Biotechnology

B.TECH. PROGRAMME

With effect from June, 2014

.

B.Tech. Biotechnology Curriculum

1st Year 1st Semester Syllabus:

Theory							
Sl. No	Course Code	Course Name	Contact Hrs per Week				Credit Points
			L	T	P	Total	
1	HMTS1101	Business English	2	0	0	2	2
2	PHYS1001	Physics I	3	1	0	4	4
3	MATH1101	Mathematics I	3	1	0	4	4
4	ECEN1001	Basic Electronics Engineering	3	1	0	4	4
5	MECH1101	Engineering Mechanics	3	1	0	4	4
		Total Theory	**14**	**4**	**0**	**18**	**18**

Laboratory							
Sl. No	Course Code	Course Name	Contact Hrs per Week				Credit Points
			L	T	P	Total	
1	PHYS1011	Physics I Lab	0	0	3	3	2
2	ELEN1011	Basic Electronics Engineering Lab	0	0	3	3	2
3	MECH1011	Workshop Practice	1	0	3	4	3
4	HMTS1111	Language Practice Lab (Level 1)	0	0	2	2	1
		Total Laboratory	**1**	**0**	**11**	**12**	**8**

Sessional							
Sl. No	Course Code	Course Name	Contact Hrs per Week				Credit Points
			L	T	P	Total	
1	HMTS1121	Extra curricular activities	0	0	2	2	1
		Total Sessional	**0**	**0**	**2**	**2**	**1**
		Total of Semester	**15**	**4**	**13**	**32**	**27**

1st Year 2nd Semester Syllabus:

Theory							
Sl. No	**Course Code**	**Course Name**	**Contact Hrs per Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	CSEN1201	Introduction to Computing	3	1	0	4	4
2	CHEM1001	Chemistry I	3	1	0	4	4
3	MATH1201	Mathematics II	3	1	0	4	4
4	ELEC1001	Basic Electrical Engineering	3	1	0	4	4
5	MECH1201	Engineering Thermodynamics and Fluid Mechanics	3	1	0	4	4
		Total Theory	**15**	**5**	**0**	**20**	**20**

Laboratory / Practical							
Sl. No	**Course Code**	**Course Name**	**Contact Hrs per Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	CSEN1211	Introduction to Computing Lab	0	0	3	3	2
2	CHEM1011	Chemistry I Lab.	0	0	3	3	2
3	ELEC1011	Basic Electrical Engineering Lab	0	0	3	3	2
4	MECH1012	Engineering Drawing	1	0	3	4	3
		Total Laboratory	**1**	**0**	**12**	**13**	**9**
		Total of Semester	**16**	**5**	**12**	**33**	**29**

2nd Year 1st Semester:

A. THEORY								
Sl No	**Code**	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
				L	**T**	**P**	**Total**	
1	**HMTS2002**	Humanities	Indian Culture and Heritage	2	0	0	2	1
2	**BIOT2101**	Basic Science	Chemistry of Biomolecules	3	1	0	4	4
3	**CHEM2001**	Basic Science	Basic Environmental Engineering & Ecology	3	0	0	3	3
4	**BIOT2102**	Prof. Core	Industrial Stoichiometry	3	1	0	4	4
5	**BIOT2103**	Prof. core	Biochemistry	3	1	0	4	4
6	**BIOT2104**	Prof. core	Microbiology	3	1	0	4	4
			Total of Theory				**21**	**20**
B. PRACTICAL/ LABORATORY								
7	**BIOT2111**	Basic Science	Biomolecular Chemistry Lab	0	0	3	3	2
9	**BIOT2112**	Prof. core	Biochemistry Lab	0	0	5	3	2
10	**BIOT2113**	Prof. core	Microbiology Lab	0	0	5	5	3
			Total of Practical				**11**	**7**
			Total of Semester				**32**	**27**

2nd Year 2nd Semester:

A. THEORY								
Sl No	**Code**	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
				L	**T**	**P**	**Total**	
1	**HMTS2001**	Humanities	Human Values and Professional Ethics	2	0	0	2	2
2	**MATH2002**	Basic Science	Numerical & Statistical Methods	3	0	0	3	3
3	**BIOT2201**	Basic Science	Thermodynamics & Kinetics	3	1	0	4	4
4	**BIOT2202**	Prof. Core	Transfer Operation-I	3	0	0	3	3
5	**BIOT2203**	Prof. core	Molecular Biology	3	1	0	4	4
6	**BIOT2204**	Prof. core	Industrial Microbiology & Enzyme Technology	3	1	0	4	4
			Total of Theory				**20**	**20**
B. PRACTICAL/ LABORATORY								
7	**HMTS2011**	Humanities	Language Practice Lab (Level 2)	0	0	3	3	2
8	**MATH2012**	Basic Science	Numerical & Statistical Methods Lab	0	0	2	2	1
9	**BIOT2211**	Prof. Core	Transfer Operation-I Lab	0	0	3	3	2
10	**BIOT2212**	Prof. core	Molecular Biology Lab	0	0	3	3	2
11	**BIOT2214**	Prof. core	Enzyme Technology & Fermentation Technology Lab	0	0	3	3	2
			Total of Practical				**14**	**9**
			Total of Semester				**34**	**29**

3rd Year 1st Semester:

A. THEORY								
Sl No	**Code**	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
				L	**T**	**P**	**Total**	
1	**HMTS3101**	Humanities	Economics for Engineers	3	0	0	3	3
2	**BIOT3101**	Prof. core	Genetics	3	0	0	3	3
3	**BIOT3102**	Prof. core	Bioinformatics	3	0	0	3	3
4	**BIOT3103**	Prof. core	Recombinant DNA Technology	3	0	0	3	3
5	**BIOT3104**	Prof. core	Transfer Operation-II	3	0	0	3	3
6	**CSEN3106**	Engineering Science	Data Structure & Algorithm	3	0	0	3	3
			Total of Theory				**18**	**18**
B. PRACTICAL/ PRACTICAL								
7	**BIOT3111**	Prof. core	Genetics lab	**0**	**0**	**3**	3	2
8	**BIOT3112**	Prof. core	Bioinformatics lab	**0**	**0**	**3**	3	2
9	**BIOT3113**	Prof. core	Recombinant DNA Technology lab	**0**	**0**	**3**	3	2
10	**BIOT3114**	Prof. core	Transfer Operation-II lab	**0**	**0**	**3**	3	2
11	**CSEN3116**	Engineering Science	Data Structure & Algorithm lab	**0**	**0**	**3**	3	2
			Total of Practical				**15**	**10**
			Total of Semester				**33**	**28**

3rd Year 2nd Semester:

A. THEORY								
Sl No	**Code**	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
				L	**T**	**P**	**Total**	
1	**HMTS3201**	Humanities	Principles of Management	3	0	0	3	2
2	**BIOT3201**	Prof. core	Immunology	3	0	0	3	3
3	**BIOT3202**	Prof. core	Plant Biotechnology	3	0	0	3	3
4	**BIOT3203**	Prof. core	Bioreactor Design and Analysis	3	0	0	3	3
5	**CSEN3205**	Engineering Science	Data Base Management System and Computer Networking	3	0	0	3	3
6	**BIOT3241**	Prof. elective-I	Molecular Modeling & Drug Designing	3	0	0	3	3
	BIOT3242		Biophysics of Macromolecules					
	BIOT3243		Biosensors and Diagnostics					
	BIOT3244		Biofertilizers and Biopesticides					
			Total of Theory				**18**	**17**
B. PRACTICAL/ LABORATORY								
7	**BIOT3211**	Prof. core	Immunology lab	0	0	3	3	2
8	**BIOT3212**	Prof. core	Plant Tissue Culture lab	0	0	3	3	2
9	**BIOT3213**	Prof. core	Bioreactor Design lab	0	0	3	3	2
10	**CSEN3215**	Engineering Science	Data Base Management System and Computer Networking lab	0	0	3	3	2
			Total of Practical				**12**	**8**
B. SESSIONAL								
11	**HMTS3221**	Sessional	Personality Development	0	0	2	2	1
12	**BIOT3222**	Sessional	Seminar-I	0	0	3	3	2
			Total of Sessional				**5**	**3**
			Total of Semester				**35**	**28**

4th Year 1st Semester:

A. THEORY								
Sl No	**Code**	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
				L	**T**	**P**	**Total**	
1	**BIOT4101**	Prof. core	Animal Cell Culture & Animal Biotechnology	3	0	0	3	3
2	**BIOT4102**	Prof. core	Bioseparation Technology	3	1	0	4	4
3	**BIOT4141**	Prof. elective-II	Food Biotechnology	3	0	0	3	3
	BIOT4142		Environmental Biotechnology					
	BIOT4143		Bioprocess & Process Instrumentation					
4	**BIOT4161**	Prof. elective-III	Modeling & Simulation of Bioprocess	3	0	0	3	3
	BIOT4162		Biomaterials					
	BIOT4163		Biometallurgy					
	BIOT4164		Proteomics and Protein Engineering					
	BIOT4165		Human Genomics					
5	**BIOT4181**	Free elective-I *	Biosensors	3	0	0	3	3
	BIOT4182		Biopolymers					
			Total of Theory				**16**	**16**
B. PRACTICAL/ LABORATORY								
6	**BIOT4151**	Prof. elective-II	Food Biotechnology Lab	0	0	0	3	2
	BIOT4152		Environmental Biotechnology lab					
	BIOT4153		Bioprocess & Process Instrumentation lab					
			Total of Practical				**3**	**2**
B. SESSIONAL								
7	**HMTS4121**	Humanities	Professional Development	0	0	3	3	2
8	**BIOT4134**	Sessional	Seminar-II	0	0	3	3	2
9	**BIOT4131**	Sessional	Industrial Training Evaluation	4 to 6 weeks				2
10	**BIOT4191**	Sessional	Project-I	0	0	8	8	4
			Total of Sessional				**14**	**10**
			Total of Semester				**33**	**28**

Training in a suitable industry, R&D Organization, Reputed Laboratory or Research Institute for 4 to 6 weeks to be arranged during summer vacation.

*** Open Elective papers offered by the Department of Biotechnology for other departments**

4th Year 2nd Semester:

A. THEORY								
Sl No	**Code**	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
				L	**T**	**P**	**Total**	
1	**HMTS4203**	Humanities	Bioethics & IPR	3	0	0	3	2
2	**BIOT4241**	Prof. elective-IV	Renewable Energy Technology	3	1	0	4	4
	BIOT4242		Tissue Engineering					
	BIOT4243		Biomedical Engineering					
	BIOT4244		Post Harvest Technology					
	BIOT4245		Metabolic Engineering					
	BIOT4246		Medical & Pharmaceutical Biotechnology					
	BIOT4247		Basic Process Equipment Design					
3	**BIOT4281**	Free elective-II*	Computational Biology	3	0	0	3	3
	BIOT4282		Non-conventional Energy					
			Total of Theory				**10**	**9**
B. SESSIONAL								
4	**BIOT4231**	Sessional	Comprehensive Viva Voce					3
5	**BIOT4291**	Sessional	Project-II	0	0	16	16	8
			Total of Sessional				**16**	**11**
			Total of Semester				**26**	**20**

*** Open Elective papers offered by the Department of Biotechnology for other departments**

List of Free Electives:

Free Elective 1		**Free Elective 2**	
Paper Code	**Title of the Paper**	**Paper Code**	**Title of the Paper**
CHEN4181	Industrial Safety and Hazard Analysis	**CHEN4281**	Catalytic Reactor Design
CHEN4182	Project Engineering	**CHEN4282**	Total Quality Management & Assurance
MATH4181	Operations Research and Optimization Techniques	**CIVL4281**	Remote Sensing and GIS
INFO4181	Cyber Law & Security Policy	**HMTS4281**	Introduction to Industrial Sociology
CIVL4183	Environmental Pollution & Control	**HMTS4282**	Critical Gender Studies
		HMTS4283	Elementary Spanish for Beginners

Credit Summary of B.Tech. Biotechnology programme

Course Component	**Total number of credits**
Basic Sciences	38
Engineering Sciences	45
Humanities and Social Sciences	18
Program Core	76
Program Electives	15
Open Electives	6
Project(s)	12
Internships/ Seminars	6
Any other (Please specify)	-
Total number of credits	216

Course Name : Business English					
Course Code: HMTS1101					
Contact hrs per week:	L	T	P	Total	Credit points
	2	0	0	2	2

Course Outcomes:

After completion of this course, the students will be able to:

1. Analyse the dynamics of business communication and communicate accordingly.
2. Write business letters and reports.
3. Learn to articulate opinions and views with clarity.
4. Appreciate the use of language to create beautiful expressions.
5. Analyse and appreciate literature.
6. Communicate in an official and formal environment.

Module I – [5L]

Communication Skill
Definition, nature & attributes of Communication
Process of Communication
Models or Theories of Communication
Types of Communication
Levels or Channels of Communication
Barriers to Communication

Module II-[12L]

Business Communication- Scope & Importance
Writing Formal Business Letters
Writing Reports
Organizational Communication: Agenda & minutes of a meeting, notice, memo, circular
Project Proposal Technical
Report Writing
Organizing e-mail messages E-
mail etiquette
Tips for e-mail effectiveness

Module III-[10L]

Language through Literature
Modes of literary & non-literary expression
Introduction to Fiction, (An Astrologer's Day by R.K. Narayan and Monkey's Paw by W.W. Jacobs), Drama (The Two Executioners by Fernando Arrabal) or (Lithuania by Rupert Brooke) & Poetry (Night of the Scorpion by Nissim Ezekiel and Palanquin Bearers by Sarojini Naidu)

Module IV-[3L]

Grammar in usage (nouns, verbs, adjectives, adverbs, tense, prepositions, voice change) -to be dealt with the help of the given texts.

References:

1. Armand Matterlart and Michele Matterlart, Theories of Communication: A Short Introduction, Sage Publications Ltd., 1998.
2. Chan, Janis Fisher, and Diane Lutovich. Professional Writing Skills. San Anselmo, CA:Advanced Communication Designs, 1997.
3. Geffner, Andrew P. Business English. Hauppauge, New York: Barron's Educational Series, 1998.
4. Good, Edward C. Mightier Than the Sword. Charlottesville: Word Stone Publications, 1989.
5. Edward P.Bailey, Writing and Speaking at Work: A Practical Guide for Business Communication, Prentice-Hall, 7th edn, 2004.
6. Kitty O. Locker, Business and Administrative Communication, McGraw-Hill/ Irwin, 7th edn, 2004.
7. Lillian Chaney and Jeanette Martin, Intercultural Business Communication, Prentice Hall, 4th edn, 2005.
8. Yudkin, Marcia. Persuading on Course Name. Lansing, IL: Infinity Publishing, 2001.

Course Name : Physics-I					
Course Code: PHYS1001					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Course Outcome

1. Interpret oscillations under different conditions, with the understanding of Resonance phenomena followed by calculation of Q factor.
2. Analyze the Quantum phenomenon like Black body radiation , Compton effect and origin of X-ray spectrum.
3. Understand the wave character of light through the phenomenon of interference, diffraction and polarization.
4. Study of various crystal structures and classification of different crystal planes.
5. Explain the working principle of LASER, and apply the knowledge in different lasing system and their engineering applications in holography.
6. Understand the dual nature of matter, Heisenberg's uncertainty relation and it's various application.

Module I: [22 L]

Optics

1.Interference :
The principle of superposition of waves, Superposition of waves: Two beam superposition, Multiple-beam superposition, coherent and incoherent superposition.
Two source interference pattern (Young's double slit), Intensity distribution. Interference in thin films, wedge shaped films and Newton's rings, applications of interference. Newton's rings: Determination of wavelength of light, refractive index of
liquid.

2 Diffraction:
Diffraction of light waves at some simple obstacles. Fraunhoffer diffraction through double slit and diffraction grating, grating spectra, resolving power of grating.

3. Polarisation & Fibre Optics:
Elementary features of polarization of light waves.Production and analysis of linearly, elliptic and Circularly polarized light, polaroids and application of polarizations. fibre optics - principle of operation, numerical aperture, acceptance angle

4 Laser
Characteristics of Lasers, Spontaneous and Stimulated Emission of Radiation, Meta-stable State, Population Inversion, Lasing Action, Einstein's Coefficients and
Relation between them, Ruby Laser, Helium-Neon Laser, Semiconductor Diode Laser, Applications of Lasers.

Module II : [8L]

Waves & Oscillation
Superposition of two linear SHMs (with same frequency), Lissajou**s' figures. Damped** vibration – differential equation and its solution, Critical damping, Logarithmic decrement, Analogy with electric circuits. Forced vibration – differential equation and solution, Amplitude and Velocity resonance, Sharpness of resonance and Quality factor. Progressive wave- Wave equation and its differential form, Difference between elastic (mechanical) and electromagnetic waves.

Module III : [9L]

Quantum Mechanics
Need for Quantum physics-Historical overviews, Particle aspects of radiation-Black body radiation, Compton scattering, pair production., Origin of X-ray spectrum. Wave aspect of particles- matter wave, de Broglie Hypothesis, Heisenberg Uncertainty principles- Statement, Interpretation and application.

Module IV: [6L]

Introduction of Crystallography
Space Lattice**,** Unit Cell, Lattice Parameters, Crystal Systems, Bravais Lattices, Miller Indices and its applications, Crystal Planes and Directions, Inter Planar Spacing of Orthogonal Crystal Systems, Atomic Radius, Co-ordination Number and
Packing Factor of SC, BCC, FCC. Bragg's law and its applications.

Text Books

1. Atomic Physics Vol 1 – S.N. Ghoshal
2. Optics – Ajoy Ghak
3. Waves & Oscillation – N.K. Bajaj
4. Quantum Physics of Atoms , Molecules, Solids, Nuclei and particles – Eisberg and Resnick

Reference Books

1. Introduction to Special Relativity – Robert Resnick
2. Prespective on Modern Physics - Arthur Beiser
3. Optics – Jenkins and White
4. University Press – Sears & Zemansky
5. Introduction to modern Physics – Mani and Meheta
6. Optics – Brijlal and Subrahmanyam

Course Name : Mathematics-I					
Course Code: MATH1101					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcome:- After completing the course the student will be able to:

MATH1101.1 Apply the concept of rank of matrices to find the solution of a system of linear simultaneous equations.

MATH1101.2 Develop the concept of eigen values and eigen vectors.

MATH1101.3 Use Mean Value Theorems for power series expansions of functions of one variable.

MATH1101.4 Analyze the nature of sequence and infinite series.

MATH1101.5 Describe the concept of differentiation and integration for functions of several variables with their applications in vector calculus.

MATH1101.6 Combine the concepts of gradient, curl, divergence, directional derivatives, line integrals, surface integrals and volume integrals.

Module-I

Matrix

Matrices and their basic attributes, Determinant of a square matrix, Minors and Cofactors, Laplace's method of expansion of a determinant, Product of two determinants, Adjoint of a determinant, Jacobi's theorem on adjoint determinant.

Singular and non-singular matrices, Adjoint of a matrix, Inverse of a non-singular matrix and its properties, Orthogonal matrix and its properties, Special Complex Matrices: Hermitian, Unitary, Normal(definition only), Rank of a matrix and its

determination using elementary row and column operations, Solution of simultaneous linear equations by :Cramer's Rule and Matrix inversion method,

Consistency and inconsistency of a system of homogeneous and inhomogeneous linear simultaneous equations, Characteristic Equation and computation of eigenvalues and eigenvectors of a square matrix (of order 2 or 3), Cayley-Hamilton theorem and its applications(with special reference to higher power of matrices, e.g. Idempotent and Nilpotent matrices)

Module II [10 L]

Mean Value Theorems & Expansion of Functions:

Rolle's theorem: its geometrical interpretation and its application, Concavity and

Convexity of curves, Mean Value theorems – Lagrange & Cauchy and their application,

Taylor's theorem with Lagrange's and Cauchy's form of remainders and its application,

Expansions of functions by Taylor's and Maclaurin's theorem,

Maclaurin's infinite series expansion of the functions:

sinx, cosx, ex , log(1+ x), (a + x) n , n being an integer or a fraction (assuming that the remainder Rn-> 0 as n-> in each case).

Infinite Series:

Preliminary ideas of sequence, Infinite series and their convergence/divergence,

Infinite series of positive terms, Tests for convergence: Comparison test, Cauchy's Root test, D' Alembert's Ratio test(statements and related problems on these tests), Raabe's test, Proof

of e being irrational, Alternating series, Leibnitz's Test (statement, definition) illustrated by simple examples, Absolute convergence and Conditional convergence,

Module III [10 L]

Successive differentiation:

Higher order derivatives of a function of single variable, Leibnitz's theorem (statement only and its application, problems of the type of recurrence relations in derivatives of different orders and also to find $(y_n)_0$) .

