Concepts, Information Systems in Business, The Components of Information Systems, Competing with Information Technology, Fundamentals of Strategic Advantage, Using Information Technology for Strategic Advantage.

Changing Environment and its impact on Business, Kinds of Information Systems.

Computer Fundamentals, Computer Hardware, Computer Systems: End User and Enterprise Computing, Computer Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Software, System Software, Computer System Management, Data Resource Management, Technical Foundations of Database Management, Managing Data Resources

Telecommunication and Networks, Telecommunications and Networks, The Networked Enterprise, Telecommunications Network Alternatives

System Analysis and Development and Models, Developing Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Developing Business/IT Solutions, Developing Business Systems, Implementing Business Systems

Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT,

Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology

Reading:

1. Kenneth J Laudon, Jane P. Laudon, *Management Information Systems*, 10th Edition, Pearson/PHI, 2007.
2. W. S. Jawadekar, *Management Information Systems*, 3rd Edition, TMH, 2004.

BT440	BIOSENSORS	OPC	3 – 0 – 0	3 Credits

(This course is not offered to Biotechnology)

Pre-requisites: None.

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

CO1	Understand biosensing and transducing techniques
CO2	Understand principles of linking cell components and biological pathways with energy transduction, sensing and detection
CO3	Demonstrate appreciation for the technical limits of performance of biosensor
CO4	Apply principles of engineering to develop bioanalytical devices and design of biosensors

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2								
CO2	2	2		2	1					
CO3	2	1	3	1	2	1				
CO4	1	1	3	2						

Detailed Syllabus:

General principles: A historical perspective; Signal transduction; Physico-chemical and biological transducers; Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary; Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time.

Physico-chemical transducers: Electrochemical transducers (amperometric, potentiometric, conductimetric); optical transducers (absorption, fluorescence, SPR); Thermal transducers; Piezoelectric transducers.

Biorecognition systems: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors; Limitations & problems. Immobilization of biomolecules.

Biosensor Engineering: Methods for biosensors fabrication: self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS. Engineering concepts for mass production.

Application of modern sensor technologies: Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable sensors for long-term monitoring; Environmental monitoring; Technological process control; Food quality control; Forensic science benefits; Problems & limitations.

Reading:

1. Donald G. Buerk, Biosensors: Theory and Applications, 1st Edition, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

SM440	HUMAN RESOURCE MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand principles, processes and practices of human resource management.
CO2	Apply HR concepts and techniques in strategic planning to improve organizational performance.
CO3	Understand tools to manage HR systems and procedures.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3								3	2
CO2	3								3	2
CO3	3							3		2

Detailed Syllabus:

Introduction to Human Resource Management, Objectives, Scope and Significance of HRM,
Functions of HRM, Problems and Prospects in HRM, Environmental scanning.

Human Resource Planning, Demand Forecasting Techniques, Supply Forecasting Techniques,
Analyzing work and designing jobs, Recruitment and Selection, Interviewing Candidates.

Human Resource Development, Orientation, Training and Development, Management Development, Performance Appraisal and Employee Compensation, Factors Influencing Employee Remuneration and Challenges of Remuneration.

Industrial Relations, Industrial Disputes and Discipline, Managing Ethical Issues in Human
Resource Management, Workers Participation in Management, Employee safety and health,
Managing Global Human Resources and Trade Unions

International HRM, Future of HRM and Human Resource Information Systems

Reading:

1. Aswathappa, Human Resource Management — TMH., 2010.
2. Garry Dessler and Biju Varkkey ,Human Resource Management, PEA., 2011.
3. Noe & Raymond ,HRM: Gaining a Competitive Advantage, TMH, 2008.

