DELHI TECHNOLOGICAL UNIVERSITY

SCHEME OF EXAMINATION
AND
COURSE CURRICULUM

B. Tech. (BIOTECHNOLOGY)

CONTENT

SCHEME FOR B.TECH. FIRST SEMESTER (BIOTECHNOLOGY)

S.No.	Course No.	Subject	L-T-P	Evaluation		Total Marks	Credit Type
				Sessional	End		
TH1	AM 101	Mathematics-1	3 1 0	30	70	100	4H
TH2	HU 102	Communication skills	2 1 0	30	70	100	3H
TH3	AP 103	Applied Physics-I	4 0 0	30	70	100	4H
TH4	AC 104	Applied Chemistry	3 1 0	30	70	100	4H
TH5	EE 105	Electrical Science	3 1 0	30	70	100	4A
TH6	IT 106	Fundamentals of Information Technology	2 1 0	30	70	100	3A
PR1	AP 107	Applied Physics-I Lab	0 0 2	30	70	100	2H
PR2	AC 108	Applied Chemistry Lab	0 0 2	30	70	100	2H
PR3	EE 109	Electrical Science Lab	0 0 2	30	70	100	2A
PR4	IT 110	Fundamental of Information Technology Lab	0 0 2	30	70	100	2A
	TOTAL		**30 hrs**			**1000**	**30**

SCHEME FOR B.TECH. SECOND SEMESTER (BIOTECHNOLOGY)

S.No.	Course No.	Subject	L-T-P	Evaluation		Total Marks	Credit Type
				Sessional	End		
TH1	AM 111	Mathematics-II	3 1 0	30	70	100	4H
TH2	EN 112	Environmental Sciences	2 0 0	30	70	100	2H
TH3	AP 113	Applied Physics-II	4 0 0	30	70	100	4H
TH4	AP-AC 114	Engineering Materials	4 0 0	30	70	100	4H
TH5	ME 115	Basic Mechanical Engineering	4 0 0	30	70	100	4A
TH6	CO 116	Programming Fundamentals	2 0 0	30	70	100	2A
PR1	AP 117	Applied Physics-II Lab	0 0 2	30	70	100	2A
PR2	CO 118	Programming Lab	0 0 2	30	70	100	2A
PR3	ME 119	Engineering Graphics	0 0 3	30	70	100	3A
PR4	PE 120	Mechanical workshop	0 0 3	30	70	100	3A
	TOTAL		**30 hrs**			**1000**	**30**

A Allied Engineering
C Core (include major project and practical training also)
H Humanities, Social Studies and Basic Sciences
M Mandatory

THIRD SEMESTER (BIOTECHNOLOGY)

S. No.	Course No.	Subject	L T P	Evaluation		Total	Credit Type
				Sess.	End		
TH1	BT-201	Introduction to Biotechnology	3 1 0	30	70	100	4C
TH2	BT-202	Biochemistry	3 1 0	30	70	100	4C
TH3	BT-203	Cell Biology	3 1 0	30	70	100	4C
TH4	BT-204	Object Oriented Programming	3 1 0	30	70	100	4A
TH5	BT-205	Biostatistics	3 1 0	30	70	100	4A
TH6	BT-206	Numerical Methods	3 0 0	30	70	100	3A
PR1	BT-207	Introduction to Biotechnology Lab	0 0 2	30	70	100	2C
Pr2	BT-208	Biochemistry & Cell Biology Lab	0 0 2	30	70	100	2C
PR3	BT-209	Object Oriented Programming Lab	0 0 2	30	70	100	2A
VS1	BT-210	Self study	0 0 1	-	100	100	1C
GRAND TOTAL				**1000**			**30**

SCHEME FOR B.TECH. FOURTH SEMESTER (BIOTECHNOLOGY)

S. No.	Course No.	Subject	L T P	Evaluation		Total	Credit Type
				Sess.	End		
TH1	BT-211	Molecular Biology	3 1 0	30	70	100	4C
TH2	BT-212	Genetics	3 1 0	30	70	100	4C
TH3	BT-213	Microbiology	3 1 0	30	70	100	4C
TH4	BT-214	Enzymology & Enzyme Technology	3 1 0	30	70	100	4C
TH5	BT-215	Data Structure & Algorithms	3 1 0	30	70	100	4A
TH	BT-216	Engineering Economics	3 0 0	30	70	100	3H
PR1	BT-217	Molecular Biology & Genetics Lab	0 0 2	30	70	100	2C
PR2	BT-218	Microbiology Lab	0 0 2	30	70	100	2C
PR3	BT-219	Data Structure & Algorithms Lab	0 0 2	30	70	100	2A
VS2	BT-220	Self study	0 0 1	-	100	100	1
GRAND TOTAL				**1000**			**30**

A Allied Engineering
C Core (include major project and practical training also)
H Humanities, Social Studies and Basic Sciences
M Mandatory

SCHEME FOR B.TECH. FIFTH SEMESTER (BIOTECHNOLOGY)

S. No.	Course No.	Subject	L T P	Evaluation		Total	Credit Type
				Sess.	End		
TH1	BT-301	Instrumentation in Biotechnology	3 1 0	30	70	100	4C
TH2	BT-302	Immunology & Immunotechnology	3 1 0	30	70	100	4C
TH3	BT-303	Genetic Engineering	3 1 0	30	70	100	4C
TH4	BT-304	Biological	3 1 0	30	70	100	4C
TH5	BT-305	Structural Biology	3 1 0	30	70	100	4C
PR1	BT-306	Instrumentation in Biotechnology Lab	0 0 2	30	70	100	2C
PR2	BT-307	Immunology & Immunotechnology Lab	0 0 2	30	70	100	2C
PR3	BT-308	Genetic Engineering Lab	0 0 2	30	70	100	2C
PR4	BT-309	Minor Project - I	-	-	200	200	4C
GRAND TOTAL			**1000**				**30**
Industrial Training / Training School – I (4 weeks duration; to be carried out after V Semester Exams)							

SCHEME FOR B.TECH. SIXTH SEMESTER (BIOTECHNOLOGY)

S. No.	Course No.	Subject	L T P	Evaluation		Total	Credit Type
				Sess.	End		
TH1	BT-311	Plant Biotechnology	3 1 0	30	70	100	4C
TH2	BT-312	Animal Biotechnology	3 1 0	30	70	100	4C
TH3	BT-313	Fundamentals of Biochemical Engineering	3 1 0	30	70	100	4C
TH4	BT-314	Database Management Systems	3 1 0	30	70	100	4A
TH5	BT-315	Genomics & Proteomics	3 1 0	30	70	100	4C
PR1	BT-316	Plant & Animal Biotechnology Lab	0 0 2	30	70	100	2C
PR2	BT-317	Database Management Systems Lab	0 0 2	30	70	100	2A
PR3	BT-318	Minor Project – II	0 0 4	-	-	200	4
PR4	BT-319	Industrial Training	-	30	70	100	2C
GRAND TOTAL			**1000**				**30**
Industrial Training /Training School – II (8 weeks duration; to be carried out after VI Semester Exams)							

A Allied Engineering
C Core (include major project and practical training also)
H Humanities, Social Studies and Basic Sciences
M Mandatory

Note:

- Industrial training of 4 weeks during winter vacation after 5th Semester and 8 Weeks during summer vacation after 6th Semester.

SCHEME FOR B.TECH. SEVENTH SEMESTER (BIOTECHNOLOGY)

S. No.	Course No.	Subject	L T P	Evaluation		Total	Credit Type
				Sess.	End		
TH1	BT-401	Computational Biology	3 1 0	30	70	100	4C
TH2	BT-402	Bioprocess Technology & Downstream Processing	3 1 0	30	70	100	4C
TH3	BT-403	Elective – I	3 1 0	30	70	100	4C
TH4	BT-404	Open Elective - I	3 1 0	30	70	100	4C
PR1	BT-405	Computational Biology – I Lab	0 0 3	30	70	100	3C
PR2	BT-406	Bioprocess Technology & Downstream Processing Lab	0 0 3	30	70	100	3C
PR3	BT-407	Major Project (Part - I)	0 0 4	-	-	300	C
PR4	BT-408	Industrial Training	-	30	70	100	C
GRAND TOTAL				**1000**			**30**

SCHEME FOR B.TECH. EIGHTH SEMESTER (BIOTECHNOLOGY)

S. No.	Course No.	Subject	L T P	Evaluation		Total	Credit Type
				Sess.	End		
TH1	BT-411	Computational Biology – II	3 1 0	30	70	100	4C
TH2	BT-412	Elective – II	3 1 0	30	70	100	4C
TH3	BT-413	Open Elective – II	3 1 0	30	70	100	4A
PR1	BT-414	Computational Biology – II Lab	0 0 3	30	70	100	3C
PR2	BT-415	Genomics & Proteomics Lab	0 0 3	30	70	100	3C
PR3	BT-416	Seminar	0 0 2	100	-	100	2C
PR4	BT-417	Major Project – II	0 0 10	-	400	400	10C
GRAND TOTAL				**1000**			**30**

Departmental Elective – I	**Open Elective – I**
BT - 403-1 Thermodynamics of Biological Systems BT - 403-2 Pharmaceutical Chemistry BT - 403-3 Current Topics in Biotechnology BT - 403-4 Drug Delivery Systems	BT - 404-1 Biomechanics BT - 404-2 Biofuels BT - 404-3 Nanobiotechnology BT - 404 Biosensors
Departmental Elective – II	**Open Elective – II**
BT - 412-1 Drug Design and Development BT - 412-2 Pharmacogenomics and Personalized Medicine BT - 412-3 Entrepreneurship Development & Marketing Research BT - 412-4 Genomics and Medicin	BT - 413 Bioprocess Plant Design BT - 413 Intellectual Property Rights BT - 413 Computer-aided Drug Design BT - 413 Environmental Biotechnology

AM-101 Mathematics – I	L T P	Credits
	3 1 0	4

UNIT I

Infinite series: Tests for convergence of series (comparison, ratio, root, integral, Raabe's, logarithmic), Alternating series, Absolute convergence, Conditional convergence.

UNIT II

Calculus of single variable: Taylor's & Maclaurin's expansion, Radius of curvature, applications of definite integral to area, arc length, surface area and volume (in Cartesian, parametric and polar co-ordinates).

UNIT III

Calculus of several variables: Partial differentiation, Euler's theorem, total differential, Taylor's theorem, Maxima-Minima, Lagrange's method of multipliers, Application in estimation of error and approximation.

UNIT IV

Multiple Integrals: Double integral (Cartesian and polar co-ordinates), change of order of integration, triple integrals (Cartesian, cylindrical and spherical co-ordinates), Gamma and Beta functions. Applications of multiple integration in area, volume, centre of mass, and moment of inertia.

UNIT V

Vector Calculus: Continuity and differentiability of vector functions, Scalar and vector point function, Gradient, Directional derivative, divergence, curl and their applications. Line integral, surface integral and volume integral, applications to work done by the force . Applications of Green's, Stoke's and Gauss divergence theorems.

Text Books/Reference Books:

1. "Advanced Engineering Mathematics" by Alan Jeffery ; Academic Press
2. "Calculus and Analytic Geometry" by Thomas/Finney; Narosa.
3. "Advanced Engineering Mathematics" by Kreyszig; Wiley.
4. "Advanced Engineering Mathematics" by Taneja ; I K international
5. "Advanced Engineering Mathematics" by Jain/Iyenger; Narosa.

HU-102 Communication Skills	L T P	Credits
	2 1 0	3

UNIT I

Functional English:

(A) Parts of speech; Tense and concord; Conditional clauses; Question tags & short responses; Punctuation; Common errors.

(B) Vocabulary and Usage: Synonyms & Antonyms; One word substitutions; Words often confused; Idioms / Idiomatic expressions.

UNIT II

Basics of Writing:

(A) Presentation of Technical Information: Technical description of simple objects, tools, appliances; Processes and operations; Scientific Principles; Definitions ; Interpretation of Visual Data (graph, charts etc)

(B) Writing of: Paragraph; Summary and Abstract; Taking and Making Notes.

(C) Comprehension of Unseen Passages based on reading exercises like Skimming, Scanning and Inference making.

UNIT III

Oral Communication: Phonetics: Speech Sounds and their articulation; Phonemes, syllable, Stress, Transcription of Words and Simple Sentences; Presentation and Seminar; Language Lab Practice for Oral Communication.

UNIT IV

Texts for Appreciation and Analysis:

(A) Wings of Fire by APJ Abdul Kalam

(B) The Fortune at the Bottom of the Pyramid by C.K. Prahalad.

(C) The Branded (Uchalya) by Laxman Gaikwad

(D) Geetanjali by Ravindranath Tagore.

Text Books/Reference Books:

1. Day, Robert A. Scientific English: A Guide for Scientists and Other Professionals. UP.
2. Maison Margaret, Examine Your English, New Delhi: Orient Longman.
3. Tikoo M.L., A.E. Subramaniam and P.R. Subramaniam. Intermediate Grammar Usage and Composition. Delhi: Orient Longman.
4. Weiss, Edmond H. Writing Remedies: Practical Exercises for Technical Writing. University Press.
5. Lesikar and Flatley. Business Communications. New Delhi, Biztantra Press.
6. O'Connor, Better English Pronunciation, Cambridge: Cambridge University Press.
7. Gaikwad, Laxman, The Branded, Delhi: Sahitya Akademi.
8. Kalam, APJ Abdul, Wings of Fire, Delhi: University Press.
9. C.K. Prahalad, The Fortune at the Bottom of the Pyramid, Wharton School Publishing.
10. Rabindranath Tagore, Gitanjali, Filiquarian Publishing, LLC.

AP – 103 Applied Physics - I	L T P	Credits
	3 1 0	4

UNIT I

Relativity : Review of concepts of frames of reference and Galilean transformation equation, Michelson – Morley experiment and its implications, Einstein's special theory of relativity, Lorentz transformation equations, Law of addition of velocities, Mass variation with velocity, Concept of energy and momentum, Mass energy relation.

UNIT II

Oscillations, waves : Damped and forced oscillations, Resonance (amplitude and power), Q – factor, Sharpness of resonance. Equations of longitudinal and transverse waves and their solutions, Impedance, Reflection and transmission of waves at a boundary, Impedance matching between two medium.

UNIT III

Physical optics: Interference by division of wave front and amplitude, Multiple beam interference and Fabry-Perot interferometer, Fresnel diffraction through a straight edge, Fraunhoffer diffraction, Zone plate, single slit and N-slit / grating, Resolving power of telescope, prism and grating. Polarization by reflection and by transmission, Brewster's law, Double refraction, elliptically and circularly polarized light, Nicol prism, Quarter and half wave plates.

UNIT IV

Optical Instruments: Cardinal points of co-axial lens systems, spherical and chromatic aberrations and their removal, Huygens and Ramsden's eyepiece.

UNIT V

Laser optics: Coherence and coherent properties of laser beams, Brief working principle of lasers, Spontaneous and stimulated emission, Einstein's co-efficient, Ruby laser, He-Ne laser.

UNIT VI

Optical Fiber: Classification of optical fibers, Refractive index profile, Core cladding refractive index difference, Numerical aperture of optical fiber, Pulse dispersion in optical fiber (ray theory).

Text Books/Reference Books:

1. "Physics of Vibrations and Waves" by H.J. Pain.
2. "Vibrations and Waves" by A.P. French.
3. "Perspective of Modern Physics" by Arthur Beiser.
4. "Optics" by A. Ghatak.
5. Berkley Physics Course Vol – 1.

AC-104 Applied Chemistry	L T P	Credits
	3 1 0	4

UNIT I

(a) Conventional Analysis: Volumetric Analysis, Types of titrations, Theory of indicators.

(b) Spectral Analysis: Electromagnetic radiation, Lambert-Beer's Law, UV-VIS, IR, instrumentation & applications.

UNIT II

Thermal Methods of Analysis: Principle, working and applications of Thermo-gravimetry, Differential thermal analysis and Differential scanning calorimetry.

UNIT III

(a) Polymers: Monomer & polymer, functionality and Degree of Polymerization. Mechanism of polymerization. Molecular weights of polymers. Methods of polymerization. Industrial production of PE and PF resins. Industrial applications of polymers.

b) Bio-molecules: Classification, Structure, physical and chemical properties of Amino-acids, Peptides and Proteins, Carbohydrates, Cellulose and its derivatives, RNA, DNA. Introduction to Bio-degradable Polymers.

UNIT IV

Electrochemistry : Electrochemical cells, components, characteristics of batteries. Primary and Secondary battery systems, Zinc-Carbon cells, Lead storage and lithium batteries. Fuel Cells, Electro-deposition, Electrical and chemical requirements. Electroplating bath and linings. Agitation, Circulation and filtration equipment. Plating of copper, gold and rhodium.

UNIT V

Phase Equilibrium: Definitions of Phase, component and degree of freedom, Gibb's phase rule. One component systems: Water and sulphur. Two component systems: Pb-Ag and Cu-Ni system.

Univ VI

Green Chemistry: Introduction, Goals & Significance of Green Chemistry. Reagents, solvents and catalysts for green synthesis. Principles of Green Chemistry, Evaluation of feedstocks, reaction types and methods. Future trends in Green Chemistry.

Text Books/Reference Books:

1. "Thermal Analysis" by T. Hatakeyama, F.X. Quinn; Wiley.
2. " Inorganic Quantitative Analysis" by A.I. Vogel.
3. "Instrumental Method of Analysis" by Skoog D.A.; HRW International.
4. "Green Chemistry: Theory & Practice" by P.T. Anastas & JC Warner; Oxford Univ Press.
5. "Polymer Science and Technology" by Billmeyer; John Wiley.
6. "Polymer Science and Technology" by Fried; Prentice Hall.