Calculus of Functions of Several Variables:

Recapitulation of some basic ideas of limit and continuity of functions of single variable, Introduction to functions of several variables with examples, Knowledge of limit and continuity, Determination of partial derivatives of higher orders with examples, Homogeneous functions and Euler's theorem and related problems up to three variables, Chain rules, Differentiation of implicit functions, Total differentials and their related problems, Jacobians up to three variables and related problems, Maxima, minima and saddle points of functions and related problems.

Module-IV [10 L]

Multiple Integration and Vector Calculus:

Concept of line integrals, Double and triple integrals. Vector function of a scalar variable, Differentiation of a vector function, Scalar and vector point functions, Gradient of a scalar point function, divergence and curl of a vector point function, Directional derivative, Related problems on these topics, Green's theorem, Gauss Divergence Theorem and Stoke's theorem (Statements and applications).

Reduction formula:

Reduction formulae both for indefinite and definite integrals of types:
$\int \sin^n x, \int \cos^n x, \int \sin^m x \cos^n x, \int \cos^m x \sin nx, \int \frac{dx}{(x^2+a^2)^n}, m, n$ are positive integers.

References

1. Advanced Engineering Mathematics: Erwin Kreyszig by Wiley India
2. Engineering Mathematics: B.S. Grewal (S. Chand & Co.)
3. Higher Engineering Mathematics: John Bird (Elsevier)
4. Advanced Engineering Mathematics: Wiley and Barrett (Tata McGraw-Hill)
5. Calculus: M. J. Strauss, G. L. Bradley and K. L. Smith (Pearson Education)
6. Engineering Mathematics: S. S. Sastry (PHI)
7. Advanced Engineering Mathematics: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP),Indian Edition.
8. Linear Algebra(Schaum's outline series): Seymour Lipschutz, Marc Lipson (McGraw Hill Education)
9. Vector Analysis(Schaum's outline series): M.R. Spiegel, Seymour Lipschutz, Dennis Spellman (McGraw Hill Education)
10. Introduction to Real Analysis: S.K.Mapa (Sarat Book Distributors)

Course Name : Basic Electronics Engineering					
Course Code: ECEN1001					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcome:

1. Categorize different semiconductor materials based on their energy bands and analyze the characteristics of those materials for different doping concentrations based on previous knowledge on semiconductors acquired.
2. Describe energy band of P-N Junction devices and solve problems related to P-N Junction Diode both from device and circuit perspectives.
3. Design different application specific circuits associated with diodes operating both in forward and reverse bias.
4. Analyze various biasing configurations of Bipolar Junction Transistor and categorize different biasing circuits based on stability.
5. Categorize different field-effect transistors based on their constructions, physics and working principles and solve problems associated with analog circuits based on operational amplifiers.
6. Design and implement various practical purpose electronic circuits and systems meant for both special purpose and general purpose and anlayze their performance depending on the type of required output and subsequently the applied input.

Module I : 10 L

Semiconductors:

Crystalline material, Energy band theory, Fermi levels; Conductors, Semiconductors and Insulators: electrical properties, band diagrams. Semiconductors: intrinsic and extrinsic, energy band diagram, electrical conduction phenomenon, P-type and N-type semiconductors, drift and diffusion carriers.

Diodes and Diode Circuits:

Formation of P-N junction, energy band diagram, built-in-potential forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics, Zener Diode and its Application, Zener and Avalanche breakdown.

Simple diode circuits, load line, piecewise linear model; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.

Module II [10 L]

Bipolar Junction Transistors:

Formation of PNP / NPN junctions, energy band diagram; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off, active and saturation modes of operation, transistor action, input & output characteristics, load line & amplifier operation and current amplification factors for CB and CE modes. Biasing and Bias stability: calculation of stability factor.

Module III [9 L]

Field Effect Transistors:

Junction field effect transistor (JEET): Principle of operation, JFET parameters, eqv. Circuit, JFET biasing, self bias, design of bias circuits, load line, amplifier characteristics.

MOSFETs:

Construction & principle of operation of p- & n-channel enhancement & depletion mode MOSFETs, drain & transfer characteristics, threshold voltage & its control.

Cathode Ray Osilloscope:

Construction and working principle of CRO, Lissajous pattern.

Module IV [9 L]

Feed Back Amplifier:

Concept-block diagram, properties, positive and negative feedback, loop gain, open loop gain, feedback factors; topologies of feedback amplifier; effect of feedback on gain, condition of oscillation, Barkhausen criteria.

Operational Amplifier:

Introduction to integrated circuits, operational amplifier and its terminal properties; Application of operational amplifier; Concept of op-amp saturation, inverting and non-inverting mode of operation, Adders, Subtractors, Voltage follower, Integrator, Differentiator, Basic Comparator Circuit.

References:

1. Boylestad & Nashelsky:Electronic Devices & Circuit Theory
2. R.A Gayakwad:Op Amps and Linear IC's, PHI
3. D. Chattopadhyay, P. C Rakshit : Electronics Fundamentals and Applications
4. Adel S. Sedra, Kenneth Carless Smith: Microelectronics Engineering
5. Millman & Halkias: Integrated Electronics.
6. Salivahanan: Electronics Devices & Circuits.
7. Albert Paul Malvino: Electronic Principle.

Course Name : Engineering Mechanics					
Course Code: MECH1101					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcome:

1. Understand basic concepts of vector algebra as applied to engineering mechanics.
2. Analyze free body diagram of a system under equilibrium / non equilibrium along with the consideration of frictional forces.
3. Interpret dynamics of members/ links in a mechanism and evaluate inertia force with the help of D' Alembert's principle.
4. Know how to evaluate mechanical stability from CG calculations.
5. Apply MI values required for engineering design calculations.
6. Apply the principles of work - energy and impulse- momentum for analysis of dynamic systems.

Module-I [10L]

Importance of Mechanics in Engineering; Definition of Mechanics; Concepts of particles & rigid bodies;
Vector and scalar quantities; Vector algebra –definition and notation; Types of vectors – equal, equivalent, free, bound, sliding; Addition, subtraction of vectors; Parallelogram law, triangle law , vector polygon; Scalar multiplication of vectors; Resolution of vectors in Cartesian co–ordinate system; Unit vector, unit co–ordinate vectors ($\hat{i}$, $\hat{j}$, $\hat{k}$); Direction cosines; Addition/ subtraction of vectors in components form.
Definition of force vector; Dot product, cross product and the application; Important vector quantities (position vector, displacement vector); Moment of a force about a point and about an axis, moment of a couple;
Representation of force and moments in items of $\hat{i}$, $\hat{j}$, $\hat{k}$. Principle of transmissibility of force (sliding vector); Varignon's theorem for a system of concurrent forces with proof; Resolution of a force by its equivalent force-couple system; Resultant of forces.

Module-II [10L]

Type of forces – collinear, concurrent, parallel, concentrated, distributed; Active and reactive forces, different types of reaction forces; Free body concept and diagram; Concept and equilibrium of forces in two dimensions; Equations of equilibrium; Equilibrium of three concurrent forces -- Lami's theorem.

Concept of friction: Laws of Coulomb's friction; Angle of friction, angle of repose, coefficient of friction -- static and kinematic.

Module-III [12L]

Distributed force system; Centre of gravity; Centre of mass & centroid; Centroid of an arc; Centroid of plane areas – triangle, circular sector, quadrilateral and composite area consisting of above figures.

Area moment of inertia: Moment of inertia of a plane figure; Polar moment of inertia of a plane figure; Parallel axes theorem.
Concept of simple stress and strain ; Normal stress , shear stress , normal strain, shear strain; H**ooke's law; P**oisson's ratio; stress- strain diagram of ductile and brittle material; Proportional limit, elastic limit, yield point , ultimate stress, breaking point; Modulus of elasticity.

Module-IV [16L]
Introduction to dynamics: Kinematics & kinetics; N**ewton's laws of motion;** Law of gravitation and acceleration due to gravity; Rectilinear motion of particles with uniform & non – uniform acceleration.
Plane curvilinear motion of particles: Rectangular components (projectile motion), normal and tangential components.
Kinetics of particles: D'Alembert's principle and free body diagram; Principle of work & energy; Principle of conservation of energy.
Impulse momentum theory: Conservation of linear momentum

References:

1. Engineering Mechanics: Statics and Dynamics by Meriam & Kreige, Wiley India
2. Engineering Mechanics:- Statics and Dynamics by I.H. Shames, PHI.
3. Engineering Mechanics by Timoshenko , Young and Rao, TMH.
4. Element of strength of materials by Timoshenko & Young, EWP.
5. Fundamentals of Engineering Mechanics by Nag & Chanda – Chhaya Prakashani.

Course Name : Physics Lab					
Course Code: PHYS1011					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	3	2	2

Experiments:

1. Determination of Young's modulus by Flexure Method and calculation of bending moment and shear force at a point on the beam.
2. Determination of modulus of rigidity by Static/Dynamic Method.
3. Determination of thermal conductivity of a good conductor by Searle's Method.
4. Determination of thermal conductivity of a bad conductor by Lee's and Chorlton's Method.
5. Determination of dielectric constant of a given dielectric material.
6. Use of Carey Foster's bridge to determine unknown resistance.
7. Determination of wavelength of light by Newton's ring method.
8. Determination of wavelength of light by Fresnel's biprism method.
9. Determination of wavelength of light by Laser diffraction method.
10. Determination of dispersive power of the material of a given prism.
11. Determination of co-efficient of viscosity of a liquid by Poiseulle's capillary flow method.

Course Name : Basic Electronics Engineering Lab					
Course Code: ELEN1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

List of Experiments

1. Familiarisation with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multimeters etc.
2. Familiarisation with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs in CB mode
7. Study of I-V characteristics of BJTs in CE mode
8. Study of I-V characteristics of Field Effect Transistors.
9. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
10. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
11. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators.

Course Name : Workshop Practice					
Course Code: MECH1011					
Contact hrs per week:	L	T	P	Total	Credit points
	1	0	3	4	3

Job 1: General awareness of a typical workshop.

Theory requirements: Workshop definition, various shops in a typical workshop, Carpentry, Fitting, Foundry; Sheet Metal Shop, Welding and Brazing Shop, Machine Shop , Forging & Blacksmithy, Safety precautions to be followed in a workshop, Familiarization of Various safety devices and their uses.

Job 2: Making of a wooden pattern.

Theory requirements: Market forms of converted Timber ,eg, log, balk, plank,batten, beam ,Types of Wood, Hard Wood, Soft Wood, particle board; Seasoning of wood, Natural seasoning, Artificial seasoning, Carpentry Tools-Marking Tools, Cutting Tools, Planing Tools, Boring Tools, Striking Tools , Holding & Misc. Tools, Carpentry Processes (marking, sawing, planning, chiselling, boring, grooving, joining etc.), Safety precautions in Carpentry Shop.

Job 3: Making of a matched profile form MS plate.

Theory requirements: Work Bench, Fitting Tools (Bench Vice,Chisel,Hammer,Different types of Files, (Rough,Bastard, Second Cut, Half Round, Triangular File),Saw(Hack saw etc.), Scriber, Punch, Try Square, Angle Plate, caliper (outside & inside), Universal Surface Gauge, Centre Punch, Prick Punch, Drill (Flat,straight fluted, taper shank twist drill).

Fitting Operations,Filing, Marking, Drilling, Tapping (Rougher,Intermediate, Finisher taps), Tap Drill size (D=T-2d), Sawing, Dieing . Safety precautions in Fitting Shop.

Job 4: Making of an internal and external thread.

Theory requirements : Thread standards and thread classifications, Internal Thread,External Thread, Thread Nomenclature (Major dia, Minor dia, Pitch dia, pitch, Lead, TPI, Metric, BSP , Nominal size), Specifications of threaded fasteners (in Metric System). Safety precautions in Dieing and Tapping.

Job 5: Making of a green sand mould using the pattern made under Job no. 2.

Theory requirements: Mould making, Preparation of sand, (silica, clay, moisture, and misc items and their functions), Properties of a good sand mould, General procedure for making a good sand mould, Different tools used for preparation of a mould, Explanation of various terms , Cope and Drag Box, Runner, Riser, Gating and its utility, Parting sand, Vent holes.

Job 6: Demonstration of metal melting and casting

Theory requirements: Metal melting furnaces: Ladles, Using of Tongs, Molten metal pouring procedure, Safety precautions in pouring molten metal in a mould.

Job 7. Making of a stepped pin in a centre lathe. (2 Classes)

Theory requirements: Machining and common machining operations , Lathe M/c and its specifications, Head stock, Tailstock, Chuck-Self centering chuck , 4 jaw chuck, Bed, Carriage, Feed mechanism, Screw cutting mechanism, various lathe operations like turning, facing, grooving, chamfering, taper turning ,Thread cutting, Knurling, Parting, Cutting speed, Feed, Depth of cut , Different types of cutting tools-Safety precautions in a machine shop.

Job 8: Making of square prism from a round shaft by Shaping Machine

Theory requirements: Description of a Shaping machine, Base , Column, Saddle, Clapper box, Quick return mechanism, Feed Mechanism, Table, Rotation of table, Adjustment of stroke length, Adjustment of starting point of cut. Safety Precautions while working in Shaping Machine.

Job 9: Making of square prism from a round shaft by Milling Machine

Theory requirements: Description of a milling machine, Specification of a Milling machine, Types of Milling-Up Milling, Down Milling, Vertical Milling Machine, Horizontal Milling Machine , Safety precautions while working in Milling Machine.

Job 10 : Arc Welding practice and making of a welded joint

Theory requirements: Welding, Weldability, Types of Welding, MMAW, Gas Welding, Electrode , Functions of Flux, Equipment for MMAW, Different types of Flames in Gas Welding and Gas Cutting (Neutral-Oxidising-Reducing Flames), Different types of welding joints, AC Welding , DC Welding; Safety precautions in Welding Shop.

Job 11 : Sheet Metal forming & Brazing

Theory requirement: Specification of sheet metal, SWG vs. mm, HR sheet, CR sheet, GI Sheet, Stainless Steel Sheet, Aluminum sheets, Tin Plates, Sheet metal working Tools, Micrometer, Chisels, Punches, Hammers, Mallets, Hand Shear or Snippets, Various sheet metal forming operations, Shearing, Marking, Punching, Drilling, Bending, Drawing, Brazing, Safety precautions in Sheet Metal Working Shop.

References:

1. Elements of Workshop Technology (Vol- I and II)- Hajra Choudhury, Media Promoter &Publishers Privet Limited.

2. Workshop Technology (Vol- I and II) – Chapman , Viva Books Privet Limited.

Course Name : Language Practice Lab (Level-1)					
Course Code: HMTS1111					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

Module I [3P]

Introduction to Linguistics (Phonology)

Phonetics-Vowel and Consonant Sounds (Identification &articulation)
Word- stress
Intonation (Falling and rising tone)
Voice Modulation
Accent training

Module II [3P]

Listening Skills

Principles of Listening
Approaches to listening
Guidelines for Effective Listening
Listening Comprehension
Audio Visual (Reviews)

Module III [2P]

Discourse Analysis-

Spoken Discourse
Conversational Skills/Spoken Skills
Analysing Speech dynamics (Political
Speeches
Formal Business Speeches)

Module IV [9P]

Writing Skill-

Descriptive, narrative and expository writing
Writing with a purpose---Convincing skill, argumentative skill/negotiating Skill (These skills will be repeated in oral skills).
Writing reports/essays/articles—logical organization of thoughts
Book review

References

1. Munter, Mary. Guide to Managerial Communication. 5th ed. Upper Saddle River, NJ: Prentice Hall, 1999.
2. Cypres, Linda. Let's Speak Business English. Hauppauge, NY: Barron's Educational Series, 1999. Crystal, David. 1971. *Linguistics.* Baltimore: Penguin Books.
3. Larsen-Freeman, D. (1986). "Techniques and principles in language teaching." Oxford: Oxford University Press.
4. Littlewood, W. (1981). "Language teaching. An introduction." Cambridge: Cambridge University Press.
5. Savignon, S. J., & Berns, M. S. (Eds.). (1983). "Communicative language teaching: Where are we going? Studies in Language Learning," 4(2). (EDRS No. ED 278 226, 210 pages)

Course Name : Extra-curricular activities					
Course Code: HMTS1121					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	2	2	1

Objective: This course aims at instilling a sense of responsibility. This objective can be achieved by bringing in awareness about the contemporary issues relevant to the GenX and Gen Y through enlightened discussions and active participation. Since the course has 1 credit detailed planning regarding the area of activities and method of evaluation should be charted at the start of the semester.

Module I:

Project Work

Development of projects based on integral and holistic developmental models to be implemented in rural areas or underdeveloped areas in the peripheral areas of cities. This could include a wide area of activity –
from taking up a research projects to analyse the need of a particular under-developed area to trying to implement a project already formulated. This could also relate to mobilizing funds for a specific project.

Module II:

Action-oriented schemes

e.g.Organising Blood –donation camps
Conducting child –healthcare services
Helping the old and sick
(in coordination with NGOs and other institutes)

Module III:

Society and Youth

Developing Awareness among the youth about social issues both local and global for e.g. Eradication of social evils like drug abuse, violence against women and others.

Module IV:

Youth and Culture

Generating new ideas and help the participants to be creative and innovative for e.g.Enacting street plays, encouraging creative writing by organizing workshops and competitions. Active participation of the students in the nation building process by making positive changes in the social and individual space.

Course Name : Introduction to Computing					
Course Code: CSEN1201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Learning Objective: Introduction to the concept of computer and computation and solving of problems using C as a programming language. Coverage of C will include basic concepts, arithmetic and logic, flow control, and data handling using arrays, structures, pointers and files.

Course Outcome:

1. Understand and remember functions of the different parts of a computer.
2. Understand and remember how a high-level language (C programming language, in this course) works, different stages a program goes through.
3. Understand and remember syntax and semantics of a high-level language (C programming language, in this course).
4. Understand how code can be optimized in high-level languages.
5. Apply high-level language to automate the solution to a problem.
6. Apply high-level language to implement different solutions for the same problem and analyze why one solution is better than the other.

Module I: [13L]

Fundamentals of Computer

History of Computers, Generations of Computers, Classification of Computers.

Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. Assembly language, high level language, compiler and assembler (basic concepts).

Binary & Allied number systems (decimal, octal and hexadecimal) with signed and unsigned numbers (using 1's and 2's complement) - their representation, conversion and arithmetic operations. Packed and unpacked BCD system, ASCII. IEEE-754 floating point representation (half- 16 bit, full- 32 bit, double- 64 bit). Binary Arithmetic & logic gates. Boolean algebra – expression, simplification, Karnaugh Maps.

Basic concepts of operating systems like MS WINDOW, LINUX. How to write algorithms & draw flow charts.

Module II: [5L]

Basic Concepts of C

C Fundamentals:

The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements.

Operators & Expressions:

Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence and order of evaluation. Standard input and output, formatted output -- printf, formatted input scanf.

Module III: [8L]

Program Structures in C Flow of Control:

Statement and blocks, if-else, switch-case, loops (while, for, do-while), break and continue, go to and labels.
Basic of functions, function prototypes, functions returning values, functions not returning values. Storage classes - auto, external, static and register variables – comparison between them. Scope, longevity and visibility of variables.
C preprocessor (macro, header files), command line arguments.

Module IV: [14L]
Data Handling in C Arrays and Pointers:
One dimensional arrays, pointers and functions – call by value and call by reference, array of arrays. Dynamic memory usage– using malloc(), calloc(), free(), realloc(). Array pointer duality.
String and character arrays; C library string functions and their use.
User defined data types and files: Basic of structures; structures and functions; arrays of structures.
Files – text files only, modes of operation. File related functions – fopen(), fclose(), fscanf(), fprintf(), fgets(), fputs();

Text Books
1. Schaum's outline of Programming with C – Byron Gottfried
2. Teach Yourself C- Herbert Schildt
3. Programming in ANSI C – E Balagurusamy

Reference Books
1. C: The Complete Reference – Herbert Schildt
2. The C Programming Language- D.M.Ritchie, B.W. Kernighan

Course Name : Chemistry-I					
Course Code: CHEM1001					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Course Outcome:

1. Knowledge of understanding the operating principles and reaction involved in batteries and fuel cells and their application in automobiles as well as other sectors to reduce environmental pollution.
2. An ability to design and conduct experiments, as well as to organize, analyzes, and interprets data.
3. An ability to identify and formulate polymers and have a knowledge of various polymers like polyethene, PVC, PS, Teflon, Bakelite, Nylon which have engineering applications.
4. Knowledge of synthesizing Nanomaterials and their applications in industry, carbon nano tube technology is used in every industry now-a-days.
5. An ability of synthesizing bio fuels as a renewable and environment friendly alternative source for natural fuel.
6. Elementary knowledge of IR and UV spectroscopy is usable in structure elucidation and characterisation of various molecules

Module I [10 L]

Thermodynamics & Spectroscopy

Chemical Thermodynamics & Thermochemistry

Concept of Thermodynamic system, Introduction to first law of thermodynamics, Enthalpy Heat Capacity, Reversible and Irreversible processes, Adiabatic changes, Application of first law of thermodynamics to chemical processes, 2nd law of thermodynamics, Evaluation of entropy, Work function and free energy, Phase Changes, Clausius Clapeyron Equation, Chemical Potential, Gibbs Duhem Relation, Activity and Activity coefficient.