4. Bohlander George W, Snell Scott A, Human Resource Management, Cengage Learning, 2009.

MA440	OPTIMIZATION TECHNIQUES	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Formulate and solve linear Programming Problems
CO2	Determine the optimum solution to constrained and unconstrained
CO3	Apply dynamic programming principle to Linear programming problems.
CO4	Determine the integer solutions to Linear Programming Problems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2									2
CO2	2									
CO3	2									
CO4	2									

Detailed Syllabus:

Linear Programming: Introduction and formulation of models, Convexity, Simplex method, Big-M method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method, duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem .

Nonlinear Programming: Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method.

Dynamic Programming: Principle of optimality, recursive relations, solution of LPP.

Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem.

Reading:

1. Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S.Chand & Co., 2006
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo, Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

MA441	OPERATIONS RESEARCH	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Formulate and solve linear programming problems
CO2	Determine optimum solution to transportation problem
CO3	Determine average queue length and waiting times of queuing models.
CO4	Determine optimum inventory and cost in inventory models.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2									1
CO2	2									
CO3	2									
CO4	2									

Detailed Syllabus:

Linear Programming: Formulation and graphical solution of LPP's. The general LPP, slack, surplus and artificial variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method, Two-phase method. Solution in case of unrestricted variables. Dual linear programming problem. Solution of the primal problem from the solution of the dual problems.

Transportation Problems : Balanced and unbalanced Transportation problems. Initial basic feasible solution using N-W corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method. Optimal solutions. Degenracy in Transportation problems.

Queueing Theory : Poisson process and exponential distribution. Poisson queues - Model (M/M/1):(∞/FIFO) and its characteristics.

Elements of Inventory Control : Economic lot size problems - Fundamental problems of EOQ. The problem of EOQ with finite rate of replenishment. Problems of EOQ with shortages - production instantaneous, replenishment of the inventory with finite rate. Stochastic problems with uniform demand (discrete case only).

Reading:

1. Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S. Chand & Co., 2006
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo : Mathematical Programming Techniques, East-West Pub., Delhi,

1991.

PH440	NANOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Understand synthesis and properties of nanostructured materials.
CO2	Analyze magnetic and electronic properties of quantum dots
CO3	Understand structure, properties and applications of Fullerenes and Carbon nanotubes.
CO4	Understand applications of nanoparticles in nanobiology and nanomedicine

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1									2
CO2	1									
CO3	1									2
CO4	1		2							2

Detailed Syllabus:

General properties of Nano materials : Origin of nanotechnology. Classification of nanomaterials. Fullerene,carbon, Nanotubes (CNT's), Nanoparticles. Physical, Chemical, Electrical, Optical, Magnetic and mechanical properties of nanomaterials.

Fullerenes and Carbon Nanotubes (CNT's): Introduction: Synthesis and purification. Preparation of fullerenes in the condensed phase,Transport, mechanical, physical properties of CNT's.

Investigation and manipulating materials in the Nanoscale: Electron microscope, scanning probe microscopes, optical microscopes for Nanoscience and Technology, X-Ray Diffraction.

SAMs and clusters: Growth process. Patterning monolayers. Types of clusters. Bonding and properties of clusters.

Semi conducting Quantum Dots: Introduction: Synthesis of Quantum Dots. Electronic structure of Nanocrystals, properties.

Nanobiology: Interaction between Biomolecules and Nanoparticle surgaces. Different types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies. Nanoprobes for Analytical Applications.

Nanosensors: Nanosensors based on optical properties. Nanosensors based on quantum size effects. Nanobiosensors.

Nanomedicines: Developments of nanomedicines. Nanotechnology in Diagnostic Applications, materials for use in Diagnostic and therapeutic Applications.

Reading:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics; Springer,2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Willey, 2006.

PH441	BIOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure and properties of biomaterials
CO2	Classify implant biomaterials
CO3	Evaluate biocompatibility of implants
CO4	Identify appropriate biomaterials for specific medical applications

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3									2
CO2	3									2
CO3	3									2
CO4	3		3	3						2

Detailed Syllabus:

Overview of biomaterials: Historical developments, impact of biomaterials, interfacial phenomena, tissue responses to implants.