EE – 105 Electrical Science	L T P	Credits
	3 1 0	4

UNIT I

Introduction: Role and importance of circuits in Engineering, concept of fields, charge, current, voltage, energy and there interrelationship. V-I characteristics of ideal voltage and ideal current sources, various types of controlled sources. Passive circuit components: V-I characteristics and ratings of different types of R, L, C elements. Series and parallel circuits, power and energy, Kirchoff's Laws. Delta-star

conversion, Superposition Theorem, Thevenin's Theorem, Norton's theorem, Maximum Power Transfer Theorem, Tellgen Theorem.

UNIT II

Single Phase AC Circuits: Single phase EMF generation, average and effective values of sinusoids, complex representation of impedance, series and parallel circuits, concept of phasor, phasor diagram, power factor, power in complex notation, real power, reactive power and apparent power. Resonance in series and parallel circuits, Q-factor, bandwidth and their relationship, half power points.

UNIT III

Three-Phase AC Circuits: Three phase EMF generation, delta and Y connection, line and phase quantities. Solution of three phase circuits: balanced supply voltage and balanced load, phasor diagram, measurement of power in three phase circuits.

UNIT IV

Magnetic Circuits & Transformers: Amperes circuital law, B-H curve, concept of reluctance, flux, MMF, analogies between electrical and magnetic quantities solution of magnetic circuits. Hysteresis and eddy current losses, application of magnetic force, mutual inductance and dot convention. Single phase Transformer construction, principle of working, auto transformer and their applications.

UNIT V

Measuring Instruments : Analog indicating instruments, devices, Damping devices, PMMC ammeters and voltmeters, shunt and multipliers, Moving iron ammeter and voltmeters, dynamometer type wattmeters, multimeters, AC watt-hour meters. Digital voltmeters, ammeters and wattmeters.

Text Books/Reference Books:

1. "Basic electrical Engineering" by C.L. Wadhwa, 4th Edition; New Age International.
2. "Basic Electrical Engineering" by Fitzereld, Higgenbotham & Grabel; McGraw Hill International.
3. "Electrical Engineering Fundamentals" by Vincent Deltoro; Prentice Hall International (EEI).
4. Relevant Indian Electricity Supply rules & BIS codes.

IT – 106 Fundamentals of Information Technology	L T P	Credits
	2 1 0	3

UNIT I

Fundamental Concepts of Information: Definition of information, Data Vs Information, Introduction to Information representation in Digital Media, Text, image, graphics, Animation, Audio, Video etc., Need, Value and Quality of information

UNIT II

Concepts in Computer & Programming: Definition of Electronic Computer, History, Generations, Characteristic and Application of Computers, Classification of Computers, Memory, different types of memory, Computer Hardware-CPU, Various I/O devices, Peripherals, Firmware and Humanware.

UNIT III

Programming Language Classification & Program Methodology: Computer Languages, Generation of Languages, Translators, Interpreters, Compilers, Flow Charts, Dataflow Diagram, Assemblers, Introduction to 4GL and 5GL.

UNIT IV

Digital Devices and Basic Network Concepts: Digital Fundamentals: Various codes, decimal, binary, hexa-decimal conversion, floating numbers gates, flip flops, adder, multiplexes, Introduction to Data Transmission.

UNIT V

Data Communication & Networks: Computer Networks-Introduction of LAN, MAN and WAN. Network Topologies, Client-server Architecture.

UNIT VI

Internet and Web Technologies: Hypertext Markup Language, DHTML, WWW, HTTP, Gopher, FTP, Telnet, Web Browsers, Net Surfing, Search Engines, Email, Safety of Business Transaction on web. Elementary Concepts of E-Learning and E-Commerce, Electronic Payment Systems, Digital Signatures, Firewall.

Text Books/Reference Books:

1. "Using Information Technology: A Practical Introduction to Computers & Communications" by William Sawyer & Hutchinson; Publisher: Tata McGraw-Hill.
2. 'Introduction to Computers' by Peter Norton; Tata McGraw-Hill.
3. "Introduction to Computers" by Rajaraman; EPI.
4. "Data Compression" by Nelson; BPB.
5. "Internet, An introduction"by CIS Tems; Tata McGraw Hill.
6. "Information Technology: Breaking News" by Curtin; TMH.
7. "Fundamentals of Information Technology" by Leon & Leon; Vikas.
8. "Internet 101" by Lehngart; Addison Wesley.

AP-107 Applied Physics - I Lab	L T P	Credits
	0 0 2	02

AC-108 Applied Chemistry Lab	L T P	Credits
	0 0 2	02

EE-109 Electrical Science Lab	L T P	Credits
	0 0 2	02

IT-110 Fundamental of IT Lab	L T P	Credits
	0 0 2	02

AM- 111 Mathematics-II	L T P	Credits
	3 1 0	4

UNIT I

Matrices: Rank of a matrix, inverse of a matrix using elementary transformations, consistency of linear system of equations, Eigen-values and eigenvectors of a matrix, Cayley-Hamilton theorem, diagonalization of matrix.

UNIT II

Ordinary Differential Equations: Second & higher order linear differential equations with constant coefficients, General solution of homogenous and non- homogenous equations, method of variation of parameters, Euler-Cauchy equation, simultaneous linear equations.

UNIT III

Special Functions : Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel function of fist kind, Orthogonal Property, Rodrigues' Formula.

UNIT IV

Laplace Transforms: Basic properties, Laplace transform of derivatives and integrals, Inverse Laplace transform, Differentiation and Integration of Laplace transform, Convolution theorem, Unit of Step Function, Periodic function, Laplace transform to IVP and boundary value problem Applications system of linear Simultaneous differential equations.

UNIT V

Fourier series: Fourier series, Dirichlet conditions, Even and odd functions, half range series, harmonic analysis.

UNIT VI

Fourier Transforms : Fourier Transforms Sine and Cosine Transforms, Transforms of derivatives and integrals, Applications to boundary value problem in ordinary differential equations (simple cases only).

Text Books/Reference Books:

1. "Advanced Engineering Mathematics" by Greenberg; Pearson Education.
2. "Advanced Engineering Mathematics" by Kreyszig; Wiley.
3. "Advanced Engineering Mathematics" by Taneja; I K international.
4. "Advanced Engineering Mathematics" by Jain/Iyenger; Narosa.

EN – 112 Environmental Science	L T P	Credits
	2 0 0	2

UNIT I

Introduction to Environment: Origin & evolution of earth, segments of environment- lithosphere, hydrosphere, atmosphere & biosphere, Biogeochemical cycles- hydrological, oxygen, nitrogen, carbon & phosphate cycles.

UNIT II

Ecosystems: Concept of ecosystem biotic & abiotic components, types of ecosystems, functional components of ecosystem- biodiversity, productivity, food chains & food webs, material cycling and energy flow, different ecosystems- forest, grassland, desert, aquatic.

UNIT III

Water Pollution: Water quality, physical, chemical & biological characteristics of water & waste water, ground water pollution, water borne diseases.

UNIT IV

Air & Noise Pollution: Primary & secondary air pollutants, sources, effects & control of- carbon monoxide, nitrogen oxides, hydrocarbons, sulphur dioxide & particulates, Air quality standards, global warming, acid rain, El Nino, ozone hole. Classification and measurement of noise, effects of noise pollution on human, control of noise pollution.

UNIT V

Energy & Solid Waste Management: Conventional energy resources- coal, thermal, petroleum, hydroelectricity, nuclear power, wood, non conventional sources- solar, biogas, wind, ocean & tidal energy, geothermal energy. Hazardous and non hazardous solid waste management. Environmental laws and acts.

Text Books/Reference Books:

1. "Environmental Studies" by De Anil Kumar & De Arnab Kumar; New Age International (P) Ltd.
2. "Environmental Studies" by Basak Anindita; Pearson Education South Asia.
3. "A Text Book of Environmental Science" by Subramanian. V; Narosa Publishing House.
4. "Essentials of Ecology & Environment Science" by Rana. S.V.S.; EPI Publications.

AP – 113 Applied Physics - II	L T P	Credits
	4 0 0	4

UNIT I

Quantum Physics : Failure of classical physics ,Compton effect , Pair production de-broglie relation, wave function, Probability density, Schrodinger wave equation, operators, expectation values and eigen-value equation, particle in a box, simple harmonic oscillator problem, concept of

degeneracy.

UNIT II

Classical Statistics : Statistical physics : Microscopic-macroscopic systems, concept of phase space, basic postulates of statistical mechanics, Maxwell—Boltzmann distribution law.

UNIT III

Quantum statistics : Quantum Statistics : Fermi—Dirac and Bose –Einstein Distribution, Fermi- Dirac probability function, Fermi energy level.

UNIT IV

Nuclear Physics : Nuclear properties, constituent of the nucleus, binding energy, stable nuclei, radioactive decay law (alpha and beta spectrum), Q-value of nuclear reaction , nuclear models-liquid drop and shell model, nuclear fission and fusion, elementary ideas of nuclear reactors.

UNIT V

Electrodynamics : Maxwell's equations, concept of displacement current, Derivation of wave equation for plane electromagnetic wave, Poynting vector. Poynting theorem, Energy density, wave equation in dielectric & conducting media.

Text Books/Reference Books:

1. "Nuclear Physics" by Erwin Kaplan.
2. "Concept of Nuclear Physics" by Cohen.
3. "Electrodynamics" by Griffith.
4. "Electricity & magnetism" by Rangawala & Mahajan.
5. "Perspective of Modern Physics" by Arthur Beiser.

AP-AC 114 Engineering Materials	L T P	Credits
	4 0 0	4

SECTION – A (PHYSICS)

UNIT I

Crystal Structure: Bravais lattices; Miller indices, simple crystal structures, Different kind of bonding.

UNIT II

Metallic Conduction: Energy distribution of electrons in a metal, Fermi level, Conduction process.

Semi Conductors: Band theory of solids , P and N type of semiconductors , Statistics of holes and electrons, Hall effect , Effect of temperature on conductivity , Life time and recombination, drift and diffusion in PN junction .

UNIT III

Dielectric and Optical properties of Materials: Dielectric polarization and dielectric constant, optical absorption process.

Magnetism and Superconducting Materials: Diapara, Ferro-magnetism, Antiferro, Ferro-magnetism ferrites, Superconducting materials, Properties, Type of superconducting materials , Meissner effect, High- Tc superconductor, application.

SECTION – B (CHEMISTRY)

UNIT IV

Introduction to engineering materials for mechanical construction. Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.

UNIT V

Composite materials: Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fiber-reinforced composites, environmental effects on composites, applications of composites.

UNIT VI

Speciality Polymers: Conducting polymers-Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory Introduction, classification, properties, raw materials, manufacturing and applications.

NOTE: Two hrs per week load for Applied Physics Department.

Two hrs per week load for Applied Chemistry Department.

Text Books/Reference Books (PHYSICS):

1. "Solid State Physics", 7th edition by Kittel; J. W .& Sons Publication.
2. "Solid State Physics" by Wahab M.A.; Narosa Publishing House.
3. "Solid State Physics" by Ali OmerM; Pearson Education (Singapore) pvt. Ltd. India branch, New delhi.
4. "Engineering Materials: Properties and Selection", 7th edition by Kenneth G. Budinski, Budinshi; Pearson Singapor (Prentice Hall).
5. "Solid State Physics" by Pillai S.O.; New Age International Publication.

Text Books/Reference Books (CHEMISTRY)

1. "Essentials of Material Science and Engineering " by Donald R. Askeland, Pradeep P. Phule; Thomson.
2. "Speciality Polymers " by R.W.Dyson; Chapman and Hall, New York, USA.
3. "Polymer Composites " by A.P.Gupta, M.C.Gupta; New Age publication.
4. "Engineering Chemistry " by R.N.Goyal, H.Goel; Ane Books India.
5. "Engineering Chemistry" by S.S.Dara; S.Chand.
6. "Engineering Chemistry" by Raghupati Mukhopadhyay,

Sriparna Datta; New Age International.
7. "Engineering Chemistry" by P.C.Jain, Monica Jain; Dhanpat Rai.

ME 115 Basic Mechanical Engineering	L T P	Credits
	4 0 0	4

(PART A)

UNIT I

Introduction to Thermodynamics, Concepts of systems, control volume, state, properties, equilibrium, quasi-static process, reversible & irreversible process, cyclic process. Zeroth Law and Temperature, Ideal Gas. Heat and Work.

UNIT II

First Law of Thermodynamics for closed & open systems. Non Flow Energy Equation. Steady State, Steady Flow Energy Equation.

Second Law of Thermodynamics – Kelvin and Planck's Statements, Clausius inequality, Definition of Heat Engine, Heat pump, Refrigerator. Concept of Entropy and availability. Carnot Cycle; Carnot efficiency, Otto, Diedel, Dual cycle and their efficiencies.

UNIT III

Properties & Classification of Fluids, Ideal & real fluids, Newton's law of viscosity, Pressure at a point, Pascal's law, Pressure variation in a static fluid, Introduction to Bio-fluid Mechanics General description of fluid motion, stream lines, continuity equation, Bernoulli's equation, Steady and unsteady flow. Turbines and pumps.

(PART-B)

UNIT IV

Introduction to Manufacturing processes for various machine elements. Introduction to Casting & Welding processes. Fabrication of large & small components and assemblies- example Nuts and Bolts, Water turbine rotors, Large Electric Generators, introduction to turning, milling, shaping, drilling & boring processes.

UNIT V

Introduction to quality measurement for manufacturing processes; standards of measurements, line standards and, end standards, precision measuring instruments and gauges: vernier calipers, height gauges, micrometers, comparators, dial indicators, and limit gauges.

Text Books/Reference Books

1. "Engineering Thermodynamics" by P. K. Nag.
2. "Fundamentals of Classical Thermodynamics" by G. J. Van Wyle and R. E. Santag.
3. "Introduction to Fluid Mechanics and Fluid Machines" by S. K. Som and G. Biswas.
4. "Fluid Mechanics" by V. L. Streeter and E. B. Wylie.
5. "Fluid Mechanics and Hydraulic Machines" by R. K. Bansal.
6. "Manufacturing Processes" by Kalpakjian.
7. "Workshop Practics" by A. K. Hazara Chowdhary.
8. "Workshop Technology" by W. A. J. Chapman.
9. "Production Engineering" by P.C. Sharma.
10. "Production Engineering" by R. K. Jain.

COE– 116 Programming Fundamentals	L T P	Credits
	2 0 0	2

UNIT I

Introduction: Concepts of algorithm, flow chart, Introduction to different Programming Languages like C, C++, Java etc.

Elementary Programming: Data types, assignment statements, conditional statements and input/output statements. Iterative programs using loops.Concept of subprograms. Coding style: choice of names, indentation, documentation, etc.

UNIT II

Arrays: Array representation, Operations on array elements, using arrays, multidimensional arrays.

Structures & Unions: Declaration and usage of structures and Unions.

Pointers: Pointer and address arithmetic, pointer operations and declarations, using pointers as function argument.

File: Declaration of files, different types of files. File input/output and usage.

UNIT III

Object Oriented Programming: Functional and data decomposition, Characteristics of Object-Oriented Languages: Abstraction, Encapsulation, Information hiding, abstract data types,

Classes and Objects: Concept of Object & classes, attributes, methods, C++ class declaration, private and public memberships, Constructors and destructors, instantiation of objects. Introduction to Class inheritance and operator overloading.

UNIT IV

Files: Streams and files, error handling, over view of Standard Template Library.

Text Books/Reference Books

1. "Problem Solving and Program Design in C" by Jeri R. Hanly, Elliot B. Koffman; Pearson Addison-Wesley, 2006.
2. "A Structured Programming Approach Using C" by Behrouz A.Forouzan, Richard F. Gilberg; Thomson Computer Science- Third Edition [India Edition], 2007.
3. "C++: The Complete Reference" by Schildt Herbert; Wiley DreamTech, 2005.
4. "Object Oriented Programming using C++" E. Balagurusamy, TMH. R. Lafore; BPB Publications, 2004.

5. "Object Oriented Programming with C++" by D . Parasons; BPB Publication, 1999.
6. "The Art of Programming Computer Science with C++" Steven C. Lawlor; Vikas Publication, 2002.

AP 117 Applied Physics - II Lab	L T P	Credits
Laboratory Practical Based on course work corresponding AP113	0 0 2	2

COE 118 Programming Lab	L T P	Credits
Laboratory Practical Based on course work corresponding COE-116	0 0 2	2

ME– 119 Engineering Graphics	L T P	Credits
	0 0 3	3

General: Importance, Significance and scope of engineering drawing Lettering, Dimensioning, Scales, Sense of Proportioning, Different types of Projections, B.I.S. Specification, line symbols, rules of printing.

Projections of Points and Lines: Introduction of planes of projection, Reference and auxiliary planes, projections of points and lines in different quadrants, traces, inclinations, and true lengths of the lines, projections on auxiliary planes, shortest distance, intersecting and non-intersecting lines.

Planes Other than the Reference Planes: Introduction of other planes (perpendicular and oblique), their traces, inclinations etc., projections of points lines in the planes, conversion of oblique plane into auxiliary plane and solution of related problems.