Spectroscopy

Electromagnetic Radiation, Basic idea of UV-visible & IR spectroscopy.

Module II [10 L]

Structure & Bonding

Chemical Bonding

Covalent bond, VSEPR Theory, Molecular Orbital Theory, Hydrogen bond, Intermolecular forces-vander Waals forces, Ionization energy, Electronegativity, Electron affinity, Hybridisation, Dipole moment

Solid State Chemistry

Introduction to stoichiometric defects (Schottky & Frenkel) and non – stoichiometric defects (Metal excess and metal deficiency). Role of silicon and germanium in the field of semiconductor.

Ionic Equilibria and Redox Equlibria

Acid Base Equilibria in water, Strength of acids and bases, Hydrogen ion exponent, Ionic product of water, Salt Hydrolysis and Henderson Equation, Buffer solutions, pH indicator, Common ion Effect, Solubility product, Fractional Precipitation, Redox Equilibria.

Structure and reactivity of Organic molecule
Inductive effect, resonance, hyperconjugation, electromeric effect, carbocation, carbanion and free radicals.
Brief study of some addition, eliminations and substitution reactions.

Module III [10 L]
Electrochemistry & Reaction Dynamics
Conductance
Conductance of electrolytic solutions, specific conductance, equivalent conductance, molar conductance, ion conductance, effect of temperature and concentration (Strong and Weak electrolyte). Kohlrausch's law of independent migration of ions, transport numbers and hydration of ions. Conductometric titrations: SA vs SB & SA vs WB; precipitation titration KCl vs $AgNO_3$.

Electrochemical Cell
Cell EMF and thermodynamic derivation of the EMF of a Galvanic cell (Nernst equation), single electrode potentials, hydrogen half-cell and calomel half cell (construction, representation, cell reaction, expression of potential, discussion, application) Storage cell, fuel cell (construction, representation, cell reaction,
expression of potential, discussion, application). Application of EMF measurement on a) the change in thermodynamic function (ΔG, ΔH, ΔS) b) the equilibrium
constant of a reversible chemical reaction c) the valency of an ion.

Kinetics
Reaction laws: rate expression, order and molecularity, zero, first and second order kinetics. Pseudounimolecular reaction, Arrhenius equation.
Mechanism and theories of reaction rates (Collision theory and Transition state theory,).
Catalysis: Homogeneous catalysis (Definition, example, mechanism, kinetics).

Module IV [10 L]
Industrial Chemistry & Polymerization

Industrial Chemistry
Solid Fuel: Coal, Classification of coal, constituents of coal, carbonization of coal (HTC and LTC), Coal analysis: Proximate and ultimate analysis.
Liquid fuel: Petroleum, classification of petroleum, Refining, Petroleum distillation, Thermal cracking, Octane number, Cetane number, Aviation Fuel (Aviation Gasoline, Jet Gasoline), Bio-diesel.
Gaseous fuels: Natural gas, water gas, coal gas, bio gas.

Polymerization
Concepts, classifications and industrial applications. Polymer molecular weight (number avg. weight avg. viscosity avg.: Theory and mathematical expression only), Poly dispersity index (PDI). Polymerization processes (addition and condensation polymerization), degree of polymerization, Copolymerization, stereo-regularity of polymer, crystallinity (concept of T_m) and amorphicity (Concept of T_g) of polymer.

Preparation, structure and use of some common polymers: plastic (PE: HDPE, LDPE, PVC, Bakelite, PP), rubber (natural rubber, SBR, NBR) and Vulcanization., fibre(nylon 6.6, Nylon 6, Polyester).
Conducting and semi-conducting polymers.

Text Books

1. Engineering Chemistry, Gourkrishna Dasmohapatra, Vikas Publishing House
2. A Text book of Engineering Chemistry, Shashi Chawla, Dhanpat Rai & Co Pvt Ltd
3. Engineering Chemistry, K. L. Chugh, Kalyani Publishers.

Reference Books

1. General & Inorganic Chemistry, R. P. Sarkar, Fuels and Combustion, New Central Book Agency P Ltd
2. L. Finar, Organic Chemistry, Addison Wesley Longman, Inc
3. Organic Chemistry, Morrison & Boyd, Prentice Hall of India
4. Physical Chemistry, K. L. Kapoor, McMillan
5. P. C. Rakshit, Physical Chemistry, Sarat Book House (7th Edition).

Course Name : Mathematics-II					
Course Code: MATH1201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcome:

1. Construct differential equation as a mathematical model of a physical phenomena.
2. Choose proper method for finding solution of a specific differential equation.
3. Discuss the elementary concepts of graph theory, for example, walk, path, cycle, Eulerian graph, Hamiltonian graph and tree.
4. Apply basic graph algorithms for searching and finding minimal spanning tree and shortest path.
5. Solve improper integrals and initial value problems with the help of Laplace transformation.
6. Evaluate distance, angle between planes and shortest distance between two skew lines in three dimension.

Module I [10 L]

Ordinary differential equations (ODE)-

First order and first degree: Exact equations, Necessary and sufficient condition of exactness of a first order and first degree ODE (statement only), Rules for finding Integrating factors, Linear and non-linear differential equation, Bernoulli's equation.

General solution of ODE of first order and higher degree (different forms with special reference to Clairaut's equation).

Second order and first degree:

General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods for finding P.I., Method of variation of parameters, Cauchy-Euler equations.

Module II:[10L]

Basics of Graph Theory

Graphs, Digraphs, Weighted graph, Connected and disconnected graphs,Complement of a graph, Regular graph, Complete graph, Subgraph,; Walks, Paths, Circuits, Euler Graph,Cut sets and cut vertices, Matrix representation of a graph, Adjacency and incidence matrices of a graph,Graph isomorphism, Bipartite graph.

Tree:

Definition and properties, Binary tree, Spanning tree of a graph, Minimal spanning tree, properties of trees, Algorithms: Dijkstra's Algorithm for shortest path problem, Determination of minimal spanning tree using DFS, BFS, Kruskal's and Prim's algorithms.

Module III [10L]

Improper Integral:

Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations.

Laplace Transform:

Introduction to integral transformation, functions of exponential order, Definition and existence of LT (statement of initial and final value theorem only), LT of elementary functions, Properties of Laplace Transformations , Evaluation of sine , cosine and exponential integrals using LT, LT of periodic and step functions Definition and properties of inverse LT Convolution Theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODEs with constant coefficients (initial value problem) using LT.

Module IV [10L]

Three Dimensional Geometry

Equation of a plane. General form. Transformation to the normal form. Intercepts. Equation of the plane through three given points. Equation of a plane passing through the intersection of two planes. Angle between two intersecting planes. Bisectors of angles between two intersecting planes. Parallelism and perpendicularity of two planes.

Canonical equation of the line of intersection of two intersecting planes. Angle between two lines. Shortest distance between two lines. Condition of coplanarity of two lines. Length of the perpendicular from a point to a given line.

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, (Wiley Eastern)
2. Graph Theory: V. K. Balakrishnan, (Schaum's Outline, TMH)
3. A first course at Graph Theory: J. Clark and D. A. Holton (Allied Publishers LTD)
4. Introduction to Graph Theory: D. B. West (Prentice-Hall of India)
5. Graph Theory: N. Deo (Prentice-Hall of India)
6. Engineering Mathematics: B.S. Grewal (S. Chand & Co.)
7. Higher Engineering Mathematics: John Bird (4th Edition, 1st Indian Reprint 2006, Elsevier)
8. Calculus: Strauss, Bradley and Smith (3PrdP edition, Pearson Education)
9. Engineering Mathematics (Volume 2): S. S. Sastry (Prentice-Hall of India)
10. Introductory Course in Differential Equations: Daniel A. Murray (Longmans & Green).
11. Co-ordinate Geometry – S. L. Loney.
12. Analytical Geometry And Vector Algebra- R M Khan.

Course Name : Basic Electrical Engineering					
Course Code: ELEC1001					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcome:

1. Analyze DC circuits using KCL, KVL and network theorems like Superposition Theorem, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.
2. Analyze DC Machines; Starters and Speed control of DC motors.
3. Analyze magnetic circuits and apply Gauss' law for electric field and potential calculation.
4. Analyze single and three phase AC circuits.
5. Analyze the operation of single phase transformers.
6. Analyze the operation of three phase induction motors.

Module – I [12L]

DC Network Theorem: Kirchhoff's law, nodal analysis, mesh analysis, Superposition theorem, Thevenin's theorem, Norton theorem, Maximum power transfer theorem, star-delta conversion.

DC Machines: Construction, EMF equation, Principle of operation of DC generator, open circuit characteristics, external characteristics, Principle of operation of DC motor, Speed-torque characteristics of shunt and series machine, starting of DC motor, speed control of dc motor.

Module-II [8L]

Electrostatics: Gauss's law and its applications to electric field and potential calculation. Capacitor, capacitance of parallel plate capacitor, spherical capacitor and cylindrical capacitor.

Electromagnetism: Amperes law, Biot-savart's law, Ampere's circuital law and their applications, Magnetic circuits, analogy between magnetic and electric circuits, Faraday's law, self and mutual inductance. Energy stored in a magnetic field, Hysteresis and Eddy current losses.

Module-III [10L]

AC single phase system: concept of alternating signal, average and RMS values of alternating signal, peak factor, form factor, phase and phase difference, phasor representation of alternating quantities, phasor diagram, AC series , parallel and series parallel circuits, Active power, Reactive power, power factor, Resonance in RLC series and parallel circuit, Q factor, bandwidth.

Three phase system: balanced three phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams. Power measurement by two wattmeter method.

Module-IV [10L]

Single phase transformer: Construction, EMF equation, no load and on load operation and their phasor diagrams, Equivalent circuit, Regulation, losses of a transformer, open and short circuit tests, efficiency.

3-phase induction motor: Concept of rotating magnetic field, principle of operation, Construction, equivalent circuit and phasor diagram, torque-speed/slip characteristics, Starting of Induction Motor.

Text Books:

1. Basic Electrical engineering, D.P Kothari & I.J Nagrath, TMH, Second Edition
2. Basic Electrical Engineering, V.N Mittle & Arvind Mittal, TMH, Second Edition
3. Basic Electrical Engineering, Hughes
4. Electrical Technology, Vol-I,Vol-II,Surinder Pal Bali, Pearson Publication
5. A Text Book of Electrical Technology, Vol. I & II, B.L. Theraja, A.K. Theraja, S.Chand & Company

Reference Books:

1. Electrical Engineering Fundamentals, Vincent Del Toro, Prentice-Hall
2. Advance Electrical Technology, H.Cotton, Reem Publication
3. Basic Electrical Engineering, R.A. Natarajan, P.R. Babu, Sictech Publishers
4. Basic Electrical Engineering, N.K. Mondal, Dhanpat Rai
5. Basic Electrical Engineering, Nath & Chakraborti
6. Fundamental of Electrical Engineering, Rajendra Prasad, PHI, Edition 2005.

Course Name : Engineering Thermodynamics and Fluid Mechanics					
Course Code: MECH1201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcome:

1. To analyze a thermodynamic system and calculate work transfer in various quasi-static processes.
2. To understand and apply the first law and 2nd law of thermodynamics.
3. To analyze thermal efficiency of Otto, Diesel cycles.
4. To understand physical properties of fluids.
5. To apply mass, momentum and energy conservation principles to incompressible fluid flow.
6. To describe fluid flow and analyze acceleration of fluid particles.

Module I [10 L]

Basic concepts of Thermodynamics:
Introduction; Macroscopic and microscopic concept; Definition of Thermodynamic systems; Surrounding, universe; Open, closed and isolated systems; Concept of control volume; Thermodynamic properties: intensive, extensive & specific properties; state.

Thermodynamic equilibrium; Change of state; Thermodynamic processes and cycles; Quasi-static processes; Reversible processes; Zeroth law of Thermodynamics -concept of temperature.

Heat & Work:
Definition of Thermodynamic work; Work transfer-displacement work for a simple compressible system, path function, PdV work in various quasi-static processes(isothermal, isobaric, adiabatic, polytropic, isochoric); Free expansion; Indicated diagram (P-V diagram)
Definition of heat; Heat transfer-a path function; Similarities and dissimilarities between heat and work.

Module II [8 L]

First law of Thermodynamics: Statement; 1^{st} law for a closed system executing a cycle; Concept of stored energy; Energy as a property, different forms of stored energy, internal energy, first law for a non-flow process; Flow work; Definition of enthalpy, C_p, C_v; Energy of an isolated system; Flow energy; First law for an open system - steady flow energy equation; Examples of steady flow devices(nozzle and diffuser, turbine, pump, compressor, boiler, condenser and throttling device); PMM-I

Module III [10 L]

Second law of Thermodynamics:
Qualitative difference between heat and work; Definition of source & sink: cyclic heat engine, heat pump and refrigerator, thermal efficiency of heat engine, C.O.P of heat pump

and refrigerator; Kelvin-Plank and Clausius statements of second law; Equivalence of the two statements.
Reversible process; Irreversible process; Factors for irreversibility; Carnot cycle and Carnot efficiency; Reversible heat engine and heat pump; PMM-ll
Entropy: Mathematical statement of Clausius Inequality: Entropy as a property; Entropy principle; T-s plot for reversible isothermal, adiabatic, isochoric & isobaric processes.

Air standard Cycles:
Otto cycle & Diesel cycle, P-V & T-s plots, Net work done and thermal efficiency.

Module IV [10 L]

Properties & Classification of Fluid:

Definition of fluid; Concept of Continuum; Fluid properties- density, specific weight, specific volume, specific gravity; Viscosity: definition, causes of viscosity, Newton's law of viscosity, dimensional formula and units of viscosity, kinematic viscosity; Variation of viscosity with temperature. Ideal and Real fluids; Newtonian and Non-Newtonian fluids; No-slip condition.
Compressibility and Bulk modulus of elasticity.
Difference between compressible and incompressible fluids.

Fluid Statics:

Introduction; Pascal's Law--statement and proof; Basic Hydrostatic Law and its proof; Variation of pressure with depth in incompressible fluid, piezometric head, pressure head; Unit and scales of pressure measurement.
Measurement of fluid pressure: Piezometer, Manometers -Simple and Differential U-tube manometer, Inverted tube manometer, Inclined tube manometer. Characteristics and choice of manometric fluid.

Module V [10 L]

Fluid Kinematics:

Definition; Flow field and description of fluid motion(Eulerian & Lagrangian method), steady and unsteady flow, uniform and non-uniform flow-examples.
Acceleration of a fluid particle-local acceleration, convective acceleration. Stream line, Stream tube, Path line and Streak line; Laminar and Turbulent flow, Reynolds Number. Equations of streamlines and path lines.
Continuity equation for unidirectional flow and for differential form in 3-D Cartesian coordinate system.

Dynamics of Ideal fluids:

Introduction, Euler's equation of motion along a streamline; Bernoulli's equation-assumptions and significance of each term of Bernoulli's equation.
Application of Bernoulli's equation-problem on pipe line. Measurement of flow rate: Venturimeter and orificemeter .

Static pressure, Dynamic pressure, Stagnation pressure-measurement of velocity by Pitot tube.

Reference Books:

1. Engineering Thermodynamics- Nag, P.K. - T. M.H.
2. Fundamentals of Thermodynamics- Sonntag, Borgnakke & Van Wylen,Wiley India.
3. Thermodynamics- an Engineering approach - 6e, Cengel & Boles, TM.
4. Fluid Mechanics & Hydraulic Machines – R.K. Bansal, Laxmi Publications Ltd, India.
5. Introduction to Fluid Mechanics and Fluid Machines- S.K. Som, G. Biswas, & S. Chakraborty, T.M.H.
6. Fluid Mechanics – A.K. Jain, Khanna Publishers.

Course Name : Introduction to computing Lab					
Course Code: CSEN1211					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

List of experiments:

Basic Computation & Principles of Computer Programming Lab
Softwares to be used: Cygwin and notepad++, Tiny C

Day 1: LINUX commands and LINUX based editor
Day 2: Basic Problem Solving
Day 3: Control Statements (if, if-else, if-elseif-else, switch-case)
Day 4: Loops - Part I (for, while, do-while)
Day 5: Loops - Part II
Day 6: One Dimensional Array
Day 7: Array of Arrays
Day 8: Character Arrays/ Strings
Day 9: Basics of C Functions
Day 10: Recursive Functions
Day 11: Pointers
Day 12: Structures and Unions
Day 13: File Handling

Course Name : Chemistry-1 Lab					
Course Code: CSEN1211					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

List of Experiments:

1. To determine the alkalinity in a given water sample.
2. Estimation of iron using $KMnO_4$: self indicator.
3. Estimation of iron using $K_2Cr_2O_7$: redox sensitive indicator.
4. To determine total hardness and amount of calcium and magnesium separately in a given water sample.
5. To determine the value of the rate constant for the hydrolysis of ethyl acetate catalyzed by hydrochloric acid.
6. Heterogeneous equilibrium (determination of partition coefficient of acetic acid between n-butanol and water).
7. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
8. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
9. Iodometric estimation of Cu^{2+}.
10. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution)

Course Name : Basic Electrical Engineering Lab					
Course Code: ELEC1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

Course Outcomes:

The students are expected to

1. Get an exposure to common electrical apparatus and their ratings.
2. Make electrical connections by wires of appropriate ratings.
3. Understand the application of common electrical measuring instruments.
4. Understand the basic characteristics of different electrical machines.

List of Experiments:

1. Characteristics of Fluorescent lamps
2. Characteristics of Tungsten and Carbon filament lamps
3. Verification of Thevenin's & Norton's theorem.
4. Verification of Superposition theorem
5. Verification of Maximum Power Transfer theorem
6. Calibration of ammeter and voltmeter.
7. Open circuit and Short circuit test of a single phase Transformer.
8. Study of R-L-C Series / Parallel circuit
9. Starting and reversing of speed of a D.C. shunt Motor
10. Speed control of DC shunt motor.
11. No load characteristics of D.C shunt Generators
12. Measurement of power in a three phase circuit by two wattmeter method.

Course Name : Engineering Drawing					
Course Code: MECH1012					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

List of Experiments:

1. Importance of engineering drawing; Acquaintance with different drafting equipment & accessories;
2. Introduction to lines : Practising different types of lines; Basic concepts in Lettering : Practising vertical & inclined letters (Practice Sheet 1)
3. Different systems of dimensioning with practice.Introduction to the concept of scale of drawing. (Practice Sheet 2)
4. Introduction to concept of orthographic projection: 1st angle and 3rd angle projection method; Symbols; projection of points. (Practice Sheet 3)
5. Projection of straight lines for different orientation including inclined to both the planes. (Practice Sheet 4)
6. Projection of plane surfaces inclined to HP and parallel to VP; Inclined to VP and Parallel to HP (Practice Sheet 5)
7. Projection of solids: Cube, rectangular prism, Hexagonal prism, Cylinder, Pyramid, Cone. (Practice Sheet 6)
8. Section of solids and their projections on principal and auxiliary planes for true shape: Cylinder, hexagonal pyramid. (Practice Sheet 7)
9. Isometric projections: Basic concepts, isometric scale; Isometric projection and view.
10. Practice with simple laminar and solid objects. (Practice Sheet 8)

Reference Books:

1. "Elementary Engineering Drawing" by Bhatt, N.D; Charotan Book Stall, Anand.
2. "Engineering Graphics" by Narayana, K.L. and Kannaaiah P; TMH.
3. "Engineering Graphics" by Lakshminarayanan,V. and Vaish Wanar, R.S, JainBrothers.