Structure and properties of biomaterials: Crystal structure of solids, phase changes, imperfections in solids, non-crystalline solids, surface properties of solids, mechanical properties, surface improvements.

Types of biomaterials: Metallic implant materials, ceramic implant materials, polymeric implant materials composites as biomaterials.

Characterization of materials: Electric properties, optical properties, X-ray absorption, acoustic and ultrasonic properties.

Bio implantation materials: Materials in ophthalmology, orthopedic implants, dental materials and cardiovascular implant materials.

Tissue response to implants : Normal wound healing processes, body response to implants, blood compatibility, structure – property relationship of tissues.

Reading:

1. Joon Park, R.S. Lakes , Biomaterials an introduction; 3rd Ed., Springer, 2007
2. Sujatha V Bhat , Biomaterials; 2nd Ed., Narosa Publishing House, 2006.

CY440	CORROSION SCIENCE	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the electrochemical Principles of Corrosion.
CO2	Apply eight forms of corrosion to industrial problems.
CO3	Evaluate corrosion rates for industrial problems
CO4	Evaluate the corrosion rates of steel in RCC under corrosive environments.
CO5	Perform case studies using microbially induced corrosion of metals.
CO6	Perform case studies using appropriate methods of corrosion control of metals and alloys

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1								1
CO2	2	1								1
CO3	2	1								0
CO4	2	1								0
CO5	2	1								1
CO6	2	1								

Detailed Syllabus:

Understanding Corrosion:

Types of corrosion: uniform corrosion, Galvanic corrosion, pitting corrosion, stress corrosion cracking, corrosion fatigue, stray current corrosion, selective leaching, microbial corrosion Pourbaix potential-pH diagrams for iron, for aluminium, limitations of Pourbaix diagram Passivity- characteristics of passivation and the Flade potential, Theories of passivity, passive-active cells, critical pitting potential, Anodic protection and transpassivity.

Methods of corrosion monitoring:

Polarisation and corrosion rates, polarisation diagrams of corroding metals, calculation of corrosion rates from polarization data. Electrochemical impedance spectroscopy: Nyquist plots, Bode plots, simple equivalent circuits for fitting the impedance data, calculation of corrosion parameters from impedance measurements. Electrochemical cell assembly for polarization and impedance studies. Gravimetric method of determination of corrosion rates.

Measurement of corrosion rates of carbon steel in reinforced cement concrete, Corrosion rates of metals due to micriobially induced corrosion .

Methods of corrosion prevention and control:

Cathodic protection; By impressed current, By the use of sacrificial anodes, combined use with coatings, Advances in cathodic protection.

Metallic coatings: Methods of application, Electroplating, Electroless plating, specific metal platings like Cu, Ni and Cr.

Inhibitors and passivators: Picking inhibitors, vapour phase inhibitors, Inhibitors for cooling water systems, understanding of action of inhibitors through polarization and impedance.

Corrosion prevention and control strategies in different industries – case studies

Reading:

1. R. Winston Revie, Herbert H. Uhlig, Corrosion and Corrosion control, 4th edition, Wiley-Interscience, 2007
2. Mc Cafferty and Edward, Introduction to Corrosion Science, 1st Edition, Springer, 2010.
3. Mars G. Fontana, Corrosion Engineering, 3rd edition, Tata McGraw- Hill, New Delhi, 2008.

CY441	CHEMISTRY OF NANOMATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the state of art synthesis of nano materials
CO2	Characterize nano materials using ion beam, scanning probe methodologies, position sensitive atom probe and spectroscopic ellipsometry.
CO3	Analyze nanoscale structure in metals, polymers and ceramics
CO4	Analyze structure-property relationship in coarser scale structures
CO5	Understand structures of carbon nano tubes.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1								2
CO2	3	1								
CO3	3	1								1
CO4	3	1								
CO5	3	1								

Detailed Syllabus:

Introduction: Scope of Nano science and nanotechnology, Nano science in nature, classification of nanostructured materials, importance of nano materials.