Projections of Plane Figures: Different cases of plane figure (of different shapes) making different angles with one or both reference planes and lines lying in the plane figures making different given angles (with one or both reference planes). Obtaining true shape of the plane figure by projection.

Projection of Solids: Simple cases when solid is placed in different positions, Axis, faces and lines lying in the faces of the solid making given angles.

Isometric and Orthographic: First and Third angle of system of projection sketching of Orthographic views from pictorial views and vice –versa principles and type of sectioning. Development of Surface

Text Books/Reference Books

1. "Engineering Graphics" by Narayana, K.L. and Kannaiah, P.; Tata McGraw Hill, New Delhi
2. "Elementary Engineering Drawing" by Bhatt N.D.; Charotar Book Stall, Anand
3. "Engineering Graphics" by Lakshminarayaan, V. and Vaish Wanar, R.S.; Jain Brothers, New Delhi
4. "Engineering Graphics" by Chandra, A.M. and Chandra Satish; Narosa

PE 120 Mechanical Workshop	L T P	Credits
	0 0 3	3

Fitting shops, Welding shops, Foundry Shops, Sheet Metal Shop, Smithy Shop.

BT 201 : Introduction to Biotechnology	L T P	Credits
	3 1 0	

Unit I

Introduction & Scope of Biotechnology: Definition, historical perspectives, scope and achievements of Biotechnology.

Unit II

Engineering Perspective to Biology: Characteristics of living organisms; Hierarchy of organization; Cell as a unit of living matter; Cellular architecture of prokaryotic and eukaryotic cells; Transport across cell membrane.

Unit III

Fundamentals of Biochemistry and Microbiology: Definition, classification and functions of carbohydrates, lipids, proteins, nucleic acids and vitamins ; General characteristics, nomenclature and classification of enzymes; Elementary concept of cofactors and coenzymes; Types and important characteristics of microbes.

Unit IV

Basic Concepts of Molecular Biology and Genetic Engineering: Evidence of nucleic acids as genetic material; Gene structure, function and organization, Central Dogma of molecular biology; Concept of recombinant DNA technology

Unit V

Basics of Biophysical Methods & Techniques: Basic principles, procedures and types of Electrophoresis; Centrifugation; Chromatography.

Unit VI

Commercial Applications of Biotechnology: An overview of the role of Biotechnology in Agriculture, Medicine, Industry, Food & Environment.

Text books:

1. Biochemistry by D. Voet and J.G. Voet. Publisher: Wiley International (1990).
2. Concepts in Biotechnology by D. Balasubramanian, C.F.A. Bryce, K. Jayaraman, J. Green and K. Dharmalingam. Publisher: Universities Press (2004).

Reference books:

1. Microbiology by M.J. Pelczar, E.C.S. Chan and N.R. Krieg. Fifth edition.Publisher: McGraw Hill (2005).
2. Lehninger's Principle of Biochemistry by D.L. Nelson and M.M. Cox. Fifth edition. Publisher: W.H. Freeman & Co. (2008).
3. Biotechnology: An Introduction by S.R. Barnum. Publisher: Wadsworth Publishing Company (2005).

4. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick. Publisher: Pearson Education (2004).
5. Physical Biochemistry: Applications to Biochemistry & Molecular Biology by D.M. Friefelder. Publisher: W.H. Freeman & Co (1982).
6. Genes IX by B. Lewin. Publisher: Pearson Education (2007).
7. Molecular Cell Biology by H. Lodish, A. Berk, S.L. Zipursky, P. Matsudaira, D. Baltimore and J. Darnell. Publishers: W.H. Freeman & Co (2007).
8. Practical Biochemistry: Principles and Techniques by K. Wilson and J. Walker. Publisher: Cambridge University Press. (2010)
9. Gene Cloning & DNA Analysis: An Introduction by T.A. Brown. Publisher: Blackwell (2010)

BT 202 : Biochemistry	L T P	Credits
	3 1 0	

Unit I

Chemical Foundations of Biology: Properties of water; biogenic properties of water, acids, bases and buffers, covalent bonds, Non-covalent interactions in biological systems**.**

Unit II

Introduction to Biomolecules: Carbohydrates, Lipids, Proteins, Nucleic acids -classification, structure and function, Vitamins and Coenzymes.

Unit III

Metabolism and Bioenergetics: First and second law, free energy and chemical equilibrium; Electron transport chain and oxidative photophosphorylation, phosphorylation and control of ATP production.

Unit IV

Carbohydrate Metabolism: Glycolysis pathway and reactions, Glycogen breakdown and synthesis, Citric acid cycle – Overview, Metabolic sources of Acetyl Co-A, enzymes and regulation, the amphibolic nature of the Citric acid cycle Gluconeogenesis, Pentose Phosphate Pathway

Unit V

Lipid Metabolism: Lipid digestion, absorption and transport, fatty acid oxidation, ketone bodies, fatty acid biosynthesis, regulation of fatty acid metabolism. Cholesterol metabolism

Unit VI

Amino acid and Nucleotide Metabolism: Amino acid deamination, urea cycle, amino acids as biosynthetic precursors, amino acid biosynthesis, metabolism of purines and pyrimidines, biosynthesis of nucleotide coenzymes.

Text books:

1. Principles of Biochemistry by A.L. Lehninger, D.L. Nelson, M.M. Cox. Publisher: Worth Publishing (2008)
2. Biochemistry by L. Stryer. Publishers: W.H. Freeman and Company (2002)

Reference books:

1. Biochemical Calculations by I.H. Segal. Publisher: John Wiley and Sons (1968).
2. Biochemistry by C.K. Mathews, K.E. Van Holde and K.G. Ahern. Publisher: Benjamin/Cummings (1999).
3. Harper's Biochemistry by K. Robert, M.D. Murray, D.K. Granner, P.A. Mayes and V.I. Rodwell. Publisher: McGraw-Hill/Appleton and Lange (2006).
4. Principles of Physical Biochemistry by Kensal E. Van Holde, Curtis Johnson, K.E. Van Holde., W.Curtis Johnson and Pui Shing Ho. Publisher: Prentice Hall. (2005).

BT 203 : Cell Biology	L T P	Credits
	3 1 0	

Unit I

Cellular Organelles: Plasma membrane, cell wall and their structural organization, Mitochondria, Chloroplast, Nucleus and other organelles – organization, structure and function, biogenesis of cellular organelles.

Unit II

Cell Motility: Cilia, flagella of prokaryotes and eukaryotes, role of microfilaments and microtubules

Unit III

Cell Cycle: Molecular events and model systems; Apoptosis

Unit IV

Cellular Signaling: Mechanism of signal transduction, mechanism of cell to cell signaling and intracellular signaling events with special reference to hormones and receptors. Membrane transport and ion channels

Unit V

Biology of Cancer: General concepts, Mutations causing cancer, Oncogenes, Tumor suppressor genes, Mechanism of protection by p53 gene & retinoblastoma gene, Genetic pathways to cancer, Cancer & Genetic counseling

Unit VI

Cellular Basis of Differentiation and Development: Cell division, gametogenesis, and fertilization.

Text books:

1. Molecular Biology of the Cell by B. Alberts, D. Bray, J. Lewis, M. Roff, K. Roberts and J.D. Watson. Publisher: Garland Publishing Company (1994).
2. **Gene IX by B. Lewin. Publisher: Oxford University Press (2007).**

Reference books:

1. Cell in Development and Inheritance by E.B. Wilson. Publisher: MacMilan (2007)
2. Molecular Cell Biology by H. Lodish, A. Berk, S.L. Zipursky, P. Matsudaira, D Baltimore and J. Darnell. Publisher: WH Freeman and Company (2000).
3. Cell: a molecular approach by Geoffrey Cooper (2000).
4. Essential Cell Biology : An Introduction to the Molecular Biology of the Cell by B. Albers, D. Bray, A Johnson, J. Lewis, M. Roff, K Robert P. Walter and K Roberts. Publisher: Garland Publishers (1997)

BT 204 : Object Oriented Programming	L T P	Credits
	3 1 0	

Unit I

Object oriented paradigm & C++ at a glance: Evolution of programming paradigm, structured versus object-oriented development, elements of object-oriented programming, Objects, classes, methods, popular OOP languages, software reuse.

Unit II

Classes and objects: Introduction, Class revisited, constant objects and constructor, static data members with constructors and destructors, constructor overloading, nested classes, objects as arguments, returning objects , friend functions and friend classes, constant parameters and member functions, static data and member functions.

Unit III

Dynamic objects: Introduction, pointers to objects, array of objects, pointers to object members, this pointer, self-referential classes

Unit IV

Operator overloading and Inheritance: Overloading of new and delete operators, conversion between objects and basic types, conversion between objects of different classes, overloading with friend functions, abstract classes, inheritance types , virtual base classes, virtual functions, pointer to derived class objects, and base class objects, pure virtual functions, virtual destructors.

Unit V

Generic programming with templates: Introduction, function templates, overloaded function templates, class templates, inheritance of class template, class template containership, class template with overloaded operators.

Unit VI

Introduction to byte code, security and portability, Data Types, variables, operators, arrays, type conversion and casting, type promotion, Control statements, standard input-output, Designing Classes, constructors, methods, access specifies : public, private, protected, inheritance, packages and interfaces, Math, String, Vectors, and Array List classes, polymorphism: function and operator overloading, function overriding, abstract classes.

Text books:

1. E Balaguruswamy, "Object Oriented Programming with C++", The McGraw Hill Companies (2008).
2. Patrick Naughton, S. Herbert, "C++: The Complete Reference", Wiley Dream Tech. (2005).

Reference books:

1. Jeri R.Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", Pearson Addison-Wesley (2006).
2. Behrouz A. Forouzan, Richrad F. Gilberg "A structured Programming Approach Using C", Thomson Computer Science-3rd edition [India edition] (2007).
3. Budd, "An Introduction to Object Oriented Programming", Addison Wesley (2002).
4. K.R.Venugopal, Rajkumar Buyya, T.Ravishankar, "Mastering C++", TMH (2003).
5. Lippman and Lajoie, "C++ Primer ", Addison Wesley (1998).

BT 205 : Biostatistics	L T P	Credits
	3 1 0	

Unit I

Descriptive Statistics & Probability: Graphical methods for data representation. Measure of central tendency. Measure of dispersion. Moments, Skewness, and Kurtosis.

Mathematical and Statistical concepts. Axiomatic concepts; Addition rule of probability. Conditional probability. Multiplication rule of probability. Baye's rule.

Unit II

Random Variable and Expectation: Random variable and distribution function. Jointly distributed random variables; Mathematical expectation. Statistical parameters. Moment generating function; Chebyshev's inequality.

Unit III

Probability Distributions: Binomial distributions. Multinomial distribution. Geometric distribution. Poisson distribution. Normal distribution. Normal distribution as limiting case of Binomial distribution. Exponential distribution.

Unit IV

Correlation and Regression: Method of least square and curve fitting. Correlation. Karl Pearson's coefficient of linear correlation. Probable error. Rank correlation and Spearman's coefficient. Regression.

Unit V

Sampling Distributions and Large Sample Estimation: Sampling plans. Statistics and sampling distributions. The central limit theorem. The sampling distribution of the sample mean. The sampling distribution of the sample proportion. Tests of significance. Large samples testing. Sampling of attributes.

Unit VI

Exact Sampling Distributions and Small Sample Test: The Chi-square distribution. Student's t-distribution. Snedecor's F-distribution, their Properties and applications.

Text books:

1. Principles of Biostatistics by Pagano, M. and Gaureau, K. 7th ed., Publisher: Thomson Learning, (2007).
2. Probability and Statistics for Engineers and Scientists by Ross, S.M. 3rd ed. Publisher: Academic Press, (2005).

Reference books:

1. Probability and Statistics for Engineers and Scientists by Walpole, R.E., Myers, R.H., Myers, S.L., Ye, K. Publisher: Prentice Hall, Inc. (2002)
2. Statistical Method for Engineering and Sciences by Taneja, H.C. Publisher: IK International, (2009).

BT 206 : Numerical Methods	L T P	Credits
	3 0 0	

Unit I

Solution of Algebraic and Transcendental Equations: Bisection method, Regula Falsi method, Secant methods, Newton-Raphson method, Fixed-point iteration method.

Unit II

System of Linear Algebraic Equations: Gauss elimination method, Crout's method, Gauss-Seidel method.

Unit III

Interpolation and Curve Fitting: Finite differences and various difference operators, Interpolation formulae (Newton's forward and backward, Stirling, Bessel's and Everett's formula), Lagrange's polynomial for unequal intervals.

Unit IV

Numerical Differentiation & Integration: Derivatives from difference tables, Higher order derivatives. Newton-Cotes integration formula, Trapezoidal rule, Simpson's 1/3rd rule and error estimation, Romberg's Integration.

Unit V

Numerical Solution of Ordinary Differential Equations: Picard's method, Taylor series method, Euler and Modified Euler method, Runge-Kutta Fourth order methods, Milne's method.

Unit V

Case studies

Text books:

1. Applied Numerical Analysis: Curtis F. Gerald and Patrick G. Wheatley- Pearson, Education Ltd (2007).
2. Numerical Methods for Scientific and Engg. Computations: M.K.Jain, S.R.K. Iyenger and R.K. Jain-New Age International (1993)

Reference books:

1. Advanced Engineering Mathematics Vol.2: Taneja; I K International (2008)
2. Introductory Methods of Numerical Analysis: S.S.Sastry, P.H.I.(2005)

BT 207 : Introduction to Biotechnology Lab	L T P	Credits
	0 0 2	

(Based on course work corresponding to BT 201)

1. Biotechnology Lab: Orientation & Safety Guidelines.
2. Microscopic analysis of various cell types.
3. Agarose gel electrophoresis and visualization of DNA.
4. Assay of enzyme activity.

BT 208 : Biochemistry & Cell Biology Lab	L T P	Credits
	0 0 2	

(Based on course work corresponding to BT 202 and 203)

1. Preparation of buffers.
2. Colorimetric determination of pKa of bromophenol blue.
3. Qualitative test for proteins.
4. Qualitative analysis of carbohydrates.
5. Quantification of DNA.
6. Quantification of proteins.
7. Microscopy.
8. Microtomy.
9. Histochemical techniques.
10. Mitosis and meiosis.

BT 209 : Object Oriented Programming Lab	L T P	Credits
	0 0 2	

(Based on course work corresponding to BT 204)

1. Creation of classes of objects and to use that class to regenerate another class.
2. Constructors and destructors, constructor overloading
3. Inheritance and polymorphism – Creation of abstract classes.
4. Data hiding.
5. Virtual functions.
6. Friend functions and classes
7. Function and Class Templates
8. Multi level inheritance
9. Java byte code programming: Polymorphism
10. Java function and operator overloading, function overriding, abstract classes.

BT 211 : Molecular Biology	L T P	Credits
	3 1 0	

Unit I

DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, DNA repair and recombination, operon systems (Lac, Gal, Trp, Ara).

Unit II

Transcription: Prokaryotic transcription, Eukaryotic transcription, General and specific transcription factors, regulatory elements and mechanism of transcription regulation, transcriptional and post transcriptional gene silencing, 5` cap formation, 3` end processing and polyadenylation, splicing, editing, ribosome and genetic code.

Unit III

Translation: Prokaryotic and Eukaryotic translation; the translation machinery, mechanism of initiation, elongation and termination, regulation, co- and posttranslational modifications of proteins.

Unit IV

Protein Targeting: Synthesis of secretory and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis

Unit V

Regulation of Gene Expression in Prokaryotic and Eukaryotic Systems: Transposons, retrotransposons, oncogenes, tumor suppressor genes from humans, structure, function and mechanism of pRB and p53 tumor suppressor proteins.

Unit VI

Techniques of Molecular Biology: Molecular markers; Sequencing; PCR and its variations; Ribozyme designing; Antisense technology; Basic gene cloning techniques.

Text books:

1. Gene IX by B. Lewin. Publisher: Oxford University Press (2007).
2. Genomes by T.A. Brown. Publisher: John Wiley and Sons Inc (2002).

Reference books:

1. Introduction to Practical Molecular Biology by P.D. Dabre. Publisher: John Wiley and Sons Inc (1988).
2. Molecular Biology LabFax by T.A. Brown. Publisher: Bios Scientific Ltd. Oxford (1991).
3. Molecular Biology of the Cell by B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Publisher: Garland Publishing (1989).
4. Molecular Biology of the Gene by J.D. Watson, A.M. Weiner, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner (The Benjamin/ Cummings Publishing Company Inc., California) (1987).
5. Molecular Cell Biology by H. Lodish, A. Berk, S. Zipursky, P. Matsudaira, D. Baltimore and J.E Darnell. Publisher: W.H. Freeman and Company (2000).
6. Molecular Cloning: A Laboratory Manual (3 Volume Set) by J. Sambrook and David W. Russel..Third edition Publisher: Cold Spring Harbor Laboratory Press (2001)

BT 212 : Genetics	L T P	Credits
	3 1 0	

Unit I

The Science of Genetics: Introduction, history, three great milestones in Genetics, Classical and molecular genetics, role of genetics in medicine, agriculture and society, Basic principles and extensions of Mendelism.

Unit II

Chromosomal Basis of Inheritance: The Chromosomal theory of heredity, chromosomes, Variation in chromosome number and structures, Sex chromosome, Sex linkage, Sex linked genes in humans.

Unit III

Linkage, Crossing Over and Chromosome Mapping in Eukaryotes (plant and animal systems) : Molecular mapping of the genome, genetic and physical maps, physical mapping and map based cloning, Southern and fluorescence in situ hybridization for genome analysis; RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes.