Course Name : Indian Culture and Heritage					
Course Code: HMTS2002					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**1**

Course Outcomes:

After completion of this course, the students will be able to

1. Apply the basic philosophical tenets in day-to-day life.
2. Be aware of the diverse cultural heritage of our country.
3. Gain knowledge about the ancient Vedic mathematical tradition and apply it in modern day perspectives.
4. Attempt to use foundational ayurvedic concepts in his daily life.
5. Use the fundamental approach of the universal message of Bhagwad Gita.
6. Be an ambassador of Indian ethos in his workplace.

Module-I: Indian Religion & Philosophy [10L]

1. Orthodox Indian Philosophy
2. Unorthodox Indian philosophy
3. Essentials of Hinduism
4. An overview of Jainism, Buddhism, Sikhism, Islam, Christianity religions

Module-II: Values and Personality [10L]

1. Aspects of Indian Values
2. Essentials of Personality Building
3. Ethics at work place
4. Aspects of Leadership qualities

Module-III: Indian Scriptures [10L]

1. Selections from the Vedas
2. Select verses from Upanishad
3. An overview of Gita
4. XVIth chapter of Gita

Module-IV: Indian Psychology [10L]

1. Aspects of Yoga Philosophy
2. Mind and its workings according to Yoga
3. Law of Karma
4. Selections from Manusmriti

References:

1. Indian Philosophy by S.C. Chatter and D. M. Dutta, Calcutta University Press
2. Spiritual Heritage of India, Swami Prabhavananda, Sri Ramakrishna Math, Chennai
3. Raja Yoga by Swami Vivekananda, Advaita Ashrama, Mayavati
4. Vedic Selection, Calcutta University Press
5. Gita by Swami Swarupananda, Advaita Ashrama, Kolkata
6. Upanishads by any press
7. Carving a Sky (MSS) by Samarpan
8. Essentials of Hinduism (MSS) by Samarpan
9. The Call of the Vedas — Bharatiya Vidya Bhavan

Course Name : Chemistry of Biomolecules					
Course Code: BIOT2101					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcomes:

After completion of this course, the students will be able to:

1. Calculate the pH of a buffer system, identify different stereoisomer's of carbohydrate and lipids and understood the chemistry of carbohydrate and lipids.
2. Explain the different structural components and physiochemical properties of amino acids, proteins.
3. Analyses and explain the different structural components and physiochemical properties of DNA and RNA.
4. Select and apply suitable spectroscopic techniques for estimation biomolecules.
5. Select and apply suitable techniques for and structure determination of of biomolecules.
6. Able to solve mathematical problems related to estimation and structural features of biomolecules.

Module –I: Introduction and Chemistry of Carbohydrates [10L]

Introduction: Structure of water molecules, Weak inter-molecular interactions in biomacromolecules, Basic concepts of pH, buffer, pKa**.** Chemistry of Carbohydrates: Definition, classification, structure and chemical properties of: Monosaccarides; Sucrose, Lactose, Maltose; Glucosamine, Muramic Acid; Starch, Glycogen, Cellulose, Chitin, Agar, Proteoglycans; Sialic acids and blood group polysaccharides. Stereochemistry of Carbohydrates: Projection formula (Fischer, flying-wedge, Sawhorse, Newman & Howarth), Configuration, conformation, Optical isomerism (d/l, D/L and R/S nomenclature), Anomer, Epimer, Mutarotation.

Module-II: Chemistry of Lipids [10L]

Lipids: Definition, classification. Structure, Reactions and characterization of: fatty acids, Triacyl glycerols. Structure of Prostaglandins, Oil, Wax. Geometrical isomerism (cis/trans, syn/anti, E/Z) of Fatty acids. Hydrolysis, saponification value, iodine number, rancidity and Biological significance of fats. Phospholipids: Introduction and importance. Glycerophospholipids, lecithins, cephalins, phosphatidyl serine, phosphatidyl inositol, plasmalogens, sphingomyelines. Glycolipids: cerbrosides, gangliosides. Steroids and carotenoids: Introduction, and importance, cholesterol, modifications of sterols, bile acids, steroid hormones, carotenes.

Module-III: Chemistry of Amino Acids, Proteins and Nucleic acids [10L]

Classification, Structure, pH titration curve and Important Chemical reactions. Structure of Amino Acids. Peptide bond, Solid phase peptide synthesis, peptide sequencing. Four levels structures, Conformation (Ramachandran plot, domains, motif and folds), Separation Methods based on structure and chemical properties; denaturation

and renaturation of proteins. Example: RNaseA, keratins, collagen, Lectins, myoglobin, hemoglobin. Stability of protein. Chemistry of Nucleic Acids: Structure, nomenclature of Nucleoside, Nucleotides. Four levels structures, Functions, Conformations, Nucleotide sequence composition of DNA and RNA. Supercoiled structure, Denaturation and renaturation kinetics of DNA. Stability of Nucleic acids

Module-IV: Techniques for estimation and structure determination of Biomolecules [10L]

Introduction to absorption and emission spectroscopy and Lambert–Beer law**.** Estimation of biomolecules by spectroscopic, colorimetric, phosphorescence, and luminescence method. Basic concepts and principles for structure determination techniques: X-ray diffraction, crystallography; spectroscopy: UV and visible, fluorescence, Infrared, Nuclear Magnetic Resonance, circular dichroism, Optical Rotatory Dispersion, Surface plasmon resonance, Electron Spin Resonance Spetroscopy, Microscopy: atomic force (AFM) and cryoelectron. Radioisotopic techniques.

Textbooks:

1. Lehninger Principles of Biochemistry by Nelson and Cox, McMillan publishers
2. Van Holde, Principles of Physical Biochemistry, Pearson
3. Biochemistry,by 4th Edn. (2011) Voet, D. and Voet JG. (Wiley)
4. Biochemical Calculations by Irwin H. Segel, John Wiley & Sons

Reference books:

1. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY
2. Biochemistry by Zubey. Wm. C. Brown publishers
3. Organic Chemistry, Finar, IL. Part II.
4. Biochemistry, 5th edition (2002) by Berg, Tymoczko, and Stryer. (W H Freeman)
5. David Friefelder, Physical Biochemistry
6. Practical Biochemistry Principles and techniques :Ed Wilson and Walker, Cambridge University Press
7. Physical Chemistry, Principles and Applications in Biological Sciences (2001) by Tinoco, Sauer and Wang,, Prentice Hall, 4th Edition
8. Physical Chemistry for the Life Sciences (2005) by Atkins,, W.H. Freeman
9. Physical Chemistry with Applications to the Life Sciences(1979) by Eisenberg & Crothers, Benjamin/Cummings Publishing Co.
10. Principles of Physical Biochemistry (1998) by K. E. van Holde, W. C. Johnson, and P.S. Ho.
11. Biophysical Chemistry (1981), Part I: The Conformation of Biological Macromolecules, Part II: Techniques for the Study of Biological Structure and Function by C.R. Cantor and P.R.Schimmel.

Course Name : Basic Environmental Engineering & Ecology					
Course Code: CHEM2001					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course outcome

The subject code CHEM2001 corresponds to basic environmental chemistry for the 2nd year B.Tech students, which is offered as Environmental Sciences and is mandatory for all branches of engineering. The course provides basic knowledge of various environmental pollutions as well as its impact and ways to curb it. The course outcomes of the subject are:

1. Understand the natural environment and its relationships with human activities.
2. Characterize and analyze human impacts on the environment.
3. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems.
4. Educate engineers who can work in a multi-disciplinary environment to anticipate and address evolving challenges of the 21st century.
5. Understand and implement scientific research strategies, including collection, management, evaluation, and interpretation of environmental data.
6. Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Module-I: Environment & Ecology (General discussion) [10L]

Basic ideas of environment and its component

Mathematics of population growth: exponential and logistic and associated problems, definition of resource, types of resource, renewable, non-renewable, potentially renewable, Population pyramid and Sustainable Development.

General idea of ecology, ecosystem – components, types and function.

Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundarban); Food chain (definition and one example of each food chain), Food web.

Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphorus, Sulphur].

Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity.

Module-II: Air pollution and control [10L]

Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause. 1L

Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Acid rain: causes, effects and control. Earth's heat budget, carbon capture, carbon footprint

Lapse rate: Ambient lapse rate, adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion). Atmospheric dispersion, Maximum mixing depth

Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN.

Smog: Photochemical smog and London smog. Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green house gases, effect of ozone modification

Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP, cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference).

Module-III: Water Pollution and Control [10L]

Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides,

River/Lake/ground water pollution: River: DO, 5 day BOD test, Unseeded and Seeded BOD test, BOD reaction rate constants, COD.

Lake: Eutrophication [Definition, source and effect]. Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only)

Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening]

Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds]

Water pollution due to the toxic chemicals effects: Lead, Mercury, Cadmium, Arsenic

Noise Pollution

Definition of noise, effect of noise pollution, noise classification [Transport noise, occupational noise, neighbourhood noise]. Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, L_{10} (18hr Index), effective perceived noise level.

Noise pollution control.

Module-IV: Land Pollution [10L]

Solid Waste: Municipal, industrial, commercial, agricultural, domestic, pathological and hazardous solid wastes, electronic waste

Recovery and disposal method- Open dumping, Land filling, incineration, composting, recycling.

Social Issues, Health and Environment

Environmental disasters: Bhopal gas tragedy, Chernobyl disaster, Three Mile Island disaster, cancer and environment: carcinogens, teratogens and mutagens (general aspect)

Environmental impact assessment, Environmental audit, Environmental laws and protection act of India.

Energy audit, Green building, Green sources of energy, Concept of Green Chemistry, Green catalyst, Green solvents (replacement of VOC)

References/Books

1. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd., 1991.
2. De, A. K., "Environmental Chemistry", New Age International.
3. Asim K. Das, Environmental Chemistry with Green Chemistry, Books and Allied P. Ltd
4. S. C. Santra, Environmental Science, New Central Book Agency P. Ltd
5. GourKrishna Das Mahapatra, Basic Environmental Engineering and Elementary Biology, Vikas Publishing House P. Ltd.

Course Name : Industrial Stoichiometry					
Course Code: BIOT2102					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcomes:

After completion of this course, the students will be able to:

1. Solve problems related to units and conversions and fit the given data using the methodologies.
2. Able to make material balances on unit operations and processes.
3. Understand stoichiometry of microbial growth and product formation.
4. Solve problems related to energy balance for steady state processes.
5. Determine the heat of reaction for processes with biomass and secondary metabolite production.
6. Design simultaneous material and energy balances in biochemical processes

Module-I: Units and Dimensions [10L]

Small units and dimensions, dimensionless groups, dimensional analysis. Conversion of equations. Use of log-log and semi-log graph paper, graphical differentiation and graphical integration, treatment and interpretation of data by least square analysis.

Module II: Material balance [10L]

Introductory Concepts- simplification of the general mass balance equation for steady and unsteady state processes, procedure for material balance calculations, material balance without chemical reactions: application of humidification, distillation column. Material balance with chemical reaction: combustion.

Stoichiometry of growth and product formation- growth stoichiometry and elemental balances. Material Balance with recycle, bypass and purge streams in bioprocess.

Module-III: Energy Balance [10L]

General energy balance equation for steady state processes - without and with chemical reaction. Enthalpy calculation procedures: enthalpy change due to reaction, heat of combustion, heat of reaction for chemical processes.

Energy-balance equation for cell culture -heat of reaction for processes with biomass and secondary metabolites production in fermentation processes.

Module-IV: Combined material and energy balance in bioprocesses [10L]

Simultaneous material and energy balances in biochemical processes: growth associated, non-growth associated and mixed growth associated product production process.

Textbook:

1. Bhatt & Vora, Stoichiometry, 4th Ed., Tata McGraw Hill

Reference books:

1. Hougen and Watson, Chemical Process Principles (Part one): 2nd ed, John Wiley.
2. Basic Principles and Calculations in Chemical Engineering: Himmelblau, 6th Ed. Prentice Hall India.
3. Bioprocess Engineering: 2^{nd} edition, Michael L. Shuler, Filkert Kargi. Prentice Hall India.

Course Name : Biochemistry					
Course Code: BIOT2103					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcomes

After completing this course, the students will be able to:

1) Explain the basic concepts of enzymes.
2) Understand enzymatic kinetics particularly related to Michaelis-Menton Equation.
3) Understand elaborate metabolic pathways for carbohydrate metabolism
4) Explain the basis behind lipid synthesis and lipid β oxidation pathways.
5) Understand how Cholesterol synthesis happens.
6) Gain detailed knowledge about N-metabolism
7) Grasp knowledge about main intracellular cell signalling pathways
8) Explain the basic concepts of how extracellular matrix works.

Module-I: Introduction to Enzyme & Carbohydrate Metabolism [10L]

Enzymes: Basic concept of enzyme-substrate reaction, Classification and nomenclature, active site, allosteric regulation. **Metabolism of carbohydrates and their regulation:** glycolysis, TCA cycle, pentose phosphate pathway, Glyoxalate cycle, Cori cycle, glucuronate pathway**,** glycogenolysis, gluconeogenesis glycogenesis. **Oxidative phosphorylation:** electron transport chain, ATP synthesis, and its regulation. **Photosynthesis:** Photophosrylation, Calvin cycle. Disorder/ diseases of carbohydrate metabolism.

Module-II: Metabolism of lipids and vitamins [10L]

Oxidation of Fatty acid and its regulation: Beta oxidation, Alpha oxidation and omega oxidation of fatty acids - saturated and unsaturated fatty acids - even and odd numbered. Catabolism of phospholipids. Biosynthesis of fatty acids, phospholipids, cholesterol, steroids and Ketone bodies and their regulation. Disorder/ diseases of lipid metabolism. Vitamins and hormones: classification, Structure and Function; Micronutrients.

Module-III: Metabolism of Amino acid and nucleic acid [10L]

Oxidation of amino acids: Transamination, oxidative deamination. Urea cycle and its regulation. Overview of amino acid degradation. Biosynthesis of amino acids and its regulation; Protein turnover. Disorder/ diseases of amino acids metabolism.

Nucleic acid metabolism: nucleotide metabolism, Overview of purine and pyrimidine biosynthesis and degradation, De Novo and Salvage Pathways. Disorder of purines and pyrimidines metabolism.

Module-IV: Cell Signaling [10L]

Cell signaling and signal transduction pathways: Ligands and their receptors, cell surface receptor, signaling through G-protein coupled receptors, second messengers, regulation of signaling pathways, general principles of cell communication, cell adhesion and different adhesion molecules, gap junctions, extracellular matrix, integrins.

Textbook: 1. Lehninger's Principles of Biochemistry by Nelson & Cox, W.H. Freeman Pub.

Reference books:

1. Molecular Biology of the Cell by Bruce Alberts, 4th ed, Garland Science Publishers, 2002
2. Lubert Stryer, Bio chemistry, Freeman & Co, NY
3. Voet & Voet, Fundamentals of Biochemistry, John Willey & Sons
4. Harper's Illustrated Biochemistry - R.K.Murray et al. (McGraw Hill)
5. Outline of Biochemistry - Conn & Stump (John Willey & Sons)

Course Name : Microbiology					
Course Code: BIOT2104					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcomes:

After completing this course, students will be able to:

1. Describe different cell structures with subcellular functional organelles.
2. Describe the working principles of different types of microscopes.
3. Isolate pure culture from different environmental sources.
4. Preserve and maintain pure culture.
5. Understand various microbial identification processes.
6. Apply their knowledge of microbes in different environmental aspects.

Module-I: Introduction to Microbiology [10L]

Development of microbiology: rejection of abiogenesis theory- major contributions by different scientists: diversification of basic microbiology into different application domains.

Bacteria: morphology, cell structure with subcelluar functional organelles,

Archaebacteria and actinomyces: General morphology, growth characteristics.

Yeast: General morphology and subcellular structure, growth and reproduction.

Fungi: General morphology, sexual and asexual reproduction.

Algae: Classes of algae, cyanobacteria.

Virus: General morphology, virulence, types.

Applications of microbes and Algae in Biotechnology.

Biochemical & Molecular Taxonomical identification of microorganisms.

Module-II: Basic principles and methods in microbiology [10L]

Microscopy: Human visibility and microorganisms, history of development of Microscope, description optical complex microscope. Resolving power, numerical aperture and chromatic aberration Microscopy II: Optical microscope with special utility (phase contrast, fluorescence and inverted microscope), Electron microscope TEM & SEM.

Cultivation of microbes – General media for the growth of bacteria, yeast and fungi, Types of growth media (natural, synthetic, complex, enriched, selective- definition with example), pure culture methods (streak plate, spread plate, pour plate, stab culture, slant culture). Anaerobic (thioglycolate, anaerobic chamber, Robertson's media, microaerophilic), liquid shake culture of aerobic bacteria. Control of microbes: Sterilization, tyndallisation, pasteurization; Physical agents: dry heat, moist heat, UV light, ionizing radiation, filtration, HEPA filter; Chemical agents: antibiotics and antiseptics, disinfectants.

Module-III: Microbial Growth and Metabolism [10L]

Growth of bacteria- Definition, growth phases, kinetics of growth, direct and indirect measurement of growth, The mathematical nature and expression of growth. growth principles of nutrition, influence of environmental factors-pH, temperature, oxygen, Heavy metals and Other compounds. Bacterial growth, fermentation and putrification, Aerobic and anaerobic respiration (definition, examples), fermentation (alcoholic, mixed acid, acetic acid, lactic acid), Entner Duodruffs pathway, bacterial photosynthesis (green and purple bacteria), biochemical nitrogen fixation – non-symbiotic, symbiotic (definition and examples), basic concept of nif-genes. Mod genes, nitrogenase complex, legheamoglobin.

Module-IV: Environmental microbiology [10L]

Air microbiology- Microorganisms in the air, sampling techniques, air borne pathogens. Microbiology of fresh water and wastewater (sewage), water borne diseases (name of pathogen, pathogenicity and preventive measures). Outlines of method for determination of microbial safety of drinking water (presumptive, confirmatory and completed tests). Soil microbiology: soil microbes, different kinds of associations, importance of soil microbes in agriculture.

Textbook:

1. R.C Dubey and D. K Maheshwari -A Text Book of Microbiology, 3rd ed, S. Chand and Company.
2. C.B Powar and H.F Daginawala- General Microbiology (Vol I & II) 3rd ed, Himalaya Publishing House.

Reference books:

1. Stanier R. –General Microbiology, 5thed, Macmilan Press ltd.
2. M. Pelczar, E.Chan, N.Kreig, Microbiology, 5thed, MGH
3. Salle.A.J- Fundamental Principles of Bacteriology, Tata Mcgraw Hill.
4. Hans G. Schlegel, General Microbiology, 7thed, Cambridge Low Price Edition.
5. A.H. Rose, Chemical Microbiology, 3rded, Butterworth World Student Reprints

Course Name : Biomolecular Chemistry Lab					
Course Code: BIOT2111					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

Course Outcomes:
After completion of this course, the students will be able to:

1. Determine the presence of different biomolecules in a solution.
2. Develop a concept of different types of buffer and pH.
3. Develop the basic principles of spectrophotometric anaylsis.
4. Quantify the concentration of an unknown solution by spectrophotometry.
5. Estimate DNA, RNA and reducing sugars.
6. Determine saponification number and iodine number of lipids.

List of experiments:

1. Qualitative tests for different biomolecules.
2. Buffer & pH: Calibration of pH meter, Preparation of buffer (Tris-HCl or Acetate or Phosphate buffer system) and pH titration of amino acids and validation of the Henderson-Hasselbach equation.
3. Spectroscopy: Verification of Lambert-Beer's law and determination of molar extinction coefficient.
4. Estimation of Reducing Sugars (DNSA method)
5. Estimation of DNA /RNA by chemical method (DNA by diphenyl amine and RNA by orcinol)
6. Determination of Saponification number of lipid
7. Determination of Iodine Number of lipid

Reference Books:

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), CUP, Cambridge University Press.
2. Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House.
3. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw- Hill, Book Company.

Course Name : Biochemistry Lab					
Course Code: BIOT2112					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**1**

Course Outcomes:

After completion of this course, the students will be able to:

1. Estimate sugars by enzymatic method.
2. Develop the concept of enzyme kinetics
3. Determine the activity and specific activity of enzymes.
4. Determine the nature of enzyme inhibition.
5. Estimate the unknown concentration of a protein, cholesterol, vitamin C and liver enzymes.
6. Separate lipids and proteins by chromatographic techniques.

List of experiments:

1. Estimation of sugars by enzymatic method (GOD –POD method)
2. Determination of activity & specific activity of enzyme: K_m and V_{max}
3. Determination of optimum temperature & pH optima of an enzyme
4. Inhibition of Alkaline phosphatase by (F^- or arsenate) and determining the nature of inhibition.
5. Determination of SGPT, SGOT by colorimetric end point method in blood.
6. Estimation of proteins
7. Estimation of cholesterol
8. Estimation of Vitamin C in fruit juice using 2, 6-dichlorophenol indophenols
9. Separation of lipids/ amino acids/ carbohydrates by Thin layer Chromatography (TLC)/ Paper Chromatography.