Synthetic Methods: Chemical Routes (Bottom-Up approach):- Sol-gel synthesis, micro emulsions or reverse micelles, solvothermal synthesis, microwave heating synthesis and sonochemical synthesis. Physical methods (Top-Down approach):- Inert gas condensation, plasma arc technique, ion sputtering, Laser ablation, laser pyrolysis, and chemical vapour deposition method.

Techniques for characterization:

Diffraction Technique: - Powder X-ray diffraction for particle size analysis.

Spectroscopy Techniques: - Operational principle and applications of spectroscopy techniques for the analysis of nanomaterials, UV-VIS spectrophotometers and its application for band gap measurement.

Electron Microscopy Techniques:- Scanning electron microscopy (SEM) and EDAX analysis, transmission electron microscopy (TEM), scanning probe microscopy (SPM).

BET method for surface area determination.

Dynamic light scattering technique for particle size analysis.

Reading:

4. T. Pradeep, NANO: The Essentials: McGraw-Hill, 2007.
5. B. S. Murty, P. Shankar, Baldev Rai, BB Rath and James Murday, Textbook of Nanoscience and nanotechnology: Univ. Press, 2012.
6. Guozhong Cao, Nanostructures & Nanomaterials; Synthesis, Properties & Applications: Imperial College Press, 2007.
7. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology: Narosa Pub., 2010.
8. Manasi Karkare, Nanotechnology: Fundamentals and Applications: IK International, 2008.
9. C. N. R. Rao, Achim Muller, K.Cheetham, Nanomaterials Chemistry, Wiley-VCH, 2007

HS440	CORPORATE COMMUNICATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand corporate communication culture
CO2	Prepare business letters, memos and reports
CO3	Communicate effectively in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Practice corporate email, mobile and telephone etiquette
CO6	Develop good listening skills and leadership qualities

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1								3	3	3
CO2								3	3	3
CO3								3	3	3
CO4							3	3	3	3
CO5								3	3	3
CO6								3	3	3

Detailed Syllabus:

Importance of Corporate communication - Introduction to and definition of corporates – Communication, process, patterns and channels of communication- Barriers to communication and strategies to overcome them- Evolution of corporate culture- Role and contribution of individual group and organization - Role of psychology in communication.

Oral Communication- Techniques for improving oral fluency-Speech mechanics-Group Dynamics and Group Discussion – Debate and oral presentations.

Written Communication- Types and purposes- Writing business reports, and business proposals- Memos, minutes of meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used for drafting different forms of communication. Internal and external communication.

Corporate responsibility- Circulating to employees vision and mission statements- ethical practices- Human rights -Labour rights-Environment- governance- Moral and ethical debates surrounding -Public Relations - Building trust with stakeholders.

Corporate Ethics and Business Etiquette- Integrity in communication-Harmful practices and communication breakdown- Teaching how to deal with tough clients through soft skills. Body language- Grooming- Introducing oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail, mobile and telephone.

Listening Skills - Listening- for information and content- Kinds of listening- Factors affecting listening and techniques to overcome them- retention of facts, data and figures- Role of speaker in listening.

Leadership Communication Styles - Business leadership -Aspects of leadership-qualities of leader- training for leadership-delegation of powers and ways to do it-humour-commitment.

Reading:

1. Raymond V. Lesikar, John D. Pettit, Marie E. Flatley Lesikar's Basic Business Communication - 7th Edition: Irwin, 1993
2. Krishna Mohanand Meera Banerji, Developing Communication Skills: Macmillan Publishers India, 2000
3. R.C. Sharma & Krishna Mohan Business Correspondence and Report Writing: – 3rd Edition Tata McGraw-Hill, 2008
4. Antony Jay & Ross Jay, Effective Presentation, University Press, 1999.
5. Shirley Taylor, Communication for Business, Longman, 1999.