Unit IV

Mechanism of Genetic Change: Mutation and mutagenesis, screening for mutagenicity, DNA repair mechanism, Recombination and transposable genetic elements.

Unit V

Microbial Genetics: Bacterial genetic system, mechanism of gene transfer inbacteria, plasmids and transposons, bacterial genetic map with reference to E. coli, Viruses and their genetic system; Extrachromosomal inheritance in microbial systems.

Unit VI

Population Genetics: Hardy-Weinberg Law and its applications; Deviations from H.W. Law.

Text books:

1. Concepts of Genetics By W.S. Klug, M.R.Cummings, M. A. Palladino C.A. Spencer and C. Spencer. Publisher: Benjamin-Cummings Pub Co. (2008).
2. Genetics by M.W. Strickberger. Publisher: Prentice Hall College Division (2008).

Reference books:

1. Genetics by U. Goodenough. Publisher : International Thomson Publishing (1978).
2. Introduction to Genetic Analysis by A.J.F. Griffiths, J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. Publisher : W.H. Freeman and Company (2000).
3. Modern Genetic Analysis by A.J. F. Griffiths, W.M. Gelbart, J.H. Miller and R.C. Lewontin and. Publisher: W.H. Freeman and Company (1999).

4. Principles of Genetics by E.J. Gardner, M.J. Simmons and D.P. Snustad. Publisher: John Wiley and Sons Inc (1991)

BT 213 : Microbiology	L T P	Credits
	3 1 0	

Unit I

Introduction and Methods in Microbiology: Discovery of the microbial world, controversy over spontaneous generation, principles of microbial nutrition, Culture media, Theory and practice of sterilization, pure culture techniques, Enrichment culture techniques for isolation of different microorganism, culture collection and maintenance of cultures.

Unit II

Prokaryotic Structure and Function: functional anatomy of bacteria: cell envelope, cell wall, cytoplasmic membrane, capsule, surface appendages, cytoplasm and cytoplasmic inclusions.

Unit III

Microbial Nutrition and Growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen, Chemolithotrophy; nitrate and sulfate reduction; methanogenesis and acetogenesis. Fermentations- diversity, syntrophy, role of anoxic decompositions. Nitrogen metabolism; nitrogen fixation; antimicrobial agents, sulfa drugs, antibiotics – penicillins and cephalosporins, broad spectrum antibiotics.

Unit IV

Microbial Taxonomy: New approaches to bacterial taxonomy, classification including ribotyping, ribosomal RNA sequencing, characteristics of primary domains, taxonomy, nomenclature and Bergey's manual.

Unit V

Host-parasite Relationship: Normal microflora of skin, oral cavity, gastrointestinal tract; entry of pathogens into the host, colonization factors predisposing to infections, types of toxins (exo-, endo-, entero-) and their structure, mode of actions, vigilance and pathogenesis. Plant – Microbe Interactions

Microbial Pathogenesis: Disease reservoirs; Epidemiological terminologies; Infectious disease transmission; Respiratory infections caused by bacteria and viruses, Tuberculosis; Sexually transmitted disease including AIDS, Disease transmitted by animals (rabies and plague) and insects and ticks (rickettsias and malaria); Food and waterborne diseases; pathogenic fungi, emerging and resurgent infectious diseases; Viruses, virioids, and prions; Microbial control of pathogenesis.

Unit VI

Control of Undesirable Microorganisms in Biosystems: Introduction, Methods of Controlling Undesirable Microoganisms, Disinfectant Decay and Bacterial Inactivation Kinetics

Text books:

1. Microbiology by M.J. Pelczar, E.C.S. Chan and N.R. Kreig. Publisher: Tata McGraw Hill (2005).
2. Microbiology by Bernard D. Davis, Renato Dulbecco, Herman N.Eisen and Harold S. Ginsberg. Publisher: Lippincott Williams & Wilkins (1990).

Reference books:

1. Brock Biology of Microorganisms by M.T. Madigan, J.M. Martinko and J. Parker. Publisher: Prentice-Hall, Inc (1997).
2. General microbiology by R.Y. Stanier, J.L. Ingraham, M.L. Wheelis and P.R. Painter. Publisher: Macmillan (1987).
3. Microbial genetics by S.R. Maloy, J.E. Cronan and J.D. Freifelder. Publisher: Bartlett Publishers (1994).
4. Microbiology – A Laboratory Manual by J.G. Cappuccino and N. Sherman. Publisher: Addison-Wesley (2007).
5. Microbiology Applications – (A Laboratory Manual in General Microbiology) by H.J. Benson. Publisher: Wm C Brown Publishers (2001).
6. Microbiology by Prescot Harley and Kliein. Publisher: Mc Graw Hill (2007).

BT 214 : Enzymology & Enzyme Technology	L T P	Credits
	3 0 0	

Unit I

Enzyme : Introduction and scope, Nomenclature, Mechanism and catalysis, Application of enzyme - Industrial, Analytical and Medical; Biosynthesis, regulation and control of enzyme in microorganisms. Enzyme catalysis in organic media: catalytic antibodies and Non-protein biomolecules as catalyst, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria.

Unit II

Enzyme Kinetics: Kinetics of enzymatic reaction, Single and multiple substrate systems, King-Altman's method Inhibition - substrate, product and inhibitors, Analysis of kinetic data, Active and legend binding sites, Mechanism of enzyme action.

Unit III

I**mmobilization of Enzyme:** Methods of immobilization External and diffusional mass transfer limitation, Effectiveness factor and modulus; electrostatic and stearic effects in immobilized enzyme systems.

Unit IV

Enzyme Reactor: Reactors for Batch/ continuous enzymatic processing, choice of reactor type: idealized enzyme

reactor systems; Mass transfer in enzyme reactors: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors.

Unit V

Bioprocess Design: Physical parameters, reactors operational stability; immobilized cells.

Unit VI

Case studies

Text books:

1. Fundamentals of Enzymology by Price and Stevens. Publisher: Oxford University Press (2002).
2. Applied Biocatalysis: From Product Request to Idea to Product by Tramper, J. Publisher: Harwood Academic Publishers GmbH, Chur (1994).

Reference books:

1. Introduction to Biocatalysis using Enzymes and Microorganisms by S.M. Roberts, N.J. Turner and A. J. Willetts. Publisher: Cambridge University Press (1995).
2. Enzyme Technology by Helmut Uhling. Publisher: John Wiley (1998).
3. Introduction to Proteins Structure by Branden and Tooze. Publisher: Garland Publishing (1998).
4. Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady - State Enzyme Systems by I.H. Segel. Publisher: Wiley-Interscience.(1993).
5. Enzyme Technology by M.F. Chaplin and C. Bucke. Publisher: Cambridge University Press (1990).
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis by R.A. Copeland. Publisher: John Wiley and Sons Inc (1996).
7. Enzymes: biochemistry, biotechnology and clinical chemistry by Trevor Palmer: Horwood Publishing Series (2001).

BT 215 : Data Structures & Algorithms	L T P	Credits
	3 0 0	

Unit I

Introduction: Introduction to Algorithmic, Complexity-Time-Space Trade off. Introduction to abstract data types, design, implementation and applications. Introduction to List data structure.

Arrays and Strings: Representation of Arrays in Memory: one dimensional, Two dimensional and Multidimensional, Accessing of elements of array, performing operations like Insertion, Deletion and Searching. Sorting elements of arrays. Strings and String Operations.

Stacks and Queues: Introduction to data structures like Stacks and Queues. Operations on Stacks and Queues, Array representation of Stacks , Applications of Stacks : recursion, Polish expression and their compilation conversion of infix expression to prefix and postfix expression, Operations of Queues, Representations of Queues Applications of Queues, Priority queues.

Unit II

Linked Lists: Singly linked lists, Representation of linked list, Operations of Linked list such as Traversing, Insertion and Deletion, Searching, Applications of Linked List. Concepts of Circular linked list and Doubly linked list and their Applications. Stacks and Queues as linked list.

Unit III

Trees: Basic Terminology, Binary Trees and their representation, binary search trees, various operations on Binary search trees like traversing, searching, Insertion and Deletion, Applications of Binary search Trees, Complete Binary trees, Extended binary trees. General trees, AVL trees, Threaded trees, B- trees.

Unit IV

Sorting: Insertion Sort, Quick sort, Merge sort, Heap sort, sorting on different keys, External sorting.

Unit V

Graphs: Terminology and Representations, Graphs & Multi-graphs, Directed Graphs, Representation of graphs and their Transversal, Spanning trees, shortest path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths.

Unit VI

File Structure: File Organization, Indexing & Hashing, Hashing Functions, Collision Resolution Techniques.

Text books:

1. Ellis Horowitz and Sartaz Sahni. Fundamentals of Data structures. Galgotia Publications, New Delhi (1984).
2. Tanenbaum, “Data Structures using C and C++”, PHI (1997).

Reference books:

1. Data Structures through C by Yashavant Kanetkar, Bpb publications (2008)
2. J. Tremblay and P.G. Sorensen. “An Introduction to Data Structures and Application”, McGraw Hill College Division (1998)
3. Data Structures and Algorithms by A.V. Aho, J.E. Hopcroft and J. Ullman. Publisher: Addison-Wesley Publishing (1983)
4. Data Structures (Schaum’s Outline series) by Lipschutz S.Publisher: McGraw-Hill (2007)
5. R.L. Kruse, B.P. Leary, C.L. Tondo, “Data structure and program design in C”, PHI.

BT 216 : Engineering Economics	L T P	Credits
	3 0 0	3

Unit I

Introduction: Nature and significance of economics, Goods and Utility, Basic Concept of Demand and Supply, Elasticity of Demand- Price elasticity of Demand, Cross elasticity of Demand, Production - Production Function, Production Process and Factors of Production, Market – Introduction to Monopoly, Perfect Competition, Oligopoly and Monopolistic Competition, Cost Concepts, E-commerce.

Unit II

Money- its evaluation and function, Bank- Commercial Bank and Central Bank and brief idea about function of banking system. Tax and Subsidy, Type of Tax- Direct and Indirect, Monetary and fiscal policy, Inflation and Business cycle, IPR & WTO, International trade, terms of Trade, Gain from International Trade, Free Trade vs. Protection, Dumping, Balance of Payment

Unit III

Role of Science, Engineering and Technology in economic development: Some of the burning problems of rural and slum areas in India and how engineering and technology may be used to alleviate them, example of Green Revolution and White revolution. Reasons for their success and can we replicate them; sustainable development.

Unit IV

Elementary Economic Analysis; Interest formulas and their Applications; Calculations of economic equivalence, Bases for Comparison of Alternatives: Present Worth Method, Future worth method, Annual equivalent, Internal Rate of return; Evaluating Production Operations, Business Risk Management.

Text books:

1. G.J. Thuesen, & W.J. Fabrycky, Engineering Economy, Prentice-Hall of India Private Limited, New Delhi.
2. William G. Sullivan, James A. Bontadelli & Elin M. Wicks, Engineering Economy, Pearson Education Asia, First Indian reprint.
3. Donald G. Newnan, Jerome P. Lavelle & ted G. Eschenbach, EngineeringEconomic Analysis , Engineering press, Austin, Texas.
4. Seema Singh, Economics for Engineering Students, IK International Publishing House Pvt. Ltd.

BT 217 : Molecular Biology & Genetics Lab	L T P	Credits
	0 0 2	2

(Based on course work corresponding to BT 211 and BT 212)

1. Isolation of DNA: genomic, plasmid and lambda phage.
2. Isolation of RNA: total RNA and mRNA.
3. RFLP analysis
4. Mutation: Isolation and screening of mutants, e.g., colour mutation in fungi, Aspergillus; Bacterial mutation involving antibiotic resistance.
5. Bacterial transformation, transduction and conjugation.
6. Recombination experiments: Linkage analysis in Drosophila.
7. Karyotype - discussion of human genetic disorders - staining of plant cells to study chromosomes.
8. Microbial Genetics- syndrophism test

BT 218 : Microbiology Lab	L T P	Credits
	0 0 2	2

(Based on course work corresponding to BT 213)

1. Preparation of solid and liquid media.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution.
3. Slants and stab culture.
4. Storage of microorganisms.
5. Growth curve determination – measurement of bacterial population by turbidometry and dilution methods.
6. Effect of temperature, pH, carbon and nitrogen sources on microbial growth.
7. Microscopic examination of bacteria, yeasts and molds.
8. Staining of the microorganisms-Gram staining, acid fast-staining and spores staining.
9. Isolation of industrially important microorganisms for microbial processes.

BT 219 : Data Structure & Algorithms Lab	L T P	Credits
	0 0 2	2

(Based on course work corresponding to BT 216)

1. Programs for string functions like find length of string, number of occurrences of a substring in a given string
2. Stack implementation using arrays and linked list
3. Queue implementation using arrays and linked list
4. Evaluate postfix expression using stacks
5. Convert infix to postfix expression using stacks
6. Circular and Doubly linked list implementation
7. Binary tree operations traversal (pre-order, post order, in-order), addition and deletion to tree
8. Binary Search tree
9. Sorting algorithms – bubble, insertion, selection, quicksort, merge sort
10. Graph traversals Breadth first and Depth first

BT 301 : Instrumentation in Biotechnology	L T P	Credits
	3 1 0	10

Unit I

Hydrodynamic Techniques: Centrifugation: Viscosity and diffusion, Sedimentation equilibrium and sedimentation velocity methods, Analytical and Preparative centrifuges, application of density gradient and differential centrifugation; Cell disruption techniques.

Unit II

Electrophoretic Techniques: Paper and gel electrophoresis, Immuno electrophoresis, isoelectric focussing, two - dimensional electrophoresis, capillary electrophoresis.

Unit III

Chromatographic Methods: Paper, TLC gas chromatography, gel filtration, ionexchange chromatography, affinity chromatography and HPLC, FPLC, adsorption and desorption.

Unit IV

Spectroscopic and Diffraction Techniques: UV and visible, spectrofluorimetry, Atomic absorption spectrophotometry, Mass Spectrometry, Infrared and Raman Spectroscopy, Mossbauer, MALDITOF, ORD and Circular Dichorism, Nuclear Magnetic Resonance and Electron Spin Resonance spectroscopy, X - Ray diffraction, Electron diffraction, Neutron Diffraction.

Unit V

Optical Techniques: Microscopy: Optical and Electron Microscopy, Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Polarization and Fluorescence microscopy.

Radioisotope Techniques: Radio tracers, GM Counter, Proportional and Scintillation Counters, autoradiography, radioimmunoassay (RIA).

Unit VI

Chemosensors and Biosensors: Sensors and transducers; Electrochemical sensors; Semiconductor devices as chemical sensors; Optical chemical sensors; Piezoelectric sensors; Sensor signal processing; Chemistry of biomolecules and their immobilization for biosensors; Types of biosensors and their application - Environmental monitoring, process control, and clinical/biochemical analysis; Amperometric biosensors; Immunosensors

Text books:

1. Principles and Techniques of Practical Biochemistry by Keith Wilson and John Walker, Fifth edition, Cambridge University Press (2000)

2. **Biophysical Chemistry:** The conformation of Biological Macromolecules by C.R.Cantor and P.R. Schimmel. Publisher: W.H. Freeman (1980).

Reference books:

1. Essentials of Biophysics by P. Narayanan. Publishers: New Age International Publishers (2007)
2. Introduction to Spectroscopy by D.L. Pavia, G.M. Lampman and G. S. Kriz.and Vyvyan Publisher: Brooks Cole (2009)
3. Physical Chemistry of Macromolecules by C. Tanford. Publisher: John Wiley and Sons Inc.(1961)
4. Principles of Physical Biochemistry by Kensal E. Van Holde, Curtis Johnson, K.E. Van Holde., W.Curtis Johnson and Pui Shing Ho. Publisher: Prentice Hall. (2005)
5. Process Biotechnology Fundamentals by S N Mukhopadhyay. Publisher: Viva Books Pvt. Ltd., New Delhi.(2010)
6. Microbiology by Bernard D. Davis, Renato Dulbecco, Herman N.Eisen and Harold S. Ginsberg. Publisher: Lippincott Williams & Wilkins (1990).

BT 302 : Immunology & Immunotechnology	L T P	Credits
	3 1 0	

Unit I

Introduction: Phylogeny of Immune System, Innate and acquired immunity, clonal nature of immune response, organization and structure of lymphoid organs, Types of immunity- innate, acquired, active and passive.

Unit II

Cells of the Immune System: Hematopoiesis and differentiation, lymphocyte trafficking, B-Lymphocytes, T-Lymphocytes, macrophages, dendritic cells, natural killer, lymphokines and lymphokine activated killer cells, eosinophils, neutrophils and mast cells.

Unit III

Regulation of Immune Response: Antigen processing and presentation, generation of humoral immune responses, antibody structure, function and immunoglobulin gene rearrangement; Cell mediated immune response, activation of B- and Tlymphocytes, TCR gene rearrangement, T-cell regulation and MHC restriction; cytokines and their role in immune regulation, immunological tolerance.

Unit IV

Cell-mediated Toxicity: Mechanism of T-cell and NK-cell mediated lysis, antibody dependent cell mediated toxicity, cytotoxicity and macrophage mediated cytotoxicity, complement activation.

Unit V

Immune Response: Hypersensitivity, Autoimmunity, Immunity to infectious agents, Tumor immunology, transplantation immunology.