Reference Books:

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), CUP, Cambridge University Press.
2. Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House.
3. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw- Hill Book Company.

Course Name : Microbiology Lab					
Course Code: BIOT 2113					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**5**	**5**	**3**

Course Outcomes:

After completion of this course, the students will be able to:

1. Prepare different microbial media and plating.
2. Isolate pure culture by streak, spread and pour plate method.
3. Handle different types of microscopes
4. Determine bacterial growth kinetics
5. Perform the assay of antibiotic by zone inhibition method.
6. Study the biochemical activity of micro organism by some standard tests: IMViC test, hydrolysis of starch, casein etc.

List of experiments:

1. General laboratory procedure; microbial safety and precaution; study of methods of sterilization
2. Preparation of microbial media and plating.
3. Isolation of pure culture by streak, spread and pour plate method.
4. Microscope and microscopy and identification of bacterial sample by differential staining.
5. Determination of microbial load in air, soil and water.
6. Determination of bacterial growth kinetics.
7. Assay of antibiotic by zone inhibition method.
8. Study of biochemical activity of micro organism by some standard tests: IMViC test, hydrolysis of starch, casein etc.
9. Isolation and morphological characterization of fungi.
10. Endospore staining.

Course Name : Human Values and Professional Ethics					
Course Code: HMTS2001					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**1**

Course Outcomes:

After completion of this course, the students will:

i) be aware of the value system and the importance of following such values at workplace
ii) learn to apply ethical theories in the decision making process
iii) follow the ethical code of conduct as formulated by institutions and organizations
iv) Implement the principles governing work ethics
v) Develop strategies to implement the principles of sustainable model of development
vi) Implement ecological ethics wherever relevant and also develop eco-friendly technology

Module-I [10L]

Human society and the Value System

Values: Definition, Importance and application.
Formation of Values: The process of Socialization
Self and the integrated personality
Morality, courage, integrity

Types of Values:

Social Values: Justice, Rule of Law, Democracy, Indian Constitution, Secularism
Aesthetic Values: Perception and appreciation of beauty
Organizational Values: Employee: Employer--- rights, relationships, obligations
Psychological Values: Integrated personality and mental health
Spiritual Values &their role in our everyday life
Value Spectrum for a Good Life, meaning of Good Life

Value Crisis in Contemporary Society

Value crisis at----
Individual Level
Societal Level
Cultural Level
Value Crisis management --- Strategies and Case Studies

Module-II [10L]

Ethics and Ethical Values
Principles and theories of ethics
Consequential and non-consequential ethics

Egotism,Utilatirianism, Kant's theory and other non-consequential perspectives
Ethics of care, justice and fairness, rights and duties
Ethics-- Standardization
Codification
Acceptance
Application
Types of Ethics--- Ethics of rights and Duties
Ethics of Responsibility
Ethics and Moral judgment
Ethics of care
Ethics of justice and fairness
Work ethics and quality of life at work
Professional Ethics
Ethics in Engineering Profession;
moral issues and dilemmas, moral autonomy(types of inquiry)
Kohlberg's theory, Giligan's theory(consensus and controversy)
Code of Professional Ethics Sample Code of ethics like ASME, ASCE. IEEE,Institute of Engineers,Indian Institute of materials management, Institute of Electronics and telecommunication engineers
Violation of Code of Ethics---conflict, causes and consequences
Engineering as social experimentation, engineers as responsible experimenters (computer ethics, weapons development)
Engineers as managers, consulting engineers, engineers as experts, witnesses and advisors, moral leadership
Conflict between business demands and professional ideals, social and ethical responsibilities of technologies.
Whistle Blowing: Facts, contexts, justifications and case studies
Ethics and Industrial Law
Institutionalizing Ethics: Relevance, Application, Digression and Consequences

Module-III: [10L]

Science, Technology and Engineering
Science, Technology and Engineering as knowledge and profession
----Definition, Nature, Social Function and Practical application of science
Rapid Industrial Growth and its Consequences
Renewable and Non- renewable Resources: Definition and varieties
Energy Crisis
Industry and Industrialization
Man and Machine interaction
Impact of assembly line and automation
Technology assessment and Impact analysis
Industrial hazards and safety
Safety regulations and safety engineering
Safety responsibilities and rights
Safety and risk, risk benefit analysis and reducing risk

Technology Transfer: Definition and Types
The Indian Context

Module-IV [10L]

Environment and Eco- friendly Technology
Human Development and Environment
Ecological Ethics/Environment ethics
Depletion of Natural Resources: Environmental degradation
Pollution and Pollution Control
Eco-friendly Technology: Implementation, impact and assessment

Sustainable Development: Definition and Concept
Strategies for sustainable development
Sustainable Development--- The Modern Trends

Appropriate technology movement by Schumacher and later development
Reports of Club of Rome.

Suggested Readings:

1. Tripathi,A.N., Human Values, New Age International, New Delhi,2006.
2. Ritzer, G., Classical Sociological Theory, The McGraw Hill Companies, New York, 1996.
3. Doshi,S.L., Postmodern Perspectives on Indian Society, Rawat Publications, New Delhi,2008.
4. Bhatnagar, D.K., Sustainable Development, Cyber Tech Publications, New Delhi, 2008.
5. Kurzwell, R., The age of Spiritual Machines, Penguin Books, New Delhi, 1999.
6. Weinberg, S.K., Social Problems in Modern Urban Society, Prentice Hall Inc.,USA, 1970.
7. Giddens, Anthony 2009. Sociology. London: Polity Press (reprint 13th Edition).

Course Name : Numerical and Statistical Methods					
Course Code: MATH2002					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

After completing the course, students will be able to:

1. Apply numerical methods to obtain approximate solutions to mathematical problems where analytic solutions are not possible.
2. Implement appropriate numerical methods for solving advanced engineering problems dealing with interpolation and integration.
3. Design stochastic models to predict the outcomes of events.
4. Recognize the significance of the expansion of a function in Fourier series.
5. Provide deterministic mathematical solutions to physical problems through partial differential equations.
6. Employ statistical methods to make inferences on results obtained from an experiment.

Module-I: Numerical solution to linear and non-linear equations [8L]

Solution of non-linear algebraic equations and transcendental equations:
Bisection Method, Newton-Raphson Method, Regula-Falsi Method.
SOLUTION OF LINEAR SYSTEM OF EQUATIONS:
Gauss elimination method, Gauss-Seidel Method, LU Factorization Method.

Module-II: Numerical solution to integration and ordinary differential equations [8L]

INTERPOLATION AND INTEGRATION:
Newton's Forward and Backward Interpolation Method, Lagrange's Interpolation, Trapezoidal and Simpson's $1/3^{rd}$ Rule.
SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS:
Euler's and Modified Euler's Method, Runge-Kutta Method of 4^{th} order.

Module-III: Fundamentals of Probability [5L]

Prerequisites- Set Theory.
Random experiment, Sample space , Events .
Definition of Probability,
Addition law of probability, Multiplication law and Conditional Probability.
Bayes' Theorem (Statement only)

Module-IV: Probability distributions and Statistics [15L]

Random Variables – Discrete and Continuous, Probability Mass Function, Probability, Density and Cumulative Distribution Functions, Mathematical Expectation and Variance.

Special Distributions: Binomial, Poisson, Uniform, Exponential and Normal.
Measures of Central Tendency and Dispersion – Mean, Median, Mode and Standard Deviation for grouped and ungrouped frequency distribution.
Simple Correlation and Regression.

Suggested Books:

1. Miller & Freund's Probability and Statistics for Engineers, R.A.Johnson Prentice Hall of India.
2. Numerical Mathematical Analysis, J.B.Scarborough, Oxford and IBH Publishing Co. Pvt. Ltd.
3. Numerical Methods (Problems and Solution), Jain, Iyengar & Jain, New Age International Publishers.
4. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons.
5. A First course in Probability, Sheldon Ross, Pearson.

Course Name : Thermodynamics and Kinetics					
Course Code: BIOT2201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcomes:

After completion of this course, the students will be able to:

1. Comprehend the thermodynamic properties and functions of different systems and processes.
2. Apply the thermodynamic laws in practical problems.
3. Relate the thermodynamic properties and functions to biological systems.
4. Explain effect of temperature on rate of reaction.
5. Determine the order of a reaction using different suitable analytical methods.
6. Understand the kinetic mechanism of enzyme-substrate reactions with/without the presence of inhibitor and solve related problems.

Module-I: Basic concept of thermodynamics [10L]

Concept of Enthalpy and Entropy; Phase Rule; PVT behavior of pure substances; Equation of states: Van der Waal's Equation, Virial Equation and its Application; Low temperature processes: Refrigeration and Liquefaction; Residual properties; Chemical Potential and Phase Equilibrium; Fugacity and Fugacity Coefficient; Vapour/Liquid Equilibrium, Roult's Law, Modified Raoult's Law, Henry's law.

Module-II: Bioenergetics and Thermodynamics [10L]

Importance of thermodynamic laws and free energy in Biological system; Thermodynamic properties to understand: Enzymes, ATP synthesis and hydrolysis within cell, metabolism and ATP yield; Protein folding and free energy funnel. Transport across membrane: active transport; activation energy; gradient of chemical potential as driving force in biological process.

Module-III: Kinetics [10L]

Rate of chemical reaction; Effect of Temperature on Rate Constant, Arrehnius equation, Collision Theory, Transition State Theory, Order and Molecularity of a Chemical reaction, Elementary Reactions, First, Second and Third order reactions, Non Elementary Reactions, Pseudo-first order reaction, Determination of rate constant and order of reaction, Half life method, Fractional order reactions.

Module-IV: Applications of Kinetics [10L]

Interpretation of batch reactor data for simple and complex reactions. Kinetics of Enzyme catalyzed reactions for free and immobilized enzymes–derivation of Michaelis-Menten equation, Briggs-Haldane relationship, the determination and significance of kinetic

constants, Lineweaver-Burk, Hanes–Woolf plot and Eadie-Hofstee plot, Principles of enzyme inhibition: competitive, noncompetitive and uncompetitive.

Textbook:

1. Smith & Vanness, Thermodynamics for Chemical Engineers, McGraw Hill & Co.
2. Levenspiel. O. Chemical Reaction Engineering, Wiley Eastern Ltd.

Reference books:

1. Richardson, J.F., Peacock, D.G. Coulson & Richardson's Chemical Engineering, Volume 3rd ed., First Indian ed. Asian Books Pvt. Ltd. 1998
2. Bailey & Olis, Biochemical Eng. Fundamentals, McGraw Hill & Co., 1990
3. Gordon G. Hammes, Thermodynamics and Kinetics for the Biological Sciences; John Wiley & Sons, Inc., Publication; 2000
4. Michael L. Shuler, Filkert Kargi, Bioprocess engineering: 2nd edition, Prentice Hall India.

Course Name : Transfer Operation-I					
Course Code: BIOT2202					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of this course, the students will be able to:

1. Understand thy physical properties of fluid, flow behavior and their consequence on fluid flow.
2. Apply the basic laws and equations to analyze fluid dynamics and solve numerical problems related to them.
3. Understand the importance of fluid flow measurement by various devices in industries.
4. Analyze and calculate various parameters involved in heat transfer by conduction, convection and thermal radiation.
5. Develop and design various equipment's associated with heat transfer and evaluate heat exchanger performance.
6. Develop the knowledge of principles of communition, mechanical separation aspects, working of equipments used in mechanical operation and calculate various parameters for energy requirement related to size reduction of solid.

Module-I: Basic concepts of Fluid Mechanics [10L]

Fluid – rheological properties – compressible, incompressible fluids. Newtonian and non Newtonian fluids. Basic equations of fluid flow, fluid flow phenomena – through pipes and other devices – pressure drop calculations. Fluid friction- friction in flow through packed beds. Fundamentals of fluidization and inverse fluidization, gravity settling, terminal settling velocity. Basic concept of multiphase flow-flow regime, pressure drop measurement.

Module-II: Flow measurements and machineries [10L]

Flow measuring devices- orifice and venturi meters, pitot tube, weirs, rotameters and other types of meters. Pipe fittings and valves. Pumps – classification, centrifugal and positive displacement type, peristaltic pump. Principle of compressor and blower.

Module-III: Heat transfer [10L]

Classification of heat flow processes- conduction, convection, radiation. Conduction- Steady state and unsteady state heat conduction. Heat flow in fluids by convection (natural and forced). Heat exchanger- double pipe and shell and tube heat exchanger. Basic concept of radiation.

Module-IV: Mechanical Operations [10L]

Principles of comminution, types of comminuting equipment, energy and power requirement. Crushing, grinding, mixing and agitation, power consumption in mixing. Mechanical separation- screening, filtration (constant pressure and constant rate), centrifugation.

Textbook:

1. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5th edition

Reference books:

1. Geankopolis, Transport Processes & Unit operations: 3rd edition, PHI.
2. Coulson & Richardson, Chemical Engineering, Vol-I & II:, Butterworth Heinemann
3. D.Q. Kern, Heat Transfer, MGH
4. Badger, W.L., Banchero, J.T., Introduction to Chemical Engineering, MGH
5. Foust, A.S., Wenzel, L.A, et.al. Principles of Unit Operations, 2nd edition, JWS

Course Name : Molecular Biology					
Course Code: BIOT2203					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Course Outcomes:

After completion of this course, the students will be able to:

1. Identify and analyze the different components and mechanism of replication.
2. Describe different types of DNA damage and repair systems and recombination process.
3. Comment on various components and detailed process of transcription.
4. Comment on various components and mechanism of translation.
5. Understood the rational of genetic code.
6. Comprehend on models of gene regulation and apply the knowledge of gene regulation as genetic switch.

Module-I: Replication and DNA repair in Prokaryotes & Eukaryotes [10L]

The biochemical basis of inheritance, DNA as the genetic material, Central Dogma of molecular biology. Organization of Genome. DNA Replication: Mechanism, Models; Initiation, Elongation & Termination; Enzymes and accessory proteins; Inhibitors of DNA replication; extrachromosomal replicons. Replication in DNA and RNA virus. Mechanisms of different types of DNA Repairs, SOS repair. Repair defects and human diseases. Recombination: Mechanism of general, site specific, recombination.

Module-II: Transcription in Prokaryotes & Eukaryotes [10L]

Structure of and function of different types of RNA, promoter, RNA polymerases: structure and assembly; RNA polymerase I, II, III, transcription factors, terminators. Process of transcription: Initiation, Elongation & Termination of transcription. Post Transcriptional Modifications: Processing of hnRNA, tRNA, rRNA, siRNA, miRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing (different types); RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA, RNA transport, localization and function. Inhibitors of transcription; Reverse transcription; Ribozyme.

Module-III: Genetic code & Translation in Prokaryotes & Eukaryotes [10 L]

Concept of genetic code: Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis. Components translationa: structure and function of ORF, tRNA, rRNA, Ribosomes, RBS, aminoacyl synthetases. Process of Translation: Initiation, Elongation, Termination, Proof-reading, Translational inhibitors. Post translational modifications of protein, Protein folding, Protein trafficking, Protein transport and degradation.

Module-IV: Regulation of Gene Expressions in Prokaryotes & Eukaryotes [10 L]

Molecular structure of gene and its nomenclature. Principle of gene regulation: Negative and Positive Regulation, Structure and function of gene regulatory protein. Regulatory elements: Promoter, Operator, Inducer, Repressor, Activators, Silencers, Insulators,

Enhancers. Gene regulation in Prokaryote: concept of Operon Model (*lac*, *gal*, *trp* and *ara* operon), Attenuation; antitermination in lambda virus. Gene regulation in Eukaryotes: DNA looping model, hormonal control of gene expression (steroid and non steroid), Role of chromatin, Chromatin remodeling, Gene silencing and Epigenetic regulation. Regulations at level of translation, Riboswitch.

Text books:

1. Molecular Biology of the Gene, 6th Edition, - by J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner.
2. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
3. Essentials of molecular Biology, by Malacinski and Freifelder Jones and Bartlelt Publishers.

Reference books:

1. Molecular and Cellular Biology- by Stefen Wolfe, Wordsworth Publishing Co.
2. Genomes, by T. A. Brown, John Wiley and Sons PTE Ltd.
3. Cell and molecular Biology, Concepts and experiments by Gerald Karp, John Wiley & Sons.
4. The Cell - A molecular approach, by G. M. Cooper, ASM Press.
5. Molecular biology of cell 4thed Alberts, Bruce; Watson, J D(2002) Garland Science Publishing,
6. Molecular cell biology 4th ed Lodish, Harvey and. Baltimore,D(2000) W.H. Freeman and Co.
7. Cell and Molecular Biology 8th ed, Robertis, EDP De & Robertis, EMF De(2002) lippincott, Williams & Wilkins international student edition.

Course Name : Industrial Microbiology and Enzyme Technology					
Course Code: BIOT2204					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**1**

Course Outcomes:

After completing this course, students will be able to:

1. Describe different methods for immobilization of enzymes.
2. apply enzymes in various industries that can benefit human life
3. Produce different useful secondary metabolites by microbes.
4. Modify the enzymes for better stability.
5. Design different biosensors for applications in biotechnology.
6. Develop the fermentation techniques and downstream processes.

Module-I: Fermentation process and high-yielding microbes [10L]

Definition and scope, Basic idea on fermentation process, submerged, stationary, solid and semi-solid – with their merits and demerits, Microbial Culture systems; Media for Industrial fermentations; Media optimization; Sterilization of Industrial Media, Cellular control regulating production of microbial metabolites – Primary and Secondary metabolite – Induced mutation technique – Analogue resistant mutant – Catabolic derepressed mutants – Genetically engineered strain – Protoplast fusion technique.

Module-II: Fermentation processes [10L]

Microbial production: Production of organic acids and solvents, microbial polysaccharides, amino acids, enzymes, vitamins, growth factors and hormones, antibiotics and vaccines, alcoholic beverages and other microbial food products.
Downstream processing and fermentation economics. Postproduction techniques and future.

Module III: Enzyme Technology [10L]

Enzyme : brief overview, classification and nomenclature , general characteristics ,Units of enzyme activity, physical and chemical factors affecting enzyme activity, outlines of extraction and purification of commercial enzymes from plant, animal and microbial sources, formulation and stabilization of commercial enzymes. Commercial enzymes: Industrial application Food processing Enzymes of Analytical, diagnostic and medicinal applications Stable enzyme : selection of extremophilic producer Stable enzymes by protein engineering Enzyme electrode & Enzyme sensor Use of Enzymes in non aqueous media.

Module IV: Enzyme applications [10L]

Chemical Modification of enzymes for better stability Enzyme immobilization –Physical and chemical methods for enzyme immobilization. Adsorption, matrix entrapment. Covalent binding, cross linking – advantages and disadvantages of different immobilization techniques. Immobilized enzyme kinetics

General overview on the use of enzymes in different industrial processes
Enzyme electrode and application as biosensor in biotechnology and environmental monitoring. Different bioreactors for processes using immobilized enzymes.

Text books:

1. L.E. Cassida.Jr, Industrial Microbiology, New Age International Publisher.
2. W. Crueger, Annelise Crueger, Biotechnology: A Textbook of Industrial Microbiology, Sinauer Assoc. Inc.
3. Fundamentals of Enzymology by Nicolas C. price and Lewis Stevens. Oxford University Press.
4. Enzymes by Trevor palmer, East west Press 3. Enzyme Technology by Messing

Reference books:

1. Prescott's and Dunn's, A. Industrial Microbiology, 4th edition. CBS Publishers, New Delhi, India, 1987.
2. Atkinson.B and Marituna.F, Biochemical Engineering and Biotechnology Handbok, The Nature Press, Macmillan Publ. Ltd.
3. Enzymes : Dixon and Webb.(IRL Press) Enzyme technology by Chaplin and Bucke. Cambridge University Press.
4. Biochemical engineering fundamentals, second edition. James E Bailey, David F., Ollis, McGraw Hill Intl. Edition.