Unit VI

Applied Immunology: Immunological Techniques - Immuno diffusion, immunoelectrophoresis, ELISA, RIA, fluorescence activated cell sorter; Vaccines; Hybridoma technology; Antibody engineering, synthetic antibodies.

Text books:

1. Basic Immunology by A.K. Abbas and A.H. Lichtman. Third edition. Publisher: Saunders W.B. Company (2010)
2. Immunobiology by Charles Janeway, Paul Travers, Mark Walport and Mark J Shlomchik, Publisher: Garland Science, New York. (2001)

Reference books:

1. Immunology by Ivan Roitt, David Male and Johathan Brostoff Publisher: Mosby– Yearbook Inc (1996)

2. Kuby Immunology by T.J. Kindt, B.A. Osborne and R.A. Goldsby. Publisher: W.H. Freeman.(2006)
3. Production of Monoclonal Antibodies – Detailed Protocol by G.K. Lewis, University of Maryland (1995)
4. Immunology: A Short Course by R. Coico and G. Sunshine. Publisher: Wiley-Blackwell (2009)
5. Immunology and evolution of Infectious diseases by Steven Frank, PrincetonUniversity Press (2002)
6. Microbiology by Bernard D. Davis, Renato Dulbecco, Herman N. Eisen and Harold S. Ginsberg. Publisher: Lippincott Williams & Wilkins (1990)

BT 303: Genetic Engineering	L T P	Credits
	3 1 0	4

Unit I

Tools used in Genetic Engineering: Restriction endonuclease, mechanism of action, restriction mapping & map construction, DNA methylase, Other DNA manipulative enzymes: Nuclease, Polymerase, Ligase, Topoisomerases.

Unit II

Gene Cloning Vectors: Isolation and purification of DNA, Plasmids, bacteriophages, phagemids, cosmids, cloning vectors for eukaryotes, cloning vectors for higher plants, cloning vectors for animals.

Unit III

Introduction of DNA into Living Cells: Transformation, Transfection, Direct methods, particle bombardment, electroporation etc.

Unit IV

Library Construction and Identification of Recombinant Clones: Genomic and cDNA library construction; Selection & screening of recombinants clones.

Unit V

Expression System: Yeast, E. coli, Insects, mammals, plants; Studying gene expression and function, Production and scale-up operations of recombinant cells (bacteria and yeast).

Unit VI

Techniques in r-DNA: An overview of PCR & variations, Microarray, Gene knock out, RNA interference, Site directed mutagenesis.

Text books:

1. Gene Cloning & DNA Analysis: An Introduction by T.A. Brown. Publisher Blackwell (2001)
2. Principles of Gene Manipulation & Genomics by Primrose & Twyman. Sevenedition (2006)

Reference books:

1. Molecular Cloning: A Laboratory Manual (3 Volume Set) by J. Sambrook and David W. Russel. Third edition Publisher: Cold Spring Harbor Laboratory Press (2001)
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA by B.R. Glick and J.J. Pasternak. Publisher: ASM Press(2003)
3. Genetic Engineering by S. Rastogi and N. Pathak. Publisher: Oxford University Press (2009)
4. Recombinant DNA by J.D. Watson et al. Publisher: W.H. Freeman and Company (2007)

BT 304 : Biological Engineering Principles	L T P	Credits
	3 1 0	4

Unit I

Material and Energy Balances: Units and dimensions, Dimensional analysis, Simple problems on material balance, calculations involving unit processes and reactive systems, Available electron balances.

Unit II

Chemical Reaction Engineering: Kinetics of homogenous reactions: Concepts of reaction rate, order of reaction and molecularity.

Unit III

Reactors: Analysis of batch reactors for kinetic interpretation of the data, and isothermal reactor design for simple and multiple reactions; Design equations for CSTR and plug flow reactors.

Unit IV

Introduction to design of heterogenous reacting system, concepts of non-ideality, age distribution function and inter relationship.

Unit V

Instrumentation and Process Control: Principles of measurement: error, accuracy and sensitivity; measurement of flow, pressure, temperature level, pH, viscosity and chemical composition

Unit VI

Basic concepts of feedback control, control loop and its elements, Dynamic behavior of first, second and higher order physical systems, controller hardware, choice of controllers and settings. Introduction to advanced control systems: feedback forward, cascade and ratio control.

Text books:

1. Basic principles and calculations of Chemical Engineering by D.M. Himmelblau. Publisher: Prentice Hall.(1974)
2. Basic principles of Chemical Engineering by E.I. Shaheen Publisher: Houghton Mifflin (1975)

Reference books:

1. Chemical Process Control, an introduction to theory and practice by G.Stephanopoulos. Publisher: Prentice Hall Inc (1984)
2. Chemical reaction engineering by O.Levenspiel. Publisher: John Wiley and sons Inc.(1999)

3. Coulson's and Richardson's Chemical Engineering by J.F. Richardson and D.G. Peacock. Publisher: Asian books (1994)
4. Elementary principles of Chemical Processes by R.M.Felder and R.W. Rousseau. Publisher: John Wiley and sons Inc (2005)
5. Fundamentals of Chemical Reaction Engineering by C.D.Holland and R.G. Anthony. Publisher: Prentice Hall Inc. (1989)

BT 305 : Structural Biology	L T P	Credits
	3 1 0	4

Unit I

Protein Structures: Chemistry of amino acids and peptides (side chain structure and function in protein folding and functionality): Secondary structure of proteins - helices, sheets, loops and turns; Structural and functional proteins. Tertiary structure of proteins, homo and heterodimers, trimers and tetramers; forces governing proteinprotein interactions; open tertiary structure; Classification of proteins: Structure and function of an antibody; structure of hemoglobin, muscle proteins; Sequence and structural motifs in proteins.

Unit II

Protein-ligand Interactions: Lock and key versus handshake mechanism of substrate recognition; structural basis of recognition; reaction mechanisms of enzymes, G-Protein coupled receptors.

Unit III

Protein Solubility, Protein Stability and Stabilization: Salting in and salting out, Parameters affecting; mutations increasing stability, helix capping; Native, partially denatured and denatured proteins; Protein denaturation, Physical and chemical denaturants; Refolding.

Unit IV

DNA Structure: Covalent structure of DNA, base pairing, hydrogen bonding, DNA melting and annealing, difference between AT and GC pairing, DNA models, The Watson Crick model; Crystal structure of B-DNA, major and minor groves, dyad symmetry, base pair stacking, propellor twist, A and Z-DNA.

Unit V

Secondary Structures of DNA and Interactions: Triple stranded DNA, telomeric sequences and structure, G-quartets, palindromic and tandem sequences, Base pair flipping and DNA bulges, DNA methylation; Protein-DNA interactions; drug-DNA interactions

Unit VI

Databases of Sequences and Structure for Protein and DNA: Swiss prot, PDB, CATH, Expasy, EMBL, NCBI and DDBJ Public domain softwares for visualizing and modeling biomolecules – Rasmol, Deepview, Whatif.

Text books:

1. Essentials of Molecular Biology by G.M. Malacinski and D. Freifelder. Publisher: Jones and Bartlett Publications 4th edition (2003).
2. Biochemistry by Donald Voet and Judith Voet. Publisher: John Wiley & Sons 4th edition (2010).

Reference books:

1. D. Metzler Biochemistry: The Chemical Reactions of Living Cells by Metzler, David E.; Metzler, Carol M.; Sauke, David J Publisher: Academic Press (2001).
2. Genes IX by B. Lewin. Publisher: Jones & Bartlett (2008).
3. Introduction to Protein Architecture: The Structural Biology of Proteins by A.M. Lesk. Publisher: Oxford University Press (2000).
4. Introduction to Protein Structure by C. Branden and J. Tooze. Publisher: Garland Publishing Company (1998).

BT 306 : Instrumentation in Biotechnology Lab	L T P	Credits
	0 0 2	2

(Based on course work corresponding to BT 301)

1. Cell disruption techniques.
2. Centrifugation - low speed and high speed.
3. Spectrophotometric techniques.
4. Chromatography – ion exchange, gel filtration and affinity columns – sample application, fraction collection, monitoring UV absorbance, Applications in enzyme purification.
5. Techniques for removal of salt/solvent from a sample – desalting, dialysis, ultrafiltration, speedvac, lyophilization etc.
6. Electrophoresis – 1D and 2D.
7. Isoelectric focusing.
8. Polarization and fluorescence microscopy.

BT 307 : Immunology & Immunotechnology Lab	L T P	Credits
	0 0 2	2

(Based on course work corresponding to BT 302)

1. Blood film preparation and identification of cells.
2. Lymphoid organs and their microscopic organization.
3. Immunization, collection of serum.
4. Purification of IgG from serum.
5. Separation of mononuclear cells by Ficoll- Hypaque.
6. Con-A induced proliferation of thymocytes (by MTT method).
7. ELISA.
8. Agglutination and precipitation reactions.

BT 308 : Genetic Engineering Lab	L T P	Credits
	0 0 2	2

(Based on course work corresponding to BT 303)

1. Isolation of DNA from various sources.
2. Quantification and purification of nucleic acids.

3. Construction of restriction map of plasmid DNA.
4. Preparation of competent cells.
5. Bacterial Transformation.
6. Blotting and Hybridization techniques.
7. PCR amplification.

BT 309 : Minor Project-I	L T P	Credits
	0 0 2	2

BT 311 : Plant Biotechnology	L T P	Credits
	3 1 0	4

Unit I

Introduction: Historical perspectives, sterilization techniques, nutrient media, role of phytohormones; Biochemical and biophysical control of morphogenesis.

Unit II

Culture Techniques: Callus cultures, cell cultures and protoplast cultures; Micropropagation; Organogenesis and somatic embryogenesis; Cell suspension culture; Ovule culture; Anther culture; Production of haploids; Protoplast isolation and fusion; Selection systems for somatic hybrids / cybrids; Somaclonal variation; Preservation of germplasm.

Unit III

Formation of Secondary Metabolites in Tissue Culture: Production of pharmaceuticals by tissue culture, pigments, perfumes, flavors, insecticides, flavonoids; Biotransformation using plant cell cultures; Bioreactor system and models for mass cultivation of plant cells, hairy root culture.

Unit IV

Plant Genetic Engineering Techniques: Gene transfer techniques (vector mediated and vectorless gene transfer), transgenic plants, trans gene integration and expression, trans gene silencing, protein targeting, chloroplast transformation, targeted gene transfer, in planta transformation.

Unit V

Applications of Transgenic Techniques: Transgenic crops with new traits – herbicide tolerance, insect and disease resistance, pathogen free plants, nutrient quality, post harvest quality traits, fruit ripening, edible vaccines, therapeutic proteins and compounds.

Unit VI

Regulation of Plant Genetic Engineering: National Regulatory Mechanism; Public Concerns Related to Plant Genetic Engineering.

Text books:

1. An Introduction to Plant Tissue Culture by M.K. Razdan. Publisher: Oxford and IBH Publishing (2010)
2. Introduction to Plant Biotechnology by H. S. Chawla Publisher: Oxford and IBH Publishing (2009)

Reference books:

1. Plant Cell Tissue and Organ Culture by O.L Gamborg and G.C. Phillips. Publishers: Narosa Publications (1995)
2. Genetic Engineering by S. Rastogi and N. Pathak. Publisher: Oxford University Press.(2009)
3. Plant Biotechnology by Slater. Publisher: Oxford University Press (2003)

BT 312 : Animal Biotechnology	L T P	Credits
	3 1 0	4

Unit I

Introduction: Historical perspectives, sterilization methods, initiation and maintenance of cell cultures, cell culture substrates, culture media, natural and artificial media.

Unit II

Cell and Organ Culture Techniques: Plasma clot, raft methods, agar gel, grid method; Organ engineering, cryopreservation technology, immobilized cultures, stem cell research, in vitro fertilization and embryo transfer, somatic cell hybridization, organismal cloning, embryo split technique and nuclear transplantation; Difference between primary and secondary cultures-Development of primary culture, secondary culture-interaction between carrier and cell line with respect to cell structure, media formulation and important growth factors.

Unit III

Hybridoma Techniques and Monoclonal Antibody Production: Myeloma cell lines; Fusion of myeloma cells with antibody producing B cells, fusion methods, selection and screening methods for positive hybrids cloning methods; Production, purification and characterization of monoclonal antibodies; Development of hybridoma cell line- production of monoclonal antibodies using hollow fiber bioreactor by hybridoma cell line – stability of different bioreactors using animal cells; Applications of McAbs in biomedical research and in clinical diagnosis and treatment.

Unit IV

Principles and Strategy for Developing Vaccines: Newer methods of vaccine preparation, sub-unit vaccines, transplants, drug designing, drug targeting, microencapsulation in medicine.

Unit V

Bioreactor in Animal Cell System: T-flask, spinner reactors cultures-media formulation with special emphasis on growth factors, amino acids requirement, serum requirements, vitamins- effect of pH and temperature on cell cultures- pH profiling, CO2 requirement for cell culture growth- effect of endoplasmic reticulum on cell culture growth –explanation of microville; Different reactor studies for growing animal cells – perfusion reactor system, batch reactors, continuous reactor, air-lift reactoreffect of cell maintenance- effect of glucose to glutamine ratio, effect of amino acids with respect

to amino acid sequence in the product (protein)- Details analysis of perfusion bioreactor with respect to antibody production, protein production and enzyme production.

Unit VI

Transgenic Techniques and Applications: Gene transfer methods, Animal viral vectors, Targeted gene transfer; Molecular characterization of transformants; Molecular markers; Transgenic animals with new traits, transgenic animals as bioreactors for producing pharmaceutically important compounds; Gene therapy; Stem cell culture and their applications, Gene knock out and knock in technologies; Bioethical issues related to animal biotechnology.

Text books:

1. Animal Cell Culture Techniques by M. Clynes. Publisher: Springer Verlag. (1998)
2. Methods in Cell Biology - Animal Cell Culture Methods by J.P. Mather and D. Barnes. Publisher: Academic Press (1998)

Reference books:

1. Gene cloning & DNA Analysis: An introduction by T A Brown, Fourth edition (2001)
2. Genetic Engineering by S. Rastogi and N. Pathak. Publishers: Oxford University Press.(2009)
3. Principles of Gene Manipulation & Genomics by Primrose & Twyman. Seven edition (2006)
4. Animal Biotechnology: Identifying Science-Based Concerns by Debra Davis(2002)
5. Methods of Tissue Engineering by Anthony Atala and Robert P. Lanza. (2001)
6. Animal Cell Biotechnology: Methods and Protocols by Nigel Jenkins.(1999)
7. Transgenic Animal Technology: A Laboratory Handbook by Carl A Pinkert (2002)

BT 313 : Fundamentals of Biochemical Engineering	L T P	Credits
	3 1 0	4

Unit I

Microbial Process Principles: Microbial growth; Aerobic and anaerobic growth phenomena, Synchronous culture, different yields - growth, product, ATP, etc., metabolic quotient and maintenance energy; Energetics of the cells.

Unit II

Kinetics of Microbial Growth, Substrate Utilization and Product Formation: Mathematical modeling of microbial growth; Batch, fed-batch and continuous culture cultivation techniques; Growth kinetics with plasmid Instability. Substrate utilization and product formation kinetics; Growth and non-growth associated product formation. Major classes of interactions in mixed cultures and models for mixed culture.

Unit III

Sterilization: Principles and mechanism of media sterilization. Thermal death kinetics. Batch and continuous sterilization of media. Thermal and membrane filtration; Air sterilization - Principles and design.

Unit IV

Bioreactor Design and Analysis: Thermodynamics and rate concept of biological systems; Bioreactor configuration - batch, continuous stirred-tank, tubular, plug flow, packed bed, air lift, fluidized bed and the like; Kinetic expression; Monod's equation and its generalization; Bioreactor design and optimum operations – Mixing characteristics; Residence time distribution in bioreactors and non ideality, Concentration distribution and Temperature distribution; Analysis of multiple interacting microbial populations, Biological system parameters; Processes involving microbial flocs; Bioreactors containing microbial films; Basic concept of scale-up of bioreactors.

Unit V

Transport Processes: Unified theory of momentum, energy and mass transfer; Flow and mixing of Newtonian and non-Newtonian fluids; Gas-liquid mass transfer in microbial systems; Oxygen transfer rates; Single and multiple bubble aeration; Design of spargers and aeration equipment; Mass transfer across free surface as well as freely rising or falling bodies; Basic concept of oxygen transfer coefficient (Kla) and its measurement; Correlation of Kla with other operating variables; Factors affecting the Kla; Rheological properties of fluids; Biological heat transfer, Heat transfer coefficient.

Unit VI

Instrumentation and Control: Biochemical process variables and their measurements; Control principles and their application in bioreactors; Theory of electrode processes and their applications; Measurement and control of pH, temperature, dissolved oxygen, aeration and agitation, redox potential, foam, etc.; On-line analysis of process parameters; Introduction to biosensors; Transduction principles used in biosensors; Characteristics of biosensors; Biosensors based on amperometric, potentiometric, thermistor FET, fiber optics and bioluminescence; Microbial biosensors; Fundamentals of digital process control; Use of computer in control and optimization of microbiological processes.

Text books:

1. Biochemical Engineering Fundamentals by J.E. Baily and D.F. Ollis. Publisher: McGraw Hill. (1986)
2. Experimental Process Biotechnology Protocols by S.N. Mukhopadhyay. Viva Books Pvt Ltd, New Delhi(2007)

Reference books:

1. Bioreaction engineering principles by J. Nielson and J. Villadsen. Publisher: Plenum Press (1994).
2. Chemical Engineering Design: Fourth edition by J.M. Coulson and J.F. Richardson. Publisher: Butterworth Heinemann (2005).

3. Bioprocess Engineering - Kinetics, Mass transport, reactors and gene expression by W.R. Veith. Publisher: John Wiley and Sons Inc. (1994)
4. Bioprocess Engineering Basic Concepts by M.L. Shuler and F. Kargi. Publisher: Prentice Hall (1987).
5. Bioprocess Engineering Principles by P. Doran. Publisher-Academic Press (1995).
6. Transport Phenomena by R. B. Bird et al., 2nd Edition, Wiley, (2006).
7. Biochemical Engineering by S. Aiba, A.E. Humphry and N.F. Millis. Publisher: University of Tokyo Press (1973).

BT 314 : Database Management Systems	L T P	Credits
	3 1 0	4

Unit I

Introduction: Data base system concepts and its architecture, Data models schema and instances, Data independence and data base language and interface, Data definition languages, DML. Overall data base structure.

Data modeling using Entity Relationship Model: ER model concept, notation for ER diagrams mapping constraints, Keys, Concept of super key, candidate key, primary key generalizations, Aggregation, reducing ER diagrams to tables, extended ER model.

Unit II

Relational Data Model and Language: Relational data model concepts, integrity constraints, Keys domain constraints, referential integrity, assertions, triggers, foreign key relational algebra, relational calculus, domain and tuple calculus, SQL data definition queries and updates in SQL.

Unit III

Data Base Design: Functional dependencies, normal forms, 1NF, 2NF, 3NF and BCNF, multi-valued dependencies fourth normal forms, join dependencies and fifth normal forms. Inclusion dependencies, loss less join decompositions, normalization using FD, MVD and JDs, alternatives approaches to database design

Unit IV

C**oncurrency Control Techniques and Recovery:** Pitfalls in database design, decomposition, functional dependencies, Concurrency control and database discovery – concept of transaction: atomicity, consistency, isolation and durability, transactions and schedules, concurrent execution of transactions, Lock based concurrency control, Database recovery.

Unit V

Current Trends: Distributed databases and multimedia databases; Data warehousing – The evolution of Data management paradigms, Data warehouses; The data warehouse development lifecycle; Dimensional data modeling; Data Warehouse architecture and physical design; Data preparation and design.

Unit VI

Data Mining: Data mining primitives, languages and system architecture; Concept description - characterization and comparison; Mining complex types of data, Applications.

Text books:

1. Principles of Database and Knowledge Based Systems by J.D. Ullman. Publisher: Computer Science Press. (1989)
2. Elmasri, Navathe, “Fundamentals of Database systems”, Addison Wesley
3. Introduction to Data base Systems by C.J. Date. Publisher Addison Wesley Publishing (2003)
4. Data Mining: Concept and Techniques by J. Han and M. Kamber. Publisher: Morgan Kaufman. (2001)

Reference books:

1. Database Management system by R. Ramakrishnan. Tata McGraw- Hill Publisher. (2003)
2. The Data Warehouse Lifecycle Toolkit. Ralph Kimball, Margy Ross, Warren Thornthwaite, Joy Mundy, Bob Becker Publisher: John Wiley and Sons Inc. (2008)
3. The Data Warehouse Toolkit by R. Kimball et al. Publisher: John Wiley and Sons Inc.(1996)
4. Data Mining Techniques by A.K. Pujari. Publisher: Sangam Books Ltd. (2010)

BT 315 : Genomics & Proteomics	L T P	Credits
	3 1 0	4

Unit I

Genome Evolution and Phylogenetics: origin of genomes, Acquisition of newgenes, DNA sequencing - chemical and enzymatic methods, The origins of introns, DNA and RNA fingerprinting, The human genome.

Unit II

Structural, Comparative and Functional Genomics: Technology, Data bases (NCBI and plant databases), Sequence comparison techniques (BLAST etc.), Genome annotation; Comparative genomics - Phylogeny, Synteny (comparison of grass genomes), COGs, Metabolic reconstruction, The Basic Principles and Methodology, Pathway; Functional Genomics - ESTs, Digital Northerns, SAGE, Relational Data Base Basics, Micro Arrays-Affimetrics and spotted array concepts, cDNA Microarrays, Oligonucleotide Microarray Chips, Examples for application of microarrays, Microarray Data Analysis; Gene finding tools.

Unit III

Genotyping Background and SNPs: SNPs II and TOGA, AFLP and RFLP analysis, Arabidopsis K.O Strategies; Pharmacogenomics; Ethical considerations of genetic testing Introduction to proteomics; protein function and, expression; essential proteins; Protein function from structure; Rational drug design; Lethal mutants.

Unit IV

Interaction and Metabolic Networks: Yeast genome-wide interaction studies; Metabolic pathways, Metabolic regulation, Genome-Proteome Connection, DNAmicroarrays and Analysis of metabolic control.

Unit V

Introduction to Proteomics - How to Analyze a Proteome: 2D-gel electrophoresis, high-throughput proteome analysis with 2D-IEF, Current concepts of coimmunoprecipitation for protein interaction analysis, chromatography, amino acid sequencing, Current concepts of peptide sequencing with MS-MS methods, MALDITOF mass spectrometry and nanospray MS, Phage display, Protein chips; Twohybrid methods, Synthetic lethal screens, Proteome-wide interaction maps, TAP tags, GFP tags, Synthetic lethal screens inteins and protein splicing for interaction analysis; Protein microarrays.

Unit VI

Protein Structure, Function and Evolution: Structure function relationship; Proteinprotein interactions - Large molecular complexes - RNA polymerase II , ribosome; Unstructured proteins - Current concepts and examples; Control of ubiquitination, the proteasome, Post-translational modifications; Structure determination - experimental and theoretical methods; Evolution and design of protein function.

Text books:

1. Bioinformatics: A practical guide to the analysis of genes and proteins by AD. Baxevanis and B.F.F. Ouellette. Publisher: John Wiley and Sons Inc. (2005).
2. Bioinformatics: From Genomes to Drugs by T. Lengauer. Publisher: John Wiley and Sons Inc. (2001).

Reference books:

1. Bioinformatics: Sequence and Genome Analysis by D.W. Mount. Publisher: CBS (2003).
2. Functional Genomics - A Practical Approach by S. P. Hunt and R. Livesey.Publisher: Oxford University Press (2000).
3. Proteomics: From Protein Sequence to Function by S. Pennington and M.J. Dunn. Publisher: Springer Verlag (2001).

BT 316 : Plant & Animal Biotechnology Lab	L T P	Credits
	3 1 0	4

(Based on course work corresponding to BT 311 and BT 312)

1. Sterilization techniques and preparation media.
2. Membrane filtration.
3. Surface sterilization.
4. Callus propagation, organogenesis, transfer of plants to soil.
5. Protoplast isolation and culture.
6. Anther culture, production of haploids.
7. Cell counting and cell viability.
8. Growing animal cell in well plates, T-flask and spinner vessel.
9. Development of perfusion system for growing animal cells
10. Macrophage monolayer from PEC and measurement of phagocytic activity.
11. Trypsinization of monolayer and subculturing.
12. Cryopreservation and thawing.
13. Measurement of doubling time.
14. Role of serum in cell culture.
15. Cell fusion with PEG.

BT 317 : Database Management Systems Lab	L T P	Credits
	3 1 0	4

(Based on the course work BT 314)

1. Database creation using DDL and DML.
2. Defining the primary and secondary keys.
3. Implementation of selection, projection and joins (internal and external) with SQL and Perl.
4. Normalization of databases with SQL and Perl.
5. Implementation of transactions and schedules.
6. Detection of association rules and knowledge recovery.
7. Implementation of anomaly detection/ knowledge detection algorithms.
8. Case study in Biotechnology

BT 318 : Minor Project-II	L T P	Credits
	3 1 0	4

BT 319 : Industrial Training	L T P	Credits
	3 1 0	4

BT 401 : Computational Biology - I	L T P	Credits
	3 1 0	4

Unit I

Introduction to Biological Databases: Types, Overview of Biological Databases and Retrieve Nucleic acid databases: NCBI: Pubmed, Entrez, Blast, OMIM, Books, Taxonomy, Structure, Locuslink. Protein Databases- Primary, Functional, Composite, Secondary, Structural classification database, Sequence Formats & storage, Sequence submission to sequence Database.

Unit II

Genomics: Structure of DNA, Polymorphisms in DNA Sequence, Human Genome Project, Complete Genome Sequences, Functional Annotation.

Unit III

Perl Programming: Introduction and Installation, Arithmetic and Logical operators, Conditionals and Loops, List and Arrays, Working with files, Regular Expression and Pattern Matching.

Unit IV

Pairwise Sequence Alignment: Local alignment, Global alignment, Scoring matrices- PAM, BLOSUM, Gaps, Dot Plots. Dynamic programming Approach: Needleman and Wunsch Algorithm, Smith and waterman Algorithm, Heuristic Approach: BLAST, FASTA.

Unit V

Multiple Sequence Alignment: global and local alignments, scoring matrices and gap penalties, filtering, position specific scoring matrices, internet resources, uses of multiple sequence alignment, programs and methods for multiple sequence alignment, representation, structural inference.

Unit VI

Phylogenetic Prediction: Types, Tree building Methods, tree interpretation, phylogenetic analysis, parsimony, tree evaluation, maximum likelihood trees, softwares, Advantages and disadvantages of tree building methods, Synteny, COGs.

Text books:

1. Introduction to Bioinformatics – Teresa Atwood and David J.Parry, Pearson Smith publication 1st edition (2003).
2. Fundamental Concepts of Bioinformatics - Dan E. Krane, Michael L. Raymer, Pearson education First edition (2004).

Reference books:

1. Sequence structure and Database – Des Higgins, Willice Taylor, oxford press 1st edition (2003).
2. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, by Andreas (2005).
3. D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience, 3rd Edition, (2004). 4. Sequence and Genome Analysis by David W. Mount - Cold Spring Harbor Laboratory 1st edition; 2004.

BT 402 : Bioprocess Technology & Downstream Processing	L T P	Credits
	3 1 0	4

Unit I

Bioprocess vs. chemical processing; substrate for bioconversion process and design media. Cell culture techniques: isolation methods, media design and sterilization; Inoculum development and aseptic transfer : criteria for inoculum transfer, aseptic inoculation

Unit II

Process technology for production of primary metabolites - Baker's yeast, ethanol, acetone-butanol , citric acid, amino acids, polysaccharides and petides and plastics; Production of secondary metabolites - Penicillin , cephalosporins, streptomycin etc. metabolites from plant and animal cell culture.

Unit III

Microbial production of industrial enzymes such as glucose-isomerase, penicillin acylase, cellulase, amylase, lipase, protease etc.; Biomass (mushroom) production from agro-residues; Biofertilizers and Biopesticides.

Unit IV

Characteristic of bioproducts; Cell disruption methods; Mechanical methods of separation Flocculation and conditioning of broth. Sedimentation, Filtration and centrifugation – principle, instrumentation, types and application.

Unit V

Solid liquid separation- Protein precipitation and its separation; aqueous two phase extraction - principle, instrumentation and applications; adsorption-desorption processes; Membrane based separation; Dialysis, Electrodialysis, Microfiltration, Ultrafiltration, electrophoresis

Unit VI

Chromatographic methods of separation based on size, charge, hydrophobic interaction and biological affinity; Crystallization and drying.

Text books:

1. Industrial Microbiology by Casida. Publisher: New Age International (2003).
2. Biotechnology. A Textbook of Industrial Microbiology by W. Crueger and A. Crueger (1990).

Reference books:

1. Bioprocess Engineering Basic Concepts by M.L. Shuler and F. Kargi. Publisher: Prentice Hall (1987).
2. Biochemical Engineering Fundamentals by J.E. Baily and D.F. Ollis. Publisher: McGraw Hill 2nd edition (1986).
3. Product Recovery in Bioprocess Technology, BIOTOL Series. Publisher: Butterworth Heinmann (1992).
4. Separation processes in Biotechnology by J.M. Asenjo. Publisher: Marcel Dekker Inc. (2008)
5. Bioseparations Science and Engineering by Roger Harrison et al. Publisher: Oxford University Press (2003).
6. Prescott and Dunn's Industrial Microbiology by G. Reed. Publisher: Chapman & Hall (1981).
7. Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker and S.J. Hall. Publisher: Butterworth-Heinemann (1999).
8. Bioseparations-Downstream Processing for Biotechnology by P.A. Belter, E.L. Cussler and Wei-Shou Hu. Publisher: Wiley – Interscience 1st edition (1988).

9. Protein Purification: Principles and Practice by R.K. Scopes, Publisher: Springer (1982).
10. Protein Purification Methods by E.L.V. Harris and S. Angal. Publisher: IRL Press at Oxford University Press (1989).

BT 403 : Elective - I	L T P	Credits
	3 1 0	4

1. Database creation using DDL and DML Thermodynamics of Biological Systems
2. Pharmaceutical Chemistry
3. Current Topics in Biotechnology
4. Drug Delivery Systems

BT 404 : Open Elective - I	L T P	Credits
	3 1 0	4

1. Biomechanics
2. Biofuels
3. Nanobiotechnology
4. Biosensors

BT 405 : Computational Biology - I Lab	L T P	Credits
	3 1 0	4

(Based on course work corresponding to BT 401)
1. Genome Resources – NCBI, EMBL, DDBJ.
2. Protein Databases – SwissProt, TrEMBL
3. Bulk Data Retrieval
4. Inter-conversion different sequence file formats
5. Functional Annotation – Gene Ontology
6. Pairwise alignment.
7. Multiple sequence alignment using Clustal
8. Perl Programming – At least 5 biologically relevant programs

BT 406 : Bioprocess Technology & Downstream Processing Lab	L T P	Credits
	3 1 0	4

(Based on course work corresponding to BT 402)
1. Determination of Thermal Death Point and Thermal death time of microorganisms for design of a sterilizer.
2. Determination of growth curve of a supplied microorganism and also to determine substrate degradation profile and to compute specific growth rate and growth yield from the data obtained.
3. Comparative studies of ethanol production using different substrates.
4. Microbial production of antibiotics (Penicillin).
5. Production and estimation of alkaline protease.
6. Sauer Kraut fermentation.
7. Protein precipitation and recovery.
8. Aqueous two-phase separation.
9. Ion exchange chromatography; Gel filtration chromatography.
10. Membrane based filtration, i.e., Microfiltration and cross filtration in cross flow modules.
11. Assay of enzyme activity; Substrate specificity and efficiency of enzymatic catalysis.
12. Immobilization of enzyme / cells.
13. Mass transfer and biochemical reactions in continuous flow enzyme reactors.
14. Determination of KLa, rx and c*.

BT 407 : Major Project-I BT 408	L T P	Credits
	3 1 0	4

BT 411 : Computational Biology - II	L T P	Credits
	3 1 0	4

Unit I

Human Genetic Variation: Databases and Concepts: Introduction, Forms and mechanisms of genetic variation, Databases of human genetic variation, SNP databases, Mutation databases, Genetic marker and microsatellite databases, Nonnuclear and somatic mutation databases, Tools for SNP and mutation visualization.

Unit II

Genomics: Human Genome Project Breakthroughs, Functional Genomics, Transcriptomics, Proteomics, Mutational Genomics

Unit III

Pharmacogenomics and Personalized Medicine: Introduction, Historical Perspectives and Current Status, Management of Pharmacogenomic Information: PharmGKB, DrugBank.

Unit IV

Comparative Genome Analysis: Genome anatomy, Genome analysis, gene identification, gene expression, expression analysis, functional classification.

Unit V

Soft Computation: Machine learning, support vector machines, Neural Networks, fuzzy logic, genetic algorithms - applications to bioinformatics.

Unit VI

Structure Databases: PDB and MMDB, structure file formats, visualizing structural information.

Text books:

1. Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology by D. Gusfield. Publisher: Cambridge University Press (1997).
2 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins

Reference books:

1. Biocomputing hypertext course book at http://www.techfak.unibielefeld. de/dcd/curric/welcome.html/.
2. Bioinformatics: Sequence and Genome Analysis by D.W. Mount. Publisher: CBS (2003).
3. Computational Modeling of Genetic and Biochemical Networks by J.M. Bower and H. Bolouri. Publisher: MIT Press (2001).
4. Computational Molecular Biology: An Algorithmic Approach by P. A. Pevzner. Publisher: MIT Press (2000).

BT 412 : Elective – II	L T P	Credits
	3 1 0	4

1. Drug Design and Development
2. Pharmacogenomics and Personalized Medicine
3. Entrepreneurship Development & Marketing Research
4. Genomics and Medicine

BT 413 : Open Elective – II	L T P	Credits
	3 1 0	4

1. Bioprocess Plant Design
2. Intellectual Property Rights
3. Computer-aided Drug Design
4. Environmental Biotechnology

BT 414 : Computational Biology - II Lab	L T P	Credits
	3 1 0	4

(Based on the course work corresponding to BT 411)

1. SNP and Mutation Databases
2. Predictive Functional Analysis of SNPs
3. Pharmacogenomics databases – PharmGKB, DrugBank
4. Prediction of Secondary Structure of Proteins
5. Protein Structure databases: PDB, MMDB
6. Protein Structure Visualization – Chimera
7. Machine Learning Application in Bioinformatics

Paper I : BT 415 : Genomics & Proteomics Lab	L T P	Credits
	3 1 0	4

(Based on course work corresponding to BT 315)

1. In silico study - large molecular complexes, unstructured proteins.
2. Gene finding tools and genome annotation.
3. Comparison of two given genomes.
4. Microarray data analysis.
5. Inference of protein function from structure.