Course Name : Language Practice Lab (Level 2)					
Course Code: HMTS 2011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

Course Outcomes:

After completing this course, students will be able to:

1. Acquire conversational skills in business scenario.
2. Deliver both impromptu and prepared speeches.
3. Organize information, data, pointofviews in a logical sequence and present them convincingly.
4. Participate actively in group discussions and brainstorming sessions.
5. Apply various techniques and strategies to successfully appear at job interviews.
6. Apply language competence for various communication purposes at workplace

Module-1: Formal verbal communication

- Introduction to formal verbal communication, Interpersonal Skills & Public Speaking: Building Positive Relationships, Focusing on Solving Problems, Time Management, Dealing with Criticism: Offering Constructive Criticism, Responding to Criticism – Managing Conflict: Approaches to Conflict, Resolving Conflict

- Conversational skills in the business scenario: One-to-one and Group communication, Gender and Culture Sensitivity, Etiquette, Sample Business Conversation, Telephonic Conversation

Module-II: Presentation skills

- Speech Purposes - General: Informative Speeches, Persuasive Speeches, Entertaining Speeches, Methods of Speaking: Speaking from a Manuscript, Speaking from Memory, Impromptu Delivery, Extemporaneous Delivery, Analyzing the Audience, Nonverbal Dimensions of Presentation

- Organising the Presentation: the Message Statement, Organising the Presentation: Organizing the Speech to Inform, The Conclusion, Supporting Your Ideas – Visual Aids: Designing and Presenting Visual Aids, Selecting the Right Medium, Post- presentation Discussion

Module-III: Group Discussion

- Introduction to Group Communication
  Factors in Group Communication, Status – Group Decision Making: Reflective Thinking, Brainstorming, Body Language, Logical Argument, The Planning

Process, Strategies for Successful GDs, Role of Social Awareness (Newspapers, Magazines, Journals, TV News, Social Media), Practice GDs

Module-IV: Job Application and Personal Interview

- **Job Application** Letter: Responding to Advertisements and Forced Applications, Qualities of Well-Written Application Letters: The You-Attitude, Length, Knowledge of Job Requirement, Reader-Benefit Information, Organization, Style, Mechanics – Letter Plan: Opening Section, Middle Section, Closing Section

- **Resume and CV:** Difference, Content of the Resume – Formulating Career Plans: Self Analysis, Career Analysis, Job Analysis, Matching Personal Needs with Job Profile – Planning your Resume – Structuring the Resume: Chronological Resume, The Functional Resume, Combination Chronological and Functional Resume – Content of the Resume: Heading, Career Goal or Objectives, Education, Work Experience, Summary of Job Skills/Key Qualifications, Activities, Honours and Achievements, Personal Profile, Special Interests, References

- **Interviewing**
  Types of Interviews, Format for Interviews: One-to-one and Panel Interviews, Employment Interviews, Frequently Asked Questions, Dress Code, Etiquette, Questions for the Interviewer, Simulated Interviews

References:

1. Carter, R. And Nunan, D. (Eds), The Cambridge guide to Teaching English to Speakers of Other Languages, CUP, 2001
2. Edward P. Bailey, Writing and Speaking At Work: A Practical Guide for Business Communication, Prentice Hall, 3rd Ed., 2004
3. Munter, M., Guide to Managerial Communication: Effective Business Writing and Speaking, Prentice Hall, 5th Ed., 1999
4. Raman, M. and Sharma, S., Technical Communication: Principles and Practice, 2nd Ed., 2011

Course Name : Numerical and Statistical Methods Lab					
Course Code: MATH 2012					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

Course Outcomes:

MATH2012.1 Execute numerical methods in C programming language.
MATH2012.2 Apply knowledge of C programming language to obtain approximate solutions to mathematical problems.
MATH2012.3 Reproduce customized programs to solve problems based on numerical methods.
MATH2012.4 Construct efficient, well-documented programs in C and present numerical results in an informative way.
MATH2012.5 Develop algorithms to handle large systems of equations appearing in physical and engineering problems.
MATH2012.6 Adapt skills to write efficient programs which can reduce the time and manual effort required for lengthy recursive calculations.

Development of computer programs in C for the following problems:

1. Regula-Falsi Method
2. Newton-Raphson Method
3. Gauss-elimination Method
4. Gauss-Seidel Method
5. Newton's Forward Interpolation
6. Lagrange's Interpolation
7. Trapezoidal and Simpson's $1/3^{rd}$ rule
8. Euler's and Modified Euler's Method
9. Runge-Kutta method of 4^{th} order
10. Computation of Mean , Median , Mode and Standard Deviation for grouped and ungrouped frequency distribution
11. Computation of Correlation coefficient and Regression equation for Bivariate data.

Course Name : Transfer Operations-I Lab					
Course Code: BIOT2211					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

Course Outcomes:

After completion of this course, the students will be able to:

1. Design and conduct experiments on flow measurement by venturimeter.
2. Compare the energy loss that occurring in flow measuring devices like venturimeter and orificemeter.
3. Calibrate flow measuring device like rotameter.
4. Conduct experiment, analyze and interpret the data of packed bed reactor operation.
5. Evaluate the performance and calculate the heat transfer coefficient of a double pipe heat exchanger.
6. Understand the operation of comminution equipments like ball mill, jaw crusher and find the energy consumption in operation of those equipments.

List of experiments:

1. Experiments on Reynold's Apparatus-Determination of flow regime and plot of friction factor against NRe.
2. Experiments on flow measuring device—in closed conduit using Venturi meter.
3. Experiments on flow measuring device—in closed conduit using Orifice meter.
4. Experiments on flow measuring device—in closed conduit using Rotameter.
5. Determination of Pressure drop for flow through packed bed & verification of Ergun Equation, Kozeny-Karman equation, Blake-Plummer Equation.
6. Determination of pressure drop in flow through fluidized bed.
7. To study the working characteristics of a Jaw Crusher, calculate the energy consumption as a function of size reduction and compare it with the actual energy requirements.
8. To study the working characteristics of a Ball Mill, calculate the energy consumption as a function of size reduction and determine the critical speed.
9. To Determine the Overall heat transfer coefficient of a double pipe heat exchanger.
10. Determination of thermal conductivity of metal rod or powder.

Course Name : Molecular Biology Lab					
Course Code: BIOT 2212					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

Course Outcomes:

After completion of this course, the students will be able to:

1. Separate and visualize mixtures of DNA or mixtures of RNA or mixtures of protein.
2. Explain the mechanism of visualization of DNA, RNA and protein.
3. Determine the molecular size of unknown protein and DNA.
4. Estimate the amount of DNA, RNA and protein from a unknown solution by spectrophotometer.
5. Understood the basics of electrophoresis.
6. Able to design experiment to study gene regulation

List of experiments:

1. Agarose Gel Elctrophoresis (AGE).
2. Isolation of Genomic DNA from blood or plant cell or bacterial cell and analysis by AGE.
3. Isolation of Plasmids DNA and analysis by AGE.
4. Determination of molecular size of DNA.
5. Estimation of DNA, RNA and Protein by spectroscopic method.
6. Isolation of RNA and separation by Formaldehyde Agarose gel electrophoresis.
7. Isolation of proteins from bacterial cells and separation by SDS-PAGE.
8. Induced mutation by: (a) Chemical (b) Ultraviolet light.
9. Phage Titration.

Reference Book:

Molecular Cloning – A laboratory manual: 3rd Edition Vol. 1-3. Sambrook J and Russell D.W. (2001). CSHL Press, New York

Course Name : Enzyme Technology & Fermentation Technology Lab					
Course Code: BIOT2214					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

Course Outcomes :

After completion of the course, students will be able to:

1. Draw different types of Bioreactors and different components of Bioreactors.
2. Study acid hydrolysis of sucrose in CSTR at different temperature.
3. Carry out immobilization of enzyme by entrapment method.
4. Study Batch Fermentation and assay of Antibiotics (like Penicillin /Streptomycin).
5. Design the steps of production and recovery of Alcohol.
6. Produce different metabolites by Solid State Fermentation technique/process.

List of experiments :

1. Basic Drawing of different types of Bioreactors [Air Lift Reactor (ALR), Bubble column, Continuous Stirred Tanked Reactor (CSTR)] and different components of Bioreactors.
2. Familiarization of different types of analytical instruments including Air Compressor and Autoclave (to know the operation with real sample).
3. Acid hydrolysis of sucrose in CSTR at different temperature.
4. Enzymatic hydrolysis of starch in ALR.
5. Immobilization of enzyme by entrapment method.
6. Operation of immobilized enzyme reactor using a Packed Bed Reactor.
7. Batch Fermentation and Assay of Antibiotics (like Penicillin / Streptomycin).
8. Production of Alcohol (Fermentation and Recovery)
9. Batch Fermentation of Organic Acid
10. Solid State Fermentation

Course Name : Economics for Engineers					
Course Code: HMTS3101					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcome:

The student will be able to-

1. Evaluate a project and estimate the total cost of the project.
2. Apply financial analytical methodologies to prepare a report regarding the financial performance of an organization.
3. Participate actively in an organization's capital budgeting process.
4. Provide vital inputs regarding the pricing of a product.
5. Apply the knowledge of the interplay of various economic variables and indicators in workplace.
6. Provide insight about different accounting concepts and apply broader concepts like costs, revenues, assets, liabilities, capital, profit, investment and interest.

Module 1:

Market: Meaning of Market, Types of Market, Perfect Competition, Monopoly, Monopolistic and Oligopoly market.
The basic concept of economics – needs, wants, utility.
National Income-GDP, GNP. Demand & Supply, Law of demand, Role of demand and supply in price determination, Price Elasticity.
Inflation: meaning, reasons, etc. (6L)

Module II:

Business: Types of business, Proprietorship, Partnership, Joint-stock company, and cooperative society – their characteristics.
Banking: role of commercial banks; credit and its importance in industrial functioning. Role of central bank: Reserve Bank of India.
International Business or Trade Environment. (4L)

Module III:

Financial Accounting-Journals. Ledgers, Trial Balance, Profit & Loss Account, Balance Sheet.
Financial Statement Analysis (Ratio and Cash Flow analysis). (8L)
Cost Accounting- Terminology, Fixed, Variable and Semi-variable costs.
Break Even Analysis. Cost Sheet. Budgeting and Variance Analysis.
Marginal Cost based decisions. (6L)

Module IV:

Time Value of Money: Present and Future Value, Annuity, Perpetuity.
Equity and Debt, Cost of Capital. (4L)
Capital Budgeting: Methods of project appraisal - average rate of return - payback period - discounted cash flow method: net present value, benefit cost ratio, internal rate of return.
Depreciation and its types, Replacement Analysis, Sensitivity Analysis. (8L)

Suggested Readings:

1. R. Narayanswami, *Financial Accounting- A Managerial Perspective.* Prentice-Hall of India Private Limited. New Delhi
2. Horne, James C Van, *Fundamentals of Financial Management*. Prentice-Hall of India Private Limited, New Delhi
3. H. L. Ahuja., *Modern Economic Theory*. S. Chand. New Delhi.
4. Newman, Donald G., Eschenbach, Ted G., and Lavelle, Jerome P. *Engineering Economic Analysis.* New York: Oxford University Press. 2012.

Course Name : Genetics					
Course Code: BIOT3101					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

After completing the course, the students will be able to:

1. Understand the basic principles of Mendelian mode of inheritance and also analyze the reasons behind the exceptions to this phenomenon.
2. Interpret the different modes of linkage, sex determination patterns and chromosomal abnormalities.
3. Identify and analyze the genetic network of carcinogenesis to reach out for novel therapeutic strategies.
4. Comprehend the mechanism of action of microbial genetics and genetic patterns of embryonic development.
5. Apply the mathematical and biostatistical models in biological systems for testing of hypotheses, estimation of group differences and case-control studies.
6. Use the Hardy-Weinberg model to quantify the allele frequency in a population for better understanding of evolutionary changes and gene flow.

Module I: Classical Genetics and its deviations [10L]
Principles of Mendelian inheritance, multiple alleles, pseudoallele, Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and chromosome mapping, sex linkage, sex limited and sex influenced characters; sex determination, extra-nuclear inheritance, special types of chromosomes; structural and numerical chromosomal abnormalities and their genetic implications; pedigree analysis, lod score for linkage testing, linkage disequilibrium.

Mod-II: Mutation and Cancer Genetics [10L]
Gene Mutation: Induced and spontaneous mutation**,** mutation types, causes and detection, mutant types. Molecular basis of genetic disorders, karyotypes, inborn errors of metabolism. Cancer Genetics: genetic rearrangements in progenitor cells, oncogenes, proto-oncogenes, tumour suppressor genes – p53, RB and others, virus-induced cancer; cell cycle check points and cancer.

Module III: Microbial and Developmental Genetics [10L]
Methods of genetic transfers: transformation, conjugation, transduction and sex-duction. Gene mapping methods: interrupted mating, recombination and complementation analysis. Genetics of animal virus. Developmental genetics in Drosophila model: egg-polarity genes and formation of body axes; molecular control of segmentation: gap genes, pair-rule genes, segment polarity genes; homeotic genes, Wnt and cadherin pathways; cellular ageing & senescence.

Module IV: Biostatistics and Population Genetics [10L]

Biostatistics: Mean, median, mode, standard deviation, variance, discrete and continuous probability distributions, Poisson, normal and binomial distributions; T test, chi-square analysis, ANOVA. Population genetics: Hardy-Weinberg equilibrium, allele frequency and genotype frequency. Extensions of H-W equilibrium: mutation, selection, continuous variation, genetic drift, migration.

Textbook:

1. Concepts of Genetics, 7th edition. M.R. Cummings, A.W. Klug. Pub: Pearson Education.
2. Genetics, 3rd edition. M.W. Strickberger. Pub: Pearson Education.

Reference Books:

1. Introduction to Genetic Analysis, 8th edition, Anthony J. F. Griffiths, Jeffrey H. Miller, David T. Suzuki, Richard C. Lewontin, and William M. Gelbart. Pub: W.H. Freeman & Co.
2. Principles of Genetics, 5th edition. D. Peter Snustad, Arthur J. Simmons. Pub: John Wiley & Sons.
3. iGenetics: a Conceptual Approach, 3rd edition. Peter J. Russell. Pub: WH Freeman & Co.
4. Microbial Genetics, 2nd edition. Stanley R. Maloy, John E. Cronan, David Freifelder. Pub: Jones and Bartlett Publisher Inc.
5. Genetics: analysis of genes and genomes, 6th edition. D.L. Hartl & E.W. Jones. Pub: Jones and Bartlett Publishers.
6. An introduction to Human Molecular Genetics: Mechanism of Inherited Diseases. 2nd edition. J. Pasternak. Pub: Fitzgerald Science Press.
7. Developmental Biology, 10th edition. S.F. Gilbert. Pub: Sinauer Associates.
8. Introduction to Biostatistics, 2nd edition, Pranab Kumar Banerjee. Pub: S. Chand & Co.
9. Problems on Genetics, Molecular Genetics and Evolutionary Genetics. Pranab Kumar Banerjee. New Central Book Agency Pvt. Ltd.
10. Statistics in Biology and Psychology, 4th edition. Debajyoti Das, Arati Das. Academic Publishers.

Course Name : Bioinformatics					
Course Code: BIOT3102					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

After completing the course, the students will be able to:

1. Gain and analyze knowledge about genes and proteins obtained through primary, secondary and specialized databases (e.g. NCBI, PDB).
2. Learn and apply principles and methodologies of pairwise and multiple sequence alignment towards biological problems (e.g. Smith Waterman, Needleman and Wunsch, CLUSTAL algorithm).
3. Learn and apply principles of gene prediction algorithms with respect to prokaryotic gene systems (e.g. Hidden Markov Model based gene annotation).
4. Learn and apply PERL for bioinformatics data interpretation (e.g. sequence analysis, protein to DNA translation).
5. Learn and apply principles and algorithms for secondary and tertiary structure prediction of globular and fibrous proteins (e.g. homology modeling, fold recognition methodologies).
6. Use introductory applications of bioinformatics procedures and protein structure prediction techniques to molecular modeling, molecular docking and virtual screening using representative examples.

Module 1: Bioinformatics Resources and Databases [10L]
Definition and application of bioinformatics to biological research; Introduction to different primary and secondary databases (viz: Genbank,PDB) introduction to different modules of NCBI

Module 2: Sequence Analysis of proteins and nucleic acids [10L]
Introduction to sequence analysis, Basic concepts: Sequence similarity, identity and similarity, definitions of homologues, orthologues, paralogues, Tandem and Interspersed repeats, local and global alignment, pair wise and multiple alignment, sequence alignment algorithm: Needleman - Wunsch and Smith-Waterman algorithms; Substitution Matrices; Introduction to phylogenetics analysis through multiple sequence alignment: CLUSTALW A brief introduction to gene prediction

Module 3: Perl Programming [10L]
Accessing and installing Perl and BioPerl , Using modules, like BioPerl. Sequences and Strings: Variables, Arrays, Files .Motifs and Loops-Flow control, String operators, Writing files. Subroutines –Scoping, Arguments, Command line arguments, passing data to subroutines, Modules and Libraries, Debugging. Data Structures and Algorithms for Biology-Hashes, Translating DNA into Proteins, Working with the FASTA Format, Reading frames. Regular

Expressions.

Module 4: Protein structure prediction and drug designing [10L]
Hierarchical organization of protein structures-e.g.SCOP, CATH; Secondary structure prediction via Chou-Fasman , GOR and other methods; Hidden Markov Model and Neural network algorithms and their applications; 3D protein structure prediction using homology modeling, fold recognition and ab-initio methods; CASP; Drug design applications: Receptor-ligand interactions; binding sites, docking and virtual screening; Structure and Ligand Based drug design; QSAR and in silico predictions of drug activity and ADMET.

Textbook:

1. Xiong.J, Essential Bioinformatics, Cambridge University Press
2. An Introduction to Bioinformatics, Arthur W. Lesk, Cambridge University Press.
3. Bioinformatics-Principles and applications-Ghosh and Mallick- Oxford University Press.
4. James Tisdall, Beginning Perl for Bioinformatics, SPD

Reference books:

1. Cynthia Gibbs and Per Jambeck, Introduction to Bioinformatics computer Skills, 2001 SPD
2. Atwood, Introduction to Bioinformatics, Person Education
3. Baxevanis, A.D, Quellette. B.F.F, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.
4. Andrew Leach, Molecular Modelling: Principles and Applications,Pearson Education
5. Molecular Modelling and Drug Design-K.Anand Solomon-1st edition (2011)-MJP Publishers

Course Name : Recombinant DNA Technology					
Course Code: BIOT3103					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

After completion of this course, student will be able to

1. Understand mechanism of action and the use of the different DNA modifying enzymes, vectors and host in recombinant DNA technology and solve and analyze the problems of restriction mapping.
2. Explain and demonstrate the different techniques of recombinant DNA technology like labelling of probe, DNA, RNA and protein sequencing, blotting and hybridization, microarray; ELISA; separate and identify nucleic acid and protein by electrophoresis and chromatography, and apply the knowledge to solve and analyse problem related to these techniques.
3. Demonstrate the mechanism of standard, quantitative and different modified polymerase chain reactions (PCR), use of PCR in DNA cloning and solve and analyse problems related to PCR.
4. Apply the different types of cloning and expression methods of gene in biotechnology and screen, identify, modify and analyse the cloned gene; explain the creation and screening of genomic and cDNA library in different vectors.
5. Understand and demonstrate the applications of recombinant DNA technology in different filed of biotechnology like gene therapy, human genome project, production of recombinant vaccine, explain the creation of transgenic animals and plants, construct recombinant biopharmaceutical, analyze and use of molecular biomarkers in disease diagnostics, forensic science with analysis of gene expression
6. Analyze and solve problems related to rDNA technology.

Module -I: Tools of Recombinant DNA Technology [10L]

DNA & RNA manipulating enzymes and other tools used in Recombinant DNA technology: Restriction endonuclease; DNA polymerases (DNA Pol I, T4, T7, Taq), reversetranscriptases, DNA ligases; alkaline phosphatases; polynucleotidekinase; terminal deoxy-nucleotidetransferase; topoisomerases; DNase; RNase and others; linker and adapter. Physical map, specific host and features of Vectors: Plasmids, bacteriophage vectors, cosmids, phagemids, PAC, BAC, YAC, and MAC, Expression vectors (pET vectors, Baculovirus vectors and others).

Module -II: Techniques Recombinant DNA Technology: [10L]

DNA and RNA labeling (radioactive and non radioactive methods); Restriction mapping; DNA sequencing (Maxum & Gilbert, Sangers, pyro-sequencing, and others methods); Protein and RNA sequencing; Polymerase chain reactions (PCR), different modified PCR and Real time

PCR; Techniques of separation of nucleic acid and protein (electrophoresis, chromatography and others); Southern, northern, and western blotting & hybridization; In-situ hybridization; Site-directed mutagenesis; DNA and protein based microarray.

Module -III: Gene Cloning Methods: **[10L]**

Isolation and preparation of DNA fragments from prokaryotic and eukaryotic source; Different types of cloning and expression methods of gene in prokaryotic and eukaryotic host cell system using different vectors (by restriction enzyme, PCR product cloning and other methods); Transfer of recombinant DNA into host; Screening & Expression of cloned gene; Gene isolation; Subcloning strategies; Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors and their screening.