1. ELECTIVE COURSES:

Elective - I

Thermodynamics of Biological Systems	L T P	Credits
	3 1 0	4

Unit I

Introduction: Energetic process in the biosphere: The Ecosystem.

Unit II

Thermodynamic Systems: Equilibrium, activity coefficients and phase equilibrium functions of state, cyclic processes, work, energy and metabolic heat; Mechanical equivalent of heat, energy as a function of state. Carnot cycle; Reverse Carnot cycle; use of heat transfer in biological processes.

Unit III

The Laws of Thermodynamics: Second law; Reversible vs. irreversible processes, entropy, work; Combination of the first and second law, Free energy, useful work and delta 0. Entropy: Ideality and Molecular Cohesion, Probabilistic nature of Entropy, Order and Disorder.

Unit IV

Chemical Potential: Visualization of the potential, Steady velocity and steady flow Fick's law and diffusion. Local Equilibria and Steady State: Energy vs. Power; Transducers in biological states, Constitutive equations, Dynamic efficiency and Onsager (nonequilibrium thermodynamics), Prigogine's principle, Spontaneous coupling and entropy production.

Unit V

Non-equilibrium Thermodynamics: Reversible work, exact differentials and function of state, first and second law, The electrochemical potential, External forces and steady state, Fick's Law, chemical reactions in the steady state, internal entropy production, cells as non-equilibrium stationary states; Diffusion and membrane transport.

Biological Systems as Open, Non-equilibrium Systems: Failure of classical thermodynamics in describing biological processes, Standard free energy changes and equilibrium constants, direction and rate.

Unit VI

Thermodynamics of Biological Systems: Thermodynamic analysis of oxidative photophosphorylation, stability of non-equilibrium stationary states, ordering in time and space far from equilibrium, glycolytic oscillations. biological clocks, routes to chaos.

Text books:

1. Bioenergetics by A.L. Lehninger. Publisher: W.A. Benjamin Inc. (1965).
2. Biological Thermodynamics by D.T. Haynie. Publisher: Cambridge University Press (2001).

Reference books:

1. Biophysical Chemistry by CR. Cantor and P.R. Schimmel. Publisher: Freeman. (1980).
2. Thermodynamics and Kinetics for the Biological Sciences by G.G. Hammes. Publisher: John Wiley and Sons Inc. (2000).

Pharmaceutical Chemistry	L T P	Credits
	3 1 0	4

Unit I

Introduction to and History of Pharmaceutical Chemistry: Classification and nomenclature of organic pharmaceutical compounds; Hyperconjugation, steric effects inductive effect and mesomeric effect.

Unit II

Physicochemical Properties in Relation to Biological Action: Effects of route of administration, Sites of loss, Solubilities and partition coefficients (Ferguson, Hans'ch), Drug-receptor interactions, Steric features of drugs, The drug receptor, Structure-Activity Relationships, Representative physicochemical properties as related to biological action.

Unit III

Drug Metabolism: Oxidative Reductive, Hydrolytic, Conjugative

Unit IV

Drug Toxicity, Tolerance, Dependence, Addiction: Definitions; Classification of adverse drug reactions; Drug overdose; Drug-induced liver injury, Drug reaction with eosinophilia and systemic symptoms, Drug-drug interactions, Drug-disease interactions, Drug-food interactions; Intolerance to multiple drugs; Physical dependence, Psychological dependence, Cross dependence; Drug receptors; Learning, conditioning, and relapse.

Unit V

Survey of Various Drug Classes: Anesthetics (general, local), Analgesics, Neurotransmitters (adrenergic, cholinergic effects; psychopharmacology), CNS depressants (sedative/ hypnotic, major/minor tranquilizers), CNS stimulants, Antibiotics (especially b-lactam), Steroids.

Unit VI

Natural Products as Medicinal Compounds: Nucleic acids- Synthesis of purines and pyrimidines, isolation and structure determination of nucleosides and nucleotides, Pigments- Carotenoids, Anthocyanins, Flavones, flavonols, pyrrole pigments, porphyrins, haemoglobin and chlorophyll - Structure, General properties, classification Alkaloids and Terpenoids — Introduction, classification, properties and structure; Amino acids - Classification of amino acids, synthesis of amino acids, isolation and separation of amino acids from proteins, general physical and chemical properties of amino acids, polypeptides, general principles of polypeptide synthesis, structure of polypeptide : amino end degradation, carboxyl end degradation; Carbohydrates and lipids - Nomenclature, classification, structure and general reactions; Steroids and hormones - Diel's hydrocarbon, sterols, progesterone and androsterone; plant hormones (auxins heteroauxins, gibberellins, kinins, ethylene, traumatin).

Text books:

1. Medicinal Chemistry: An introduction by G. Thomas. Publisher: John Wiley and Sons (2000).
2. Medicinal Chemistry: The Role of Organic Chemistry in Drug Research by C. R. Ganellin and S. M. Roberts. Publisher: Academic Press (1993).

Reference books:

1. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems by H.C. Ansel, L. V Allien, N.G. Popovich. Publisher: Lippincott Williams and Wilkins Publishers (1999).
2. Review of Organic Functional Groups: Introduction to Medicinal Organic Chemistry by TL. Lemke. Publisher: Lippincott Williams & Wilkins, 4th edition (2003).

Current Topics in Biotechnology	L T P	Credits
	3 1 0	4

Unit I

Stem Cell Research: Stem cell characteristics, stem cell preparation and therapeutic uses, therapeutic and reproductive cloning, tissue engineering, global regulatory and ethical issues, and commercialization of stem cell therapy, bioethical issues

Unit II

Molecular Medicine: Gene mutations, allele specific oligonucleotides, ARMS, disease diagnostics using genetic markers; molecular targeting; Nuclear medicine: Radiotracers, PET/CT, MRI

Unit III

Nanobiotechnology: Unique functional properties of natural and synthetic biomolecular-sized (nanometer-scale) constructs such as quantum dots, carbon nanotubes, nanostructured surfaces, liposomes, artificial membranes, and molecular machines for biotechnology and medicine; Biochemical fuel cells.

Unit IV

Genetically Modified Organisms: Transgenic food crops, food animals, future goals in GM crops, legal requirements in production of GMO, current trends and consumer acceptance.

Unit V

Translational Research: Clinical trial formulations, regulations as per government directives; Translational research in clinical oncology, hematology; Case studies; Recent advances.

Unit VI

Pharmacogenetics: Introduction, New advances in post genome era, genetic differences and metabolic pathways, drug discovery and rational drug/vaccine design, drug responses, ethical issues linked with personalized medicine.

Text books:

1. Essentials of Stem Cell Biology by Robert Lanza et al. Publisher: Elsevier Academic Press, 2nd edition (2009).
2. Nanotechnology: Science, Innovations and Opportunity by Lynn Foster. Publisher: Prentice Hall (2005).

Reference books:

1. Textbook of Molecular Medicine by Jameson J.L. Publisher: Blackwell Science Inc. (1997).
2. Pharmacogenetics by Wendell Weber. Publisher: Oxford University Press (1997).

Drug Delivery Systems	L T P	Credits
	3 1 0	4

Unit I

Basic Concepts of Drug Delivery: Introduction, Concept of bioavailability, Process of drug absorption, Pharmacokinetic processes, Timing for optimal therapy, Drug delivery considerations for the new biotherapeutics.

Unit II

Advanced Drug Delivery and Targeting: Basic terminologies in drug delivery and drug targeting, Drug release, Drug targeting, Doses forms, Introduction of various routes of administration of drugs, Strategies for enhanced therapeutic efficacies (Basic principles).

Unit III

Drug Administration: Parenteral delivery - intravenous, intramuscular, interperetoneal. Oral delivery and systemic delivery through oral route -Structure and physiology of Gastro Intestinal tract, Impedements against oral availability, Advantages and disadvantages of oral drug delivery.

Unit IV

Current Technologies and New and Emerging Technologies in Oral Delivery: Nasal and pulmonary delivery, Opthalmic delivery — structure and physiology of eye, topical and intraocular drug delivery, Drug targeting to NS - Blood/Brain barrier, hysiochemical factors for delivering to CNS, current and new technologies in CNS delivery.

Unit V

Delivery of Genetic Material: Basic principles of gene expression, Viral and nonviral vectors in gene delivery, Clinical applications of gene therapy and antisense therapy

Unit VI

New Generation Technologies in Drug Delivery and Targeting: Nanotechnology/ Nanobiotechnology, Use of biosensors and challenge of chronopharmacology, Microchips and controlled drug delivery, Genetically engineered cell implants in drug delivery.

Text books:

1. Drug Delivery and Targeting by A.M. Hillery, A.W. Lloyd and J. Swabrick. Publisher: Taylor & Francis (2001).
2. Drug Delivery: Engineering Principles for Drug Therapy (Topics in Chemical Engineering) by W.M. Saltzman. Publisher: Oxford University Press (2001).

Reference books:

1. Handbook of Biodegradable Polymers (Drug Targeting and Delivery) by A. J. Domb, J. Kost and D.M. Wiseman. Publisher: Dunitz Martin Ltd. (1998).
2. Pharmaceutical Dosage Forms and Drug Delivery Systems by H.C. Ansel, L.V. Allen and NG. Popovich. Publisher: Lippincott Williams and Wilkins (2010).

Open Elective – I

BT 404 : Elective - II

Biomechanics	L T P	Credits
	3 1 0	4

Unit I

Principles of mechanics, Different operations on vector, forces, and Moments - Resultant forces of Coplaner & Noncoplaner and Concurrent & non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Moment of force-Static equillibrum-Centre of gravity- Stability of equilibrium-Steps in analyzing a biomechanical problem- Graphical methods-contact forcesresolution of forces; Applications with examples on Human Body. Work and energy Equation, Application to Biomedical System, Moment of inertia.

Unit II

Bone structure & composition mechanical properties of bone; Electrical properties of bone, viscoelastic properties, Maxwell & Voight models – anisotropy fracture mechanism and crack propagation in bones, fracture fixators, repairing of bones. Pseudo elasticity, nonlinear stress-strain relationship, viscoelasticity, structure, function and mechanical properties of skin, ligaments and tendons, mechanical properties of collagen rich tissues, teeth and its properties.

Unit III

Skeletal joints, skeletal muscles, basic considerations, basic assumption and limitations, forces and stresses in human joints, mechanics of the elbow, shoulder, spinal column, hip, knee and ankle. Human locomotion, gait analysis and goniometry, Ergonomics, Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Total Hip Prosthesis: requirements, different types of components, Stress analysis & instrumentation, Knee Prosthesis. Powered wheel chair, Crutches and canes.

Unit IV

Structure and functions of cartilages, tendons, ligaments, stress-strain relationship, soft tissue mechanics, mechanical testing of soft tissues standard sample preparation, cross-

section measurement, clamping of the specimen, strain measurement, environmental control), time dependent properties of testing.

Unit V

Mechanical properties of blood vessels – arteries, arterioles, capillaries, veins, physics of cardio vascular diseases, artificial heart valves, biological and mechanical valves development, Heterogrils, Homograil, testing of valves prosthetic heart valves and replacement. Fluids –density-pressure-blood pressure and gravity – buoyancy – moments of force and stability- movement in water - Rheological properties of blood, laminar flow, Couette flow and Hagen-Poiseuille equation, turbulent flow.

Unit VI

Alveoli mechanics, interaction of blood and lung, P-V curve of lung, breathing mechanism, airway resistance, physics of lung diseases.

Text books:

1. Biomechanics: Mechanical Properties of Living Tissues by Y C Fung, second edition. Publisher: Springer (1993).
2. Principles of Mechanics and Biomechanics by Frank Bell. Publisher: Stanley Thorne Ltd. (1998).

Reference books:

1. Biomechanics by Alexander R Mc Neill. Publisher: Chapman and Hall (1975).
2. Fundamentals of Biomechanics-equilibrium, motion and deformation by Nihat Ozkaya and Margarita Nordin, 2nd edition. Publisher: Springer-Verlag (1999).
3. Biomechanics Principles and applications by Donald R. Peterson and Joseph D. Bronzino. Publisher: CRC Press, Taylor & Francis Group, LLC (2008).
4. Biomechanics of Medical Devices by D.N. Ghista. Publisher: Marcel Dekker (1982).
5. Fundamentals of Biomechanics

Biofuels	L T P	Credits
	3 1 0	4

Unit I

Fossil versus Renewable Energy Resources: Economic impact; Comparison of bioenergy sources; Sustainable development and biomass production; Fundamental concepts in understanding biofuel / bioenergy production; Availability of cellulosic feedstock, pretreatment; Renewable feedstocks and their production; Feedstocks characterization and attributes for biofuel / bioenergy production; Biomass preprocessing: drying, size reduction, and densification; Various biofuels / bioenergy from biomass; Value-added processing of biofuel residues and co-products; Microbial modelling for biofuel production; Biofuel ethics.

Unit II

Biodiesel: Introduction; Worldwide production; Chemistry and production process; Vegetable oils and chemically processed Biofuels; Biodiesel economics; Energetics of biodiesel production; Effect on green house effect; Chemical biomass-liquid fuel; Biodiesel from microalgae and microbes; Biodiesel reactors.

Unit III

Biogas: Introduction, substrate from animal excreta, agricultural, industrial, domestic, food processing wastes for biogas production; Digesters: Batch, continuous, plug flow, upflow anaerobic sludge blanket digester, film reactors; Microorganisms involved in production e.g. methaogenic bacteria, hydrolytic and acetogenic bacteria; Process designing; Factors affecting biogas yields; Advantages and disadvantages of biogas production; Problems in biomethanation; Kinetics of anaerobic fermentation.

Unit IV

Bioethanol: Ethanol production from sugar, starch and lignocellulosic feed stock; Microbial process; Fermentation: Batch, continuous and Mille-Boinot process.

Unit V

Biohydrogen: Introduction; Photobiological production; Hydrogen production from fermentation: overview, energetics, biochemical pathway for hydrogen production; Batch fermentation; Hydrogen inhibition, Hydrogen detection, quantification and detection and reporting.

Unit VI

Microbial Fuel Cell: Overview; Biochemical basis fuel cell design: anode compartment, cathode compartment, microbial cultures, redox mediators microbial cell performance method.

Text books:

1. Biofuels Engineering Process Technology by Caye Drapcho, John Nghiem and Terry Walker. Publisher: McGraw-Hill (2008).

   Biofuels: Biotechnology, Chemistry, and Sustainable Development by David M. Mousdale. **Publisher: CRC Press (2008).**

Reference books:

1. Introduction to Biofuels by David M. Mousdale. Publisher: CRC Press (2010).
2. Biomass to Biofuels: Strategies for Global Industries edited by Alain Vert Nasib Qureshi, Hideaki Yukawa and Hans P. Blaschek. Publisher: Wiley (2010).
3. Biorenewable Resources: Engineering New Products from Agriculture by Robert C. Brown. Publisher: Iowa State Press (2003).

Nanobiotechnology	L T P	Credits
	3 1 0	4

Unit I

Introduction: Introduction to nanotechnology and overview of nanoscale materials, effect of length scale on properties, introduction to bionanotechnology, challenges and

opportunities associated with biology on the nanoscale, biological and medical applications of bionanomaterials.

Unit II

Nanomaterials: Introduction to nanomaterials, General surface and colloid chemistry, principles, experimental techniques, surface potential, DVLO theory; Characteristics of nanoparticles, chemical speciation of dissolved species, Unique functional properties of natural and synthetic biomolecular-sized (nanometer-scale) constructs such as quantum dots, carbon nanotubes, nanostructured surfaces, liposomes, artificial membranes, and molecular machines for biotechnology and medicine, Environmental behavior of nanoparticles, biological activity of nanomaterials.

Unit III

Biosensors: Introduction to biosensors, the biological component, the sensor surface, Immobilization of the sensor molecule, Transduction of the sensor signal: Optical, Electrochemical and Mechanical sensors, Sensor stabilization, Basics of Amperometric sensors; Potentiometric sensors; Optical sensors; Optical waveguide sensors; Surface Plasmon Resonance sensors; Resonant Mirror sensors; Capillary Fill devices; Electro-mechanical devices.

Unit IV

Biophotonics and Bioimaging: Overview of imaging biological systems, from the cellular level through to whole-body medical imaging, Introduction to biophysics, basic physical concepts in imaging, Major techniques using ionizing and non-ionizing radiation: fluorescence and multi-photon microscopy, spectroscopy, OCT, MRI, X-ray CT, PET and SPECT imaging.

Unit V

Nanotoxicology: Principles of toxicology; toxicology models, experimental toxicology studies; activation and detoxification mechanisms, importance of biological membrane in toxicology; Toxicology and bioaccumulation of particles.

Unit VI

Applications, Risks and Precautions: In vivo diagnosis, in vitro diagnosis, therapy, cosmetics; Environmental and Risk Prevention; Risks and Ethical considerations.

Text books:

1. Engines of Creation by K E Drexler. Publisher: Oxford, New York (1986).
2. Nanosystems: Molecular Machinery, Manufacturing and Computation by K E Drexler. Publisher: Wiley (1992).

Reference books:

1. Our Molecular Future: How Nanotechnology, Robotics, Genetics and Artificial Intelligence Will Transform the World by Mullhall D. Publisher: Prometheus (2002).
2. Web Resources: www.nanotechweb.org; www.nano.gov; www.nanotec.org.uk.