Module - IV: Application of Recombinant DNA technology [10L]

Genetically engineered vaccine; DNA vaccine; recombinant Biopharmaceuticals (insulin, human growth factor and others); Gene therapy (gene transfer technologies, antisense and ribozyme technology); Molecular biomarker in disease diagnostics and forensic science (RFLP, RAPD, AFLP SNP, EST and others), DNA fingerprinting; Human genome project (strategies for genome sequencing and its application); Genetically modified organism and food; Large scale gene expression analysis.

Textbook:

1. Principles of Gene Manipulation& Genomics, 7th Ed, (2006) Old and Primrose, Pub: Blackwell Scientific.
2. Genetic Engineering by S. Rastogi and N. Pathak, Pub: Oxford Univ. Press.
3. Molecular Cloning: A Laboratory Manual (3-volume set 4th Edn.): (2012) by Michael R. Green, Joseph Sambrook , Pub: CSHL press

Reference books:

1. Molecular Biotecnology: Principles and Applications of Recombinant DNA, 4th Edn. (2010) by Glick, Pasternak and Pattern. Pub: ASM press
2. Recombinant DNA: Genes and Genomes - A Short Course, 3rd Edn. (2007) by James D. Watson, Richard M. Meyers , Amy A. Caudy, Jan A. Witkowski. pub: CSHL
3. H.K. Das, Text Book of Biotechnology, 4th ed, 2010, Wiley Publishers
4. Genetics a Molecular Approach, 7th Ed (2010) by Brown, T.A., pub: Chapman and Hall,
5. Genomes, 3rd ed (2006) by Brown TA, Pub: Garland Science
6. Human Molecular Genetics, 4th Ed. (2011) by Tom Strachan, Andrew Read**,** Pub: Garland Science

Course Name : Transfer Operations - II					
Course Code: BIOT3104					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

After completing the course, the students will be able to:

1. Understand the concept of diffusion and diffusivity and identify the type of diffusion in a given problem and solve it.
2. Determine gas-liquid mass transfer coefficient in a wetted wall column or packed bed absorption column and calculate the number of stages required for the unit operation.
3. Apply McCabe-Thiele Method and Rayleigh's equation as required in a distillation process.
4. Comprehend different other unit operations like adsorption, liquid-liquid extraction and crystallization explicitly.
5. Draw the drying characteristic curve under a given constant drying condition.
6. Study and apply the principle and operation of different advanced separation processes like dialysis, ultrafiltration, reverse osmosis, pervaporation and electrodialysis in the field of biotechnology.

Module I: Introduction to Mass Transfer [10L]

Introduction to Mass Transfer: Molecular diffusion in fluids. Diffusivity, Mass Transfer Coefficients, Interphase

Mass Transfer, Gas Absorption, co-current and counter-current multistage operation, Packed Tower, Drying, adsorption and Leaching principles

Module II: Distillation [10L]

Distillation: Vapor-liquid equilibrium, Rayleigh's Equation, Flash and Differential distillation, McCabe-Thiele Method to determine stages

Module III: Miscellaneous Mass Transfer Operations [10L]

Liquid–liquid equilibrium. Liquid extraction, Stagewise contact; Adsorption Equilibria: batch and fixed bed adsorption, Batch drying and mechanism of batch drying. Freeze drying, Basic idea of crystallization

Module IV: Advanced Separation Processes [10L]

Advanced Separation Processes: Dialysis, Ultrafiltration, Reverse osmosis, Pervaporation, Electrodialysis and Membrane separation- Principle and operation

Textbook:

1. Unit Operations of Chemical Engineering: McCabe,Smith & Harriot, TMH, 5thedition

Reference books:

1. Transport Processes & Unit operations: Geankopolis, PHI, 3rd edition
2. Chemical Engineering, Vol-I & II: Coulson & Richardson, Butterworth Heinemann
3. Treybal, R.E., Mass-Transfer Operations, MGH 4. Perry, Chilton & Green, Chemical Engineers' Handbook, MGH

Course Name : Data Structure & Algorithm					
Course Code: CSEN3106					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

Upon successful completion of this course students should be able to:

1. Identify and select appropriate data structures as applied to specified problem definition.
2. Implement operations like searching, insertion, deletion, traversal etc. on linear data structures like array, stack and queue.
3. Implement operations like searching, insertion, deletion, traversal etc. on nonlinear data structures like tree and graph.
4. Apply appropriate sorting/searching technique for given problem.
5. Analyze and compare the different sorting algorithms.
6. Design advanced data structure using Nonlinear data structures.

Module -I. Linear Data Structure I [8L]

Introduction (2L):

Why we need data structure?

Concepts of data structures: a) Data and data structure b) Abstract Data Type and Data Type. Algorithms and programs, basic idea of pseudo-code.Algorithm efficiency and analysis, time and space analysis of algorithms – order notations.

Array (2L):

Different representations – row major, column major. Sparse matrix - its implementation and usage. Array representation of polynomials.

Linked List (4L):

Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.

Module -II: Linear Data Structure II [6L]

Stack and Queue (4L):

Stack and its implementations (using array, using linked list), applications.

Queue, circular queue, deque. Implementation of queue- both linear and circular (using array, using linked list)

Recursion (2L):

Principles of recursion – use of stack, differences between recursion and iteration, tail recursion.

Module -III. Nonlinear Data structures [13L]

Trees (9L):

Basic terminologies, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-, in-, post- order), threaded binary tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree (insertion, deletion with examples only). B- Trees – operations (insertion, deletion with examples only).

Graphs (4L):

Graph representations/storage implementations – adjacency matrix, adjacency list,
Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS)

Module - IV Searching, Sorting, Hashing. [9L]

Sorting Algorithms (5L):

Bubble sort, insertion sort, selection sort, merge sort, quicksort, heap sort, radix sort.

Searching (1L):

Sequential search, binary search

Hashing (3L):

Hashing functions, collision resolution techniques (Open and closed hashing).

Recommended books:

1. "Data Structures And Program Design In C", 2/E by Robert L. Kruse, Bruce P. Leung.
2. "Fundamentals of Data Structures of C" by Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed.
3. "Data Structures in C" by Aaron M. Tenenbaum.
4. "Data Structures" by S. Lipschutz.
5. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein.

Course Name : Genetics lab					
Course Code: BIOT3111					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Course Outcomes:

After completing the course, the students will be able to:

1. Estimate the mean, median, mode and standard deviation using basic concepts of biometry in a biological data series.
2. Identify the different patterns of inheritance by studying family pedigrees.
3. Prepare a microscopic slide from human tissue and identify the Barr body.
4. Prepare and identify different stages of mitosis and meiosis from animal and plant cells.
5. Analyze human karyotype patterns and identify chromosomal abnormalities.
6. Estimate the viability of cells upon exposure to chemical mutagens.

List of Experiments:

1. Biometry
2. Finding statistical significance of a given data using ‘t test’
3. Pedigree analysis
4. Preparation of different stages of Mitosis and Meiosis
5. Estimation of mitotix index
6. Barr body preparation from buccal smear
7. Cell viability assay
8. Karyotyping analysis and human chromosomal syndromes identification
9. Study of chromosomal aberrations in animal and plant cells.

Course Name : Bioinformatics lab					
Course Code: BIOT3112					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Course outcomes:

Upon completion of this practical course students should be able to

1. learn and utilize public domain biological/bioinformatic databases (NCBI, EMBL-EBI, PDB) *for routine research driven applications*
2. learn and utilize public domain bioinformatics tools for sequence analysis of genes and proteins (combining both pairwise and multiple sequence alignment)
3. learn and utilize public domain bioinformatics tools (including use of HMM) for annotation and structure prediction of prokaryotic genes
4. learn and utilize public domain bioinformatics tools (Homology modeling and threading based) for secondary and tertiary structure prediction of globular and fibrous proteins and subsequent structural analysis.
5. learn and compile simple bioinformatics tasks using PERL (Practical Extraction and Reporting Language) commands.

List of experiments

1. Basic understanding of biological databases.
2. Pair wise sequence alignment (LOCAL and GLOBAL Alignment)
3. Multiple sequence alignment (CLUSTALW)
4. Introduction to Gene Prediction
5. Prediction of Secondary structure of globular and membrane proteins
6. *In silico* analysis of enzyme and other biomolecular modifications
7. Structure viewer and analysis; protein 3D structure prediction
8. Basics of molecular modeling and protein-ligand binding
9. PERL Programming

Course Name : Recombinant DNA Technology lab					
Course Code: BIOT3113					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Course Outcomes:

After completion of this lab, student will be able to

1. Clone DNA fragment using restriction enzyme and DNA ligase.
2. Select of recombinant DNA clone by restriction analysis and blue-white selection.
3. Identify the clone either by southern blotting or western blotting.
4. Design PCR primer and amplification of DNA by PCR.
5. Over-express the cloned gene at protein level and analysis by SDS-PAGE.
6. Purify protein by one chromatography technique.

List of experiments:

1. Restriction enzyme digestion of DNA and construction of Restriction map.
2. Extraction of DNA from agarose gel.
3. Ligation of DNA fragments with cloning vector pUC18 or pBR322.
4. Preparation of competent cells and Transformation into *E.coli* with recombinant vector.
5. Isolation of recombinants and confirmation of insert DNA in vector.
6. Primer design for PCR and amplification of DNA by PCR.
7. Expression of cloned gene.
8. Southern/Western/Northern blotting
9. DNA finger printing

Course Name : Transfer Operations – II lab					
Course Code: BIOT3114					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Course Outcomes:

At the end of this course students will be able to

1. Verify Rayleigh's equation in batch distillation process.
2. Determine gas-liquid mass transfer coefficient in a wetted wall column or packed bed absorption column.
3. Study the drying characteristic curves under constant drying condition in tray dyer.
4. Determine Distribution Coefficient in liquid- liquid extraction operation.
5. Measure adsorption efficiency and draw the adsorption isotherm using activated carbon as an adsorbent in a batch reactor
6. Calculate diffusivity of a volatile liquid.

List of experiments:

1. Batch Distillation to verify Rayleigh's equation.
2. Drawing the vapour-liquid equilibrium diagram from Othmer Still.
3. Study of performance of a Rectification Column.
4. Determination of gas-liquid mass transfer coefficient (Wetted Wall column or packed bed).
5. Study of drying characteristic curves under constant drying condition in tray dyer.
6. Determination of Distribution Coefficient in liquid- liquid extraction operation
7. Study of adsorption efficiency and adsorption isotherm using activated carbon as an adsorbent in a batch reactor.
8. Calculation of diffusivity of a volatile liquid

Course Name : Data Structure & Algorithm lab					
Course Code: CSEN3116					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Course Outcomes:

Upon successful completion of this course students should be able to:

1. Identify the appropriate data structure for given problem.
2. Understand the concept of Dynamic memory management, data types, algorithms etc.
3. Understand and implement basic data structures such as arrays, linked lists, stacks and queues.
4. Implement various applications involving array, stack, queue and linked lists.
5. Solve problem involving graphs and trees.
6. Apply algorithm for solving problems like sorting and searching.

List of experiments:

1. Implementation of array operations.
2. Stacks and Queues: adding, deleting elements Circular Queue: Adding & deleting elements Merging Problem.
3. Evaluation of expressions operations on Multiple stacks & queues.
4. Implementation of linked lists: inserting, deleting, inverting a linked list.
5. Implementation of stacks & queues using linked lists
6. Polynomial addition.
7. Sparse Matrices : addition.
8. Recursive and Nonrecursive traversal of Trees.
9. DFS and BFS.
10. Application of sorting and searching algorithms.

Course Name : Principles of Management					
Course Code: HMTS3201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	2

Course Outcomes:

The student will be able to-

1. Apply tools of Human resource management and manage his/her team
2. Provide relevant input in the decision making process of the organization.
3. Evaluate employee output and implement the process of performance appraisal in a professional manner.
4. Create scope for personal development through interactive thought process.
5. Provide understanding about the principles and practices of management and implement them at workplace.
6. Improve managerial operations both from individual and organizational point of view.

Module I:

Management: Definition, nature, purpose and scope of management, Skills and roles of a Manager, functions, principles; Evolution of Management Thought: Taylor Scientific Management, Behavioral Management, Administrative Management, Fayol's Principles of Management, Hawthorne Studies. (4L)

Module II:

a) Planning: Types of plans, planning process, Characteristics of planning, Traditional objective setting, Strategic Management, premising and forecasting.
b) Organizing: Organizational design and structure, Coordination, differentiation and integration.
c) Staffing: Human Resource Management and Selection, Performance appraisal and Career strategy, Managing Change.
d) Decision-Making: Process, Simon's model of decision making, creative problem solving, group decision-making.
e) Coordinating: Concepts, issues and techniques.
f) Controlling: Concept, planning-control relationship, process of control, Types of Control, Control Techniques (8L)

Module III:

Span of management, centralization and de-centralization Delegation, Authority & power - concept & distinction, Line and staff organizations. (4L)

Module IV:

Organization Behaviour: Motivation, Leadership, Communication, Teams and Teamwork. (6L)
Management by Objectives (MBO): Management by exception; Styles of management: (American, Japanese and Indian), McKinsey's 7-S Approach, Self Management. (2L)

Suggested Readings:

1. Harold Koontz & Heinz Weihrich, Essentials of Management, TMH.
2. Stoner, Freeman, Gilbert Jr., Management, PHI.
3. Bhatt & Kumar, Principles of Management, OUP.

Course Name : Immunology					
Course Code: BIOT3201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

After completing the course, the students will be able to:

1. Understand the basic principles of innate and adaptive immunity and the underlying mechanisms of cellular and humoral immune responses.
2. Develop an idea about strcuture, biogeensis, function and molecular diversity of different antibody classes.
3. Apply the techniques of antibody engineering and antigen-antibody reactions in disease diagnostics and research.
4. Analyze the role of MHC molecules in transplantation and the diseases due to their incompatibility.
5. Understand the immunological basis of hypersensitivity, autoimmunity and immunodeficiency disorders.
6. Gain knowledge about different approaches of vaccine development and their applications in human diseases.

Module 1: Basics of Immunology [10L]

History and evolution of immune system; innate and acquired immunity, hematopoiesis; humoral and cell-mediated immunity; cells of the immune system; complement system: activation pathways, functions and regulation; primary and secondary lymphoid organs: structure and function; concept of epitope, immunogens, haptens, adjuvants;
B and T cells: maturation, activation and differentiation; organization and rearrangement of TCR genes; macrophage and other Antigen Presenting Cells (APCs).

Module II: Antibodies: structure, functions and applications [10L]

Structure and function of antibody classes, concept of isotype, allotype and idiotype;
genetic basis of antibody diversity: DNA rearrangements, somatic hypermutation, class switching, allelic exclusion; antibody engineering; phage display libraries; antibodies as *in vitro* and *in vivo* probes, abzymes; primary and secondary immune response; monoclonal antibody: hybridoma technology and applications, recombinant and chimeric antibodies, humanized and bispecific antibodies, immunotoxins; antigen-antibody reaction and its application; immunoelectrophoresis, Immunodiffusion, RIA and ELISA.

Module III: Major Histocompatibility Complex (MHC) and host-graft reactions [10L]

General organization, structure and functions of MHC molecules; antigen processing and presentation; transplantation immunology: graft versus host reaction, HLA typing,

immunosuppressive therapy; development of inbred mouse strain, blood group classification and Rh factor; cytokines and other co-stimulatory molecules.

Module IV: Immune tolerance, immune disorders and vaccinology [10L]
Immune tolerance: T cell anergy and T cell elimination; hypersensitivity reactions; autoimmunity with respect to Myasthenia gravis and Rheumatoid arthritis; immunodeficiency, animal models for disease study; tumour immunology: tumour antigens, tumor vaccines and immunotherapy; active and passive immunization: live, killed, attenuated, sub-unit vaccines; vaccine technology: recombinant DNA and protein based vaccines, plant-based vaccines; reverse vaccinology; peptide vaccines, conjugate vaccines.

Text books:

1. Immunology and Immune Technology by A. Chaktraborty, Oxford Univ. Pub.
2. Weir, Immunology, 8th ed, W.B. Saunders & Co.

Reference books:

1. Kuby Immunology, 6th edition. T. Kindt, R. Goldsby, B. Osborne. Pub: W.H. Freeman & Co.
2. Immunology, 7th edition. D. Male, J. Brostaff, D. Roth & I. Roitt, I. Pub: Mosby.
3. Cellular and molecular Immunology, 6th edition. .A.K. Abbas, A.H. Lichtman, S. Pillai. Pub: Saunders.
4. Fundamental Immunology, 7th edition. William E. Paul. Pub: Lippincott Williams & Wilkins.
5. Technological Applications of Immunochemicals (BIOTOL). L.S. English. Pub: Butterworth- Heinemann, Oxford Freeman & Co.
6. Immunology. C.V.Rao. Pub: Narosa Publishing House, New Delhi.
7. Janeway's Immunobiology, 7th edition. K. M. Murphy, P. Travers, M. Walport. Pub: Garland Science.
8. Immunology: An Introduction. Tizard. Pub: Cengage Learning India (P) Limited.

Course Name : Plant Biotechnology					
Course Code: BIOT 3202					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

On completion of the course, students will be able to:

1. Explain the basic concepts of plant tissue culture and its application of numerous techniques.
2. Interpret how various plant biochemical metabolic pathways work in the plant system and relate them with medicinally important bioactive compounds.
3. Understand basic molecular biological aspects of plant by studying the structure and organization of plant genome
4. Describe the molecular biological techniques of gene transfer to plants.
5. Understand concept of raising transgenic plants
6. Impart knowledge on all recent biotechnological developments related to GMO through quality improvement of crops.

Module I: Plant tissue culture – theory and methods [10L]

Propagation of plant tissue and cells under *in vitro* condition, Totipotency. Role of physico-chemical conditions and hormone requirement for propagation of plant cells and tissues . Mode of action of auxin and cytokinin. Micropropagation via axillary and adventitious shoot proliferation, somaclonal variation and haploid culture, protoplast culture, cybrids. Plant breeding and heterosis. Green revolution in India.

Module II: Mass cultivation of plant cell products: [10L]

Basic strategies and factors for secondary metabolite production, Immobilisation technology for yield enhancement , bioreactor system and models for mass cultivation of plant cells. Biotransformation for product development and selection of cell culture (only plant tissue culture products).

Module III: Structure and organization of plant genome [10L]

Structure, function and assembly of genetic material, regulation of plant genome expression at each step: Chromosome assembly, transcriptional, translational and post transcriptional regulation, protein localization and turnover; Basic structure of chloroplast and mitochondrial

genome; rubisco synthesis and assembly. Transposon. (Arabidopsis should be taken as the model for study of plant genome).

Module IV: Plant genetic engineering[10L]

Direct and indirect methods of transgene incorporation; Design of plant expression vectors: Promoters, Plant selectable markers; Reporter genes; Ti-based binary vector system. Agrobacterium mediated gene delivery, Biolistic method. Transgene silencing and strategies to avoid transgene silencing, Chloroplast transformation, Targeted gene delivery and methods of detection.

Theory and techniques for the development of transgenic plants conferring resistance to herbicide (Glyphosate, Basta), pesticide (Bt gene), plant pathogens PR-Proteins. Plant engineering towards development of enriched food products – Golden rice, therapeutic products.

Textbooks:

1. Plant Biotechnology: The Genetic Manipulation of Plants,Slater.A., Nigel W.S,Flower. R.Mark , 2009, Oxford Univesity Press.
2. Comprehensive Biotechnology Ramawat.K.G. ,Goyal, S. 2009, S.Chand & Company, New Delhi

Reference books:

1. Biochemistry and Molecular Biology of Plants Buchaman, Gursam, Jones, , 1ed, 2000, L.K.International.
2. Plant Tissue Culture: Theory and Practice Bhozwani and Razdan –1996 Elsevier
3. In vitro Cultivation of Plant Cells, Butterworth & Heineman, Biotol Series.
4. Tissue culture and Plant science, H.E Street(ed) Academic press, London, 1974
5. Tissue and Organ Culture, Gamborg O.L.,.Phillips G.C, Plant Cell, Narosa Publishing House
6. Text Book of Biotechnology Das.H.K. -First Edition 2004, Wiley Dreamtech.

Course Name : Bioreactor Design and Analysis					
Course Code: BIOT3103					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

After completing the course, the students will be able to:

1. Develop basic concept of reaction engineering.
2. Understand basic concepts of bioreactor design and analysis.
3. Understand the basic operating principles of bioreactors.
4. Interpret batch reactor data with reference to basic reactor design for a single reaction ideal reactor.
5. Analyze non-ideal flow pattern with reference to residence time distribution (RTD) and dispersion numbers (D/UL)
6. Analyze basic cell growth data to verify Monod model.

Module I: Basic reaction and microbial growth kinetics [10L]
Sterilization of air and media, Microbial growth and product kinetics: Monod equation, Chemostat, Dimension-less numbers and their importance in reactor operation.
Transport Phenomenon in Bioreactor: Role of dissolved oxygen concentration in mass transfer,Determination of mass transfer coefficient (K_La); Factors effecting K_La and their relationship.

Module II: Ideal Bioreactor [10L]
Overview of Chemical Reaction Engineering, Kinetics of homogenous reactions, Elementary Reactions. Molecularity and Order of reaction.
Introduction to batch reactor data –Different methods of analysis of data, Autocatalytic reactions, Reversible reaction, Differential method of analysis of data,Parallel and multiple reaction.Ideal batch, mixed flow and plug flow reactors and their analysis.

Module III: Non-ideal Bioreactors [10L]
Basics of non-ideal flow: Residence time distribution (RTD), Age distribution of fluids: C, E and F curve, experimental method and their relations,
Dispersion model:its significance and analysis.

Module IV: Modern bioreactor systems [10L]
Basic design operation and analysis: Fed-batch system, Surface and submerged fermentation, Air-lift reactor, Bubble column reactor, Membrane bioreactors, Photo bioreactors etc. Immobilized cell system: Diffusion limitation and Bioreactor consideration.

Scale-up and scale down: principles, methodology and problems associated with it.

Text books:

1. Chemical Reaction Engineering O.Levenspiel, Wiley Eastern Ltd. Third edition, 2004
2. Principles of fermentation technology P. F. Stanbury and A. Whitaker, Pergamon Press (1984)

Reference books:

1. Bioprocess Engineering: Basic Concepts, 2nd Edition, M. L. Shuler and F. Kargi, , Prentice Hall, 2001.
2. Bioprocess Engineering Principles, 1st Edition, Pauline M. Doran, Academic Press, 1995.
3. Biochemical Engineering Fundamentals, 2nd Revised Edition,James E. Bailey and David F. Ollis, McGraw-Hill, 1986.
4. Biochemical calculations, Wiley & Sons, Second Edition,I. H. Segel, 2004.

Course Name : Database Management System & Computer Networking					
Course Code: CSEN 3205					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

After completing the course, the students will be able to:

1. Identify the characteristics of a database and describe the architecture and languages of relational Database Management System.
2. Understand & analyze design principles for logical design of databases, including the E -R method and apply the concepts of normalization to design an optimal database.
3. Apply relational database theory, and be able to write relational algebra expressions for queries and apply the concepts to manage a database using SQL.
4. Understand the concept of database transaction, it's properties and the concept called serializability.
5. Understanding the topology, transmission mode of computer networks and explain key networking protocols in the context of a conceptual model, such as the OSI and TCP/IP framework.
6. Understanding the basic workings of Inter networking, WWW, search engine and e-mail in the context of data communication.

Module I: [10L]
Introduction to Database Concepts, File Processing System and Database Management System, DBMS Architecture and Data Independence.
Data Model: Basic Concepts, Entity-Relationship Diagram, Keys, Cardinality, Weak Entity Set.
Introduction to relational algebra & SQL: Operators like select, project, rename, Cartesian product, join, union, intersect, minus, DDL, DML.

Module II: [12L]
Relational Database Design: Functional Dependencies, Normalization: Different anomalies in database designing,1NF, 2NF, 3NF and BCNF, Lossless-Join Decomposition and Dependency Preservation.
Introduction to Transaction Processing Concepts: ACID properties, Serializability and Recoverability.

Module III: [10L] Computer Networking: Introduction, topology, transmission mode, LAN/MAN/WAN, OSI 7 layer Model, Communication Techniques, TCP/IP Protocol Stacks.

Module IV: [10L] Inter Networking, WWW, URLs, search engines, electronic mails, Distributed System, Distributed Database System Concepts.

Text books:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts, 4th Ed., McGraw Hill, Computer Science Series.
2. Behrouz A. Forouzan, Data Communications and Networking, 4th Ed., McGraw Hill.

Reference books:

3. Elmasri Ramez and Novathe Shamkant,"Fundamentals of Database Systems", Pearson.
4. Ramakrishnan: Database Management System, McGraw-Hill.
5. Gray Jim and Reuter Address, "Transaction Processing: Concepts and Techniques", Moragan Kauffman Publishers.
6. Jain: Advanced Database Management System, CyberTech.
7. Date C. J., "Introduction to Database Management", Vol. I, II, IIIPearson.
8. Ullman J. D., "Principles of Database Systems", Galgottia Publication.
9. James Martin, "Principles of Database Management Systems", 1985, Prentice Hall of India, New Delhi.
10. Ramez Elmasri, Shamkant B.Navathe "Fundamentals of Database Systems", Pearson.
11. Andrew S. Tanenbaum: Computer Networks, Pearson Education, fourth edition.
12. William Stallings: Data and Computer Communication, Prentice hall, Seventh edition.
13. William Stallings: High speed Networks and Internets, Pearson education, second edition.
14. Arun K.Majumdar, Pritimay Bhattacharya "Database Management Systems", Tata McGraw Hill.

Course Name : Molecular Modeling & Drug Designing					
Course Code: BIOT3241					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

After completion of the course student will be able to

1. Understand the molecular modeling and molecular simulation techniques for drug designing.
2. Explain the molecular mechanics for drug designing.
3. Understand different criteria and parameter for drug designing.
4. Apply pharmacodynamics and pharmacokinetics parameter to design drug.
5. Understand the basic concepts of computer based tools for drug designing.
6. Analyze and solve problems related to Molecular Modeling & Drug Design.

Module I: Molecular Modeling: (**10L**)

Useful concept in molecular modeling; molecular simulation techniques-Monte Carlo methods-Metropolis Monte Carlo algorithm, types of Monte Carlo algorithm, flow calculations in Metropolis Monte Carlo algorithm with examples; molecular dynamics and simulations- basic concepts including the integration of dynamical Equations; structural information from molecular dynamics, Monte Carlo calculation and energy minimization methods.

Module II: Molecular Mechanics: (**10L**)

Introduction to Molecular mechanics, intra molecular interactions; physicochemical parameters in drug design: hydrophobicity, electronic effect, ionization constants, chelation, solubility and partition co- efficient; over view of molecular descriptors.

Module III: Drug Discovery, Design and Development: (10L)

Introduction to diseases, drugs and drug targets; pharmacodynamics and pharmacokinetics of drug**,** rational basis of drug designing, criteria for synthesizing drugs; types of drug designing: ligand based drug design, structure based drug design, lead optimization, receptor based design and other methods;case studies.

Module IV: Tools for Drug Design: (10L)

Overview of computer based tools for drug designing- Ludi, Ludi/CAP, Autodock, GRAMM, CAMD tools; Force fileld and types of force fields; protein-protein, protein-nucleic acid, protein-ligand interaction with example; types of scoring functions, scoring and docking mode; QSAR principles and methods in drug designing; current research in drug designing- a case study.

Textbooks:

1. Molecular Modeling Principles and application, 2nd edn. (2001) by A. Leach. Pub: Pearson
2. Introduction to Medicinal Chemistry (2013) by G. L. Patrick, Pub: OUP

Reference books:

1. Biopharmaceuticals-Biochemistry and Biotechnology 2nd edn. (2003) G.Walsh, pub: Wiley
2. Drug Discovery and Design (2001) by Scolnick. J.; pub: Academic Press,
3. Guidebook on Molecular Modeling in Drug Design (1996) by N. R. Cohen, Editor. Pub:AP,
4. Text Book of Drug Design and Discovery 3rd edn. (2002) by Liljefors, Krogsgaard,-Larsen pub: CRC press.

Course Name : Biophysics of Macromolecules					
Course Code: BIOT3242					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

After completing this course, students will be able to

1. Describe the structure of different macromolecules.
2. Elucidate structure-function relations of enzymes
3. Explain the interactions of macromolecules.
4. Illustrate the thermodynamics and kinetics of macromolecular transition.
5. Describe the spectroscopic techniques for biomolecular structural analysis.
6. Explain the working principle of some non-spectroscopic techniques for structural analysis.

Module1: Fundamental interactions in macromolecules [10L]
Introduction to biophysics, strong and weak interactions in biomolecules: electrostatic and Van der Waal's interaction, hydrogen bonding, hydrophobic Interactions. Conformation and configuration of biomolecules. Structural characteristics of α-helix, β-sheet and β-turn, supersecondary structure, Protein domains and domain architecture. Tertiary structure: effect of amino acids on the structure of proteins. Quaternary structure of proteins. Conformation of nucleic acids: Structural characteristics of A, B and Z-DNA. 3D structure of t-RNA, ribozymes and riboswitches.

Module 2: Thermodynamics and kinetics of macromolecular transitions [10L]
Energy status of a protein molecule, denaturation and renaturation of proteins and DNA, helix coil transformation of proteins and DNA: kinetic study, Melting of helices: thermodynamics of melting / denaturation of alpha helix and DNA double helix, Cooperativity of melting of helices. Structure-function relations of enzymes, allosteric enzymes. Changes in nucleic acid structures during biochemical processes.

Module 3: Spectroscopic techniques for biomolecular structural analysis [10L]
Basic concepts of absorption spectroscopy, UV/visible, IR and FTIR spectroscopy, circular dichroism spectroscopy, NMRS; Emission spectroscopy - luminescence, phosphorescence and fluorescence, quenching, FRET and fluorescence lifetime measurements.

Module 4: Non-spectroscopic techniques for structural analysis
Methods for study of biomolecule structure and surface morphology: X-ray diffraction and X-ray crystallography, and electron microscopy (SEM and TEM), MS, Surface Plasma Resonance Method.

Textbooks:

1. Biophysical Chemistry Vol 2; Cantor & Schimmel, Oxford University Press
2. Biochemistry: Donald Voet, Judith G. Voet, 4th Ed, JOHN WILEY & SONS , INC.
3. Lehninger's Principles of Biochemistry by Nelson & Cox

References books:

1. Physical Biochemistry: David Friefelder, 5th Ed, PHI
2. Physical Biochemistry: Kensal E van Holde. PHI
3. Practical Biochemistry Principles and techniques: Editor Wilson and Walker, Cambridge University Press
4. Proteins: Structure and Function: David Whitford: John Wiley &Sons

Course Name : Biosensors and Diagnostics					
Course Code: BIOT3243					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Module I: Introduction to biosensor [10]

Biosensor: Principle, General Characteristics, Advantages and its limitations. Classification of biosensors based on bioreceptor. Immobilization and coupling of bioreceptors. Enzyme Biosensor: Principle, kinetics and its response to different types of inhibitors.

Module II: Bio-recognition element based sensors [10]

Principle, Operation and Limitation of: Microbial sensor, Immunological sensor, Nucleic acid sensor. Other bioreceptors (e.g. animal, plant tissue)

Module III: Biosensor based on transducer [10]

Classification of biosensor based on transducer. Principle, Construction, Calibration and Limitations of Calorimetric, Electrochemical (potentiometric, amperometric), Optical, Piezoelectric, Semiconductor biosensor etc.

Module IV: Application of biosensor [10]

Clinical and diagnostics sector, Industrial sector: Food, Environmental, defense sector and others. Commercially available biosensor.

Reference books:

1. Biosensors by Tran Minh Canh. London. Chapman and Hall, 1993.
2. Turner, A.P.F, Karube.I.,and Wilson,G.S, Biosensors Fundamentals and applications, Oxford Univ. Press.
3. Engineering biosensors, kinetics and design applications by Ajit Sadana..San Diego, Academic Press, 2002.
4. D.Thomas and J.M. Laval – Enzyme Technology in concepts in Biotechnology by Balasubramaniam et al, Univ. Press, 1996.

Course Name : Biofertilizers and Biopesticides					
Course Code: BIOT3244					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

After completing this course, students will be able to :

1. Explain the role of beneficial microbes in sustainable agriculture.
2. Gain knowledge on isolation and identification of nitrogen fixing bacteria.
3. Role of phophate solubilizing bacteria.
4. Understand molecular biology of nitrogen fixation.
5. Understand the importance of biopesticides over chemical pesticide.
6. Isolate and identify biopesticides for increased agricultural productivity.

Module-I Biofertlizers in agriculture [10L]

Definition of bio-fertilizers; composition and nutritional role based classification of different bio-fertilzers viz., composts – vermicompost and nitrogen fixers; basic knowledge and procedure of bacterial, fungal and composite bio-fertilizer production; role of *Azola, Tichoderma Cianobacteria*, *Trichogramma* in bio-fertilization; importance of bio-fertilizer used in agriculture; knowledge of bacterial and fungal suspensions as inocula and their preparations.

Module-II Biological nitrogen fixation [10L]

Basic outline of processes, characteristics and significance of biological nitrogen fixation (BNF) and phosphate solubilizing bacteria/ micro organisms (PSB and PSM) functioning; outline of biological nitrogen fixation from biochemical and biological points of view with special reference to different enzymes and other key role players; biological and biochemical process of symbiosis in nitrogen fixation by *Rhizobium* sp. with legume plants and others.

Module-III Molecular Biology of symbiotic Nitrogen fixer [10l]

Biological and biochemical process of symbiosis in nitrogen fixation by *Rhizobium* through root nodulation process and nitrogen fixation by it.

Brief concept of nod genes and nitrogen fixing genes (nif genes) --- their organization and role in the different steps of biological nitrogen fixation. Rhizosphere engineering.

Module-IV Biopesticides [10l]

Use of chemical pesticides and environmental effects, Definition and importance of biological pests and bio-pesticides in agriculture.

Brief conception of Integrated Pest Management (IPM), Integrated Pest and Disease Management (IDPM).

Advantages of bio-pesticides over chemical pesticides and developing them.

Types of Bio-pesticides with special reference to protein with anti-pest activity; gene from *Bacillus thuringenensis* and its proteins as biopesticide

Textbook

1. Stacey, Burris and Evans (ed), Biological Nitrogen Fixation, Chapman & Hall, 1992

References :

1. J K Ladha, M B Peoples, Management of Biological Nitrogen Fixation for the Development of More Productive and Sustainable Agricultural Systems, Springer.
2. P.S. Nutman, Symbiotic Nitrogen Fixation in Plants, Cambridge University Press
3. Sushil K Khetan, Microbial Pest Control, Marcel Dekker
4. Opender Koul, G S Dhaliwal, Microbial Biopesticides, Taylor & Francis

Course Name : Immunology lab					
Course Code: BIOT3211					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Course Outcomes:

After completing the course, the students will be able to:

1. Prepare a stained blood film and identify the different blood corpuscles under microscope.
2. Estimate the Total Count and Differential Count of RBCs and WBCs.
3. Identify human blood group antigens by agglutination reaction.
4. Analyze antigen-antibody reactions by radial and double immunodiffusion method.
5. Determine the presence of antigen and its concentration by Dot ELISA and Sandwich ELISA.

List of experiments:

1) Preparation of human blood film and identification of blood corpuscles.
2) Total count of R.B.C.
3) Total count of W.B.C.
4) Differential count of W.B.C.
5) Identification of human blood group antigens.
6) Radial Immunodiffusion assay
7) Ouchterlony immunodiffusion assay
8) Dot ELISA
9) Sandwich ELISA

Course Name : Plant Tissue Culture Lab					
Course Code: BIOT3212					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Course Outcomes:

On completion of the course, students will be able to:

1. Understand the importance of maintenance of sterile environment in culture maintenance room in plant tissue culture.
2. Prepare different plant tissue culture media.
3. Understand the role of different explants through different various kind of plant tissue culture techniques
4. Able to evaluate plant cell as biofactories for the production of Secondary metabolites.

List of experiments:

1. Study basic requirements for plant tissue culture lab.
2. Preparation of various tissue culture media (MS, B5).
3. Explants selection sterilization and inoculation.
4. Effect of growth hormones on organogenesis.
5. Callus and cell suspension culture; induction of growth parameters.
6. Plant regeneration from shoot tip/auxillary bud.
7. Androgenesis: anther and pollen culture.
8. Protoplast isolation.
9. Expression pattern study of secondary metabolite from plant cell culture.
10. Role of biotic and abiotic stress factors in callus culture.

Course Name : Bioreactor design Lab					
Course Code: BIOT3213					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Course Outcomes:

After completing this course, students should be able to:

i) Understand the basic concepts and applications of Bioreactor Design & Analysis Lab.

ii) Determine exit age distribution curve for liquid flowing through a vessel of a CSTR.

iii) Determine the Real Time Distribution (RTD) of liquid flowing through a reactor.

iv) Develop E and F curve for different reactors.

v) Explain the ideal and non-ideal nature of the bioreactor.

vi) Calculate D/UL values from experimental RTD data by which they can understand the degree of non-ideality of a reactor.

List of experiments:

1. Determination exit age distribution curve for liquid flowing through a vessel of a CSTR.
2. Development of flow pattern to represent the vessel from the tracer output data in an external loop airlift reactor.
3. Determination of RTD of liquid flowing through a bubble column reactor.
4. Calculation of vessel dispersion number D/uL from c-pulse data for (i) CSTR, (ii) airlift reactor, (iii) bubble column reactor.
5. Development of F- curve from c-curve for (i) CSTR, (ii) airlift reactor, (iii) bubble column reactor
6. Development of F- curve from E-curve for (i) CSTR, (ii) airlift reactor, (iii) bubble column reactor

Course Name : Data Base Management System & Computer Networking lab					
Course Code: CSEN3215					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Course Outcomes:

After completing this course, students should be able to:

1. Create tables with different integrity constraints using DDL and DML commands in SQL.
2. Understand how to populate and manage the database using DDL and DML commands in SQL.
3. Understand how to query the database by writing simple to complex SQL queries to retrieve information.
4. Understand the basics of PL/SQL programming using cursor, trigger.
5. Understand how and when to use the basic networking commands.

DBMS Lab :
Experiments on Database on RDBMS Platform (Oracle):
DDL Commands: Creating Tables along with constraints like: Primary Key, Foreign Key, unique, Not Null, Check. Altering Table Structure like adding and modifying constraints, adding column, modifying column data types, etc.
DML: Inserting rows, Updating rows, Deleting rows
SQL Query: Cartesian Product, Join, Union, Intersect, Minus, Single Row functions, multiple row functions using GROUP BY clause, ORDER BY Clause, Nested Sub-Queries
Introduction to PL/SQL: Programming Language Constructs in PL SQL like variable declaration, Conditional Statements, different types of loop structures, functions, etc. Programming using Cursors, Creating different types of Triggers.

Computer Networking Lab:
Basic Networking Commands**.**

Course Name : Personality Development					
Course Code: HMTS3221					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

Course Outcome:

After completing this course, students should be able to:

1. Employ the technique of SWOT analysis to decide goals and plans.
2. Acquire tools to improve emotional quotient.
3. Be aware of the dynamics of communication under diverse cultural setup.
4. Learn the various factors of employability quotient and plan to improve individual score.
5. Apply theories, styles and stages of leadership.
6. Implement Maslow's hierarchy of needs theory to achieve self-growth.

Module 1: Self-Growth

i) Self Growth- Maslow's Hierarchy of Needs Theory
ii) Anger, Stress & Time Management- Theories and application
iii) SWOT Analysis

Module II: Stepping Up

i) Growth & Environment
ii) Competitive Spirit
iii) Responsibility Factor

Module III: Professional Communication

i) Impression Management- theory on social psychology
ii) Employability Quotient
iii) Cross-cultural communication

Module IV: Leadership & Team Playing

i) Leadership & Team Playing: Theories, Styles, Stages
ii) Motivation, Negotiation Skills, Conflict Management
iii) Planning & Envisioning: Initiative and Innovation in the Work Environment- De Bono's Six Thinking Hats

Suggested Reading

1. Personality Development and Soft Skills by Barun K. Mitra, Oxford University, 2011

2. Soft Skills: An Integrated Approach to Maxmise Personality by Gajendra Singh Chauhan and Sangeeta Sharma, Wiley, 2016
3. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success by Gopalaswamy Ramesh and Mahadevan Ramesh, Pearson, 2010

Course Name : Seminar-I					
Course Code: BIOT3222					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	2

Seminar-I: (Review of any field related to biotechnology and presentation by PPT)

1. Student will attend seminar by invited speakers in the field of biotechnology, to be arranged by the department and submit a write-up.

2. Student will review of any field of biotechnology