Biosensors	L T P	Credits
	3 1 0	4

Unit I

Introduction to MEMS.

Unit II

Biosensors: Definition, History, Properties of biosensors, Design features of biosensors, The biological component.

Unit III

Signal Transduction: Amperometric Biosensors, Potentiometric biosensors, Detection of H+ cation, Detection of NH4 + cation, Detection of CN- anion; Calorimetric biosensors, Optical biosensors, Measuring the change in light reflectance, Measuring luminescence, Piezo-electric biosensors, Immunosensors.

Unit IV

Biomedical Sensors: Sensors and transducers: an overview, measurement systems, Classification of biomedical sensors and transducers, Why do we need Biomedical sensors and transducers? Important design considerations and system calibration.

Unit V

Commercial Examples of Biosensors: Biosensors markets: Opportunities and obstacles.

Unit VI

The Future of Biosensors and Transducers: Sensing Layer: The importance of computers in sensor and transducer technology, Recent engineering solutions to health care using biosensors and transducers, Modern health care solutions.

Text books:

1. Affinity Biosensors: Techniques and Protocols by K.R. Rogers and A. Mulchandani. Publisher: Humana Press (1998).
2. Biosensors and their Applications by V.C. Yang and T.T. Ngo. Publisher: Springer (2000).

Reference books:

1. Chemical Sensors and Biosensors by B.R. Eggins. Publisher: John Wiley and Sons Inc. (2002).
2. Sensors and Sensing in Biology and Engineering by F.G. Barth, et al. Publisher: Springer Verlag (2003).
3. Bioinstrumentation and Biosensors by D.L. Wise. Publisher: Marcel Dekker (1991).
4. Process Biotechnology Fundamentals by S N Mukhopadhyay. Publisher: Viva Books Pvt. Ltd., New Delhi (2010).

Elective - II
BT 412 : Elective - II

Drug Design and Development	L T P	Credits
	3 1 0	4

Unit I

Drug Targets Classification: DNA, RNA, post-translational processing enzymes, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors, neuropeptide receptors, ion channels (monomeric multi-transmembrane proteins, ligand-gated ion channels (oligomeric transmembrarie proteins), transporters (multi-transmembrane proteins),

Unit II

Target Discovery and Validation Strategies: Genomics (new target discovery), biological activity directed and other types of screening; natural products, combinatorial chemistry; General overview modeling methodologies, structure based drug design, protein structure determination: X-ray, protein homology and alternative techniques.

Unit III

Structure-based Design: 'de novo' design methodologies: indirect drug design, pharmacophore development and receptor mapping, 3D-database searching techniques, new strategies and recent technologies in drug design.Unit 4:

Unit IV

Design and Development of Combinatorial Libraries for New Lead Generation: the molecular diversity problem, drug characterization- principles of equilibria, diffusion, and kinetics, preformulation: pKa, partition coefficient, solubility, dissolution, chemical stability, and permeability, optimization of ADME characteristics, physicochemical properties calculation, chemiometrics in drug design.

Unit V

QSAR: Statistical techniques behind QSAR, classical QSAR, molecular descriptors 3D QSAR and COMFA, drug design to discovery and development,

Unit VI

Drug metabolism, toxicity and pharmacokinetics, toxicology considerations, problems and drawbacks on drug discovery and development.

Text books:

1. Introduction to Biophysical Methods for Protein and Nucleic Acid Research by J.A. Glasel and M.P. Deutscher. Publisher: Academic Press (1995).
2. Principles of Drug Action by W.B. Pratt and P. Taylor. Publisher: Churchill Livingston (1990).

Reference books:

1. Principles of Medicinal Chemistry by W.O. Foye T.L. Lemke, and D.A. Williams. Publisher: Williams and Wilkins (1988).
2. Side Effects and Drug Design by B.J. Lien. Publisher: Marcel Dekker (1987).
3. The Anticancer Drugs by W.B. Pratt, R.W. Ruddon, W.D. Ensminger, and J. Maybaurn. Oxford University Press (1994).

Pharmacogenomics and Personalized Medicine	L T P	Credits
	3 1 0	4

Unit I

Introduction to Pharmacogenomics: The roots of pharmacogenomics, Historical Perspectives and Current Status.

Unit II

The Human Genome: Computational genome analysis.

Unit III

Functional Analysis of Gene Variation & Genotyping Techniques: Aspects influencing method of selection, SNP Genotyping, TaqMan Genotyping.

Unit IV

Pharmacogenomics in Drug Discovery: The need of protein structure information, protein structure and variation in drug targets-the scale of problem, Mutation of drug targets leading to change in the ligand binding pocket.

Unit V

Case Studies.

Unit VI

Management of Pharmacogenomic Information: PharmGKB.

Text books:

1. Pharmacogenomics: The Search for the Individualized Therapies by Licinio, Julio and Ma-Li Wong. Publisher: Wiley-VCH (2002).
2. Pharmacogenomics: An Approach to New Drugs Development by Chakrabarthy, Chiranjib and Bhattacharyya, Atane (2004).

Reference books:

1. Pharmacogenomics: Social, Ethical and Clinical Dimensions by Rothstein, Mark, A. Publisher: Wiley-Liss (2003). 98
2. Pharmacogenomics in Drug Discovery & Development by Qing Yan. Publisher: Humana Press (2008).
3. Pharmacogenomics Methods and Protocols by Federico Innocenti. Publisher: Humana Press (2005).

Entrepreneurship Development & Marketing Research	L T P	Credits
	3 1 0	4

Unit I
The evolution of management thought, Foundations of individual behavior, Personality, Perception, OB models, Interpersonal behavior and group dynamics; Entrepreneurship and entrepreneurial process, business plan, form of ownership suitable for business.

Unit II
Regulatory issues, Environmental issues, Interpersonal skills and wealth creation process.

Unit III
Entrepreneurial motivation and leadership, Entrepreneurial competencies, Entrepreneurial development programme.

Unit IV
Introduction to marketing function; The concept of marketing mix, Various market Research concepts; process, exploratory, descriptive and conclusive research.

Unit V
The marketing decision- making process and the need of different types of research; Types of marketing problems and type of marketing research activity; Sources of data; use and appraisal of existing information, primary and secondary data.

Unit VI
Information from respondents, sampling design, scaling techniques and questionnaire design, interviewing, various methods of survey / data collection; Information from experiment, experimental design for marketing.

Text books:
1. Essentials of Management by H, Koontz, H. Weihrich and C. O'Donnell. Publisher: McGraw-Hill/Irwin 4th edition (1990).
2. The Practice of Management by P. Drucker. Publisher: Harper Business (1993).

Reference books:
1. Marketing Research by Naresh Malhotra. Publisher PHI 6th edition (2009).

Genomics and Medicine	L T P	Credits
	3 1 0	4

Unit I
Genomics in Medicine: Introduction; Gene medicine; Disease Models; Impact of Genomics on Medicine

Unit II
Genomics and the challenge of Infectious Diseases: Understanding pathogenicity; Comparative genomics and genome plasticity; Combating infectious diseases: bacterial, fungal, protozoan, viral.

Unit III
Analyzing and Treating Genetic Disorders: Detection, Treatment, Analysis; Haplotypes; Pharmacogenomics

Unit IV
Diagnosis and treatment of Cancer: Introduction; The impact of genomics on cancer research; New approaches to cancer therapy

Unit V
Genomics and the development of new chemical entities: Introduction; Highthroughput screening; Target validation and animal models; Combinatorial chemistry; Virtual screening

Unit VI
Gene and cell therapies: Introduction; Gene Delivery; Nucleic acids as drugs: DNA vaccines; Disease models; Cell Therapy

Text books:
1. Bioinformatics: Genomics and Post-Genomics by Frédéric Dardel, François Képès, Noah Hardy. Publisher: John Wiley & Sons India Pte. Ltd. (2006).

   Bioinformatics: Theory and Practice by Chikhale NJ and Gomase VS. Publisher: Himalaya Publication House (2007).

Reference books:
1. Discovering Genomics, Proteomics and Bioinformatics by Campbell. Publisher: Pearson Education, 2nd edition (2006).
   Essentials of Genomics and Bioinformatics by Christoph W. Sensen. Publisher: John Wiley & Sons India Pvt. Ltd. (2002).
   Genomics Applications in Human Biology by Sandy B. Primrose and Richard M. Twyman. Publisher: Blackwell Science Ltd. (2004).
   Introduction to Computational Genomics: A Case Studies Approach by Nello Cristianini, Matthew W. Hahn. Publisher: Cambridge University Press India Pvt. Ltd. (2007).

Open Elective - II

BT 413 : Open Elective - II

Bioprocess Plant Design	L T P	Credits
	3 1 0	4

Unit I
Introduction general design information; Mass and energy balance; Flow sheeting.

Unit II
Materials of construction for bioprocess plants; Mechanical design of process equipment; Vessels for biotechnology application.

Unit III
Design of fermenters; Design considerations for maintaining sterility of processing equipment; Piping and instrumentation; Design engineering calculations; Penicillin case study.

Unit IV
Selection and specification of equipment for handling fluids and solids; Selection, specification, design of heat and mass transfer equipment used in bioprocess industries; Design of facilities for cleaning of process equipment used in biochemical industries; Utilities for biotechnology.

Unit V
Production plants; Process economics; Bioprocess validation; Safety considerations.

Unit VI
Case studies.

Text books:
1. Applied Process Design for Chemical and Petrochemical Plants by E.E. Ludwig. Publisher: Butterworth-Heinemann (2001).
2. Chemical Engineering by R.K. Sinnott, J.M. Coulson and J.F. Richardsons. Publisher: Butterworth-Heinemann 3rd edition (1999).

Reference books:
1. Chemical Engineers Handbook by RH. Perry and D.W. Green. Publisher McGraw-Hill 8th edition (2008).
2. Manufacturing Facilities Design and Material Handling by F.B. Meyers and M.P. Stephens. Publisher: Prentice Hall 3rd edition (2004).
3. Plant Design and Economics for Chemical Engineers by M. Peters and K. Timmerhaus. Publisher: McGraw-Hill (2002).
4. Process Plant Layout and Piping Design by E. Bausbacher and R. Hunt. Publisher: Prentice Hall PTR (1993).
5. Process Biotechnology Fundamentals by S.N. Mukhopadhyay. Publisher: Viva Books (2010).

Intellectual Property Rights	L T P	Credits
	3 1 0	4

Unit I
General Overview of Intellectual Property Rights: History and evolution of IPR like patent, design and copyright, WIPO, WTO, Trade related Intellectual Property Right International background of intellectual property.

Unit II
Patents: Basic requirements of patentability, Patentable subject matter, Legal requirements and administrative steps for getting a patent for a biotechnological invention, databases & search of technical and patent information, Drafting of Patents; Patenting Biotechnology Inventions - Objective, Concept of novelty, Concept of inventive step, Microorganisms, Moral issues in patenting biotechnological inventions; Plant Varieties Protection - Objectives, Justification, International position, Plant varieties protection in India.

Unit III
Copyright: Objectives of copyright, Understanding Copyright Law, Rights conferred by registration of copyright, Infringement of copyright.

Unit IV
Trademark: Basic principle of Trademark, Rights conferred by registration of Trademark, Infringement of Trademark.

Unit V
Geographical Indications: Objectives of Geographical Indications, Right conferred, Infringement of Geographical Indications, International position, Bioprospecting and Biopiracy.

Unit VI
Biotechnology and the Law: Objective, Evolution, Basic Structure of Gene Techniques, Applications, Commercial Potential of Biotech Inventions, Rationale for Intellectual Property Protection.

Text books:
1. Intellectual Property Rights & Copyright by S.V. Satarkar. Publisher: Ess Ess Publications (2002).
2. The Role of Intellectual Property Rights in Biotechnology Innovation Edited by D. Castle (2009).

Reference books:
1. WTO-Trade-related Aspects of Intellectual Property Rights Edited by P.T. Stoll, J. Busche, K. Arend (2009).
2. Intellectual Property Rights in Agricultural Biotechnology by F.H. Erbisch and K.M. Maredia (2000).
3. Intellectual Property Rights- A Primer by R.A. Rao & B. Rao. Publisher: Eastern Book Co. (2008).
4. Intellectual Property Rights in the Global Economy by K.E. Maskus (2000).
5. Intellectual Property Rights under WTO by T. Ramappa. Publisher: H Wheeler Publishing Co Ltd. (2002).

Computer-aided Drug Design	L T P	Credits
	3 1 0	4

Unit I
Introduction: Introduction to CADD, SBDD, Representation of Molecular Structures, Chemical Nomenclature and Structure Representation, Processing Constitutional Information, Representation of 3D Structures, Molecular Shape Analysis, Representation of Chemical Reactions.

Unit II
Lead Discovery: High Throughput Screening, Hit and Lead Discovery, Enhancing Hit Quality and Diversity within Assay Throughput Constraints, Molecular Graphics, Molecular Dynamics and Simulation of Lead, Molecular Diversity in Lead Discovery: From Quantity to Quality, In Silico Lead Optimization.

Unit III

Databases and Libraries: Databases and Libraries, PubChem, PubEchm-BioAssay, Pharma Project, Drug Bank, WOMBAT: World of Molecular Bioactivity, Cabinet - Chemical and Biological Informatics Network, Structure Modification in Chemical Databases, Rational Design of GPCR-specific Combinational Libraries Based on the Concept of Privileged, Substructures.

Unit IV

Molecular Docking & Simulation: de novo pharmacophore elucidation/ drug design for structurally well-defined receptor targets like HIV protease inhibition, ER antagonism, H2 receptor antagonism, Chirase inhibition (quinoline derivative antibiotics) and ACE inhibition, macromolecule-ligand docking, docking algorithms, AUTODOCK, Molecular dynamic simulations, relative energy, energy minimization methods, ligand binding free energy calculations (both simulation and empirical methods), intermolecular interactions, forces related to drug binding, force-field calculation including solvation, role of solubility in drug binding and pKa, Poisson- Boltzmann Surface Area (PBSA), AMBER, GROMOS and GROMACS.

Unit V

CADD Applications: CADD Applications, A Practical Strategy for Directed Compound Acquisition, Efficient Strategies for Lead Optimization, Chemoinformatics Tools for Library Design, Hit-to-Lead Process: A User's Perspective, Application of Predictive 3DQSAR Models to, Database Mining, Drug Discovery - Case Study.

Text books:

1. Computer Applications in Pharmaceutical Research and Development by Wang, Binghe, ISBN-10: 0-471-73779-8. Publisher: John Wiley & Sons India Pte. Ltd. (2006)
2. Engineering Chemistry by R.V. Gadag and A. Nityananda Shetty. Publisher: I.K. International Publishing House Pvt. Ltd., 2nd Edition (2010).

Reference books:

1. Virtual Screening in Drug Discovery by Juan Alvarez and Brian Shoichet, ISBN- 13: 978-0824754792. Publisher: CRC Press.
2. Biological Thermodynamics by Donald T. Haynie, ISBN:9780521704045, Publisher: Cambridge University Press India Private Limited.
3. Chemoinformatics in Drug Discovery by Tudor I. Oprea, Raimund Mannhold, Hugo.
4. Kubinyi, Gerd Folkers, ISBN: 978-3-527-30753-1. Publisher: John Wiley & Sons India Pvt. Ltd.

Environmental Biotechnology	L T P	Credits
	3 1 0	4

Unit I

Environmental Pollution: Types of pollution, methods for the measurement of pollution; Methodology of environmental management the problem solving approach, its limitations.

Unit II

Air Pollution and its Control through Biotechnology: Active trace gases in air, reactive odd nitrogen, carbon, sulfur and Halogen compounds in air, aerosols in air, direct and indirect effect on radioactive forcing, Biofilteration

Unit III

Water Pollution and its Control: Water resource management, waste water collection, Measurement of water pollution, sources of water pollution, waste water treatment - physical, chemical and biological treatment processes. Activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Ananerobic processes of biological treatment- Anaerobic digestion, anaerobic filters. Upflow anaerobic sludge blanket reactors; Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries

Unit IV

Microbiology of Degradation of Xenobiotics in Environment: Ecological considerations, decay behavior and degradative plasmids: Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.

Unit V

Solid Wastes: Treatment and Management: Sources of solid waste and management (composting, Vermiculture and methane production) Bioremediation of contaminated soils and waste land, Biopesticides in integrated pest management.

Unit VI

Global Environmental Problems: Ozone depletion, greenhouse effect and acid rain, their impact and biotechnological approaches for management.

Text books:

1. Comprehensive Biotechnology by M. Moo- Young. 4-volume set Publisher: Pergarmon Press (1985)
2. Environmental Chemistry AK. De. Publisher: New Age Publications (Academic) India (2006)

Reference books:

1. Introduction to Biodeterioration by D. Allsopp and K.J. Seal. Publisher ELBS/Edward Arnold.(1986)
2. Waste Water Engineering - Treatment and Reuse by Metcalf, Eddy and G. Tchobanoglous. Publisher: Tata McGraw Hill (2002)
3. Microbiology by Bernard D. Davis, Renato Dulbecco, Herman N. Eisen and Harold S. Ginsberg. Publisher: Lippincott Williams & Wilkins (1990)
4. Biochemical Engineering Fundamentals by J.E. Baily and D.F. Ollis. Publisher: McGraw Hill. (1986).
5. Process Biotechnology Fundamentals by S.N. Mukhopadhyay. Publisher: Viva Books (2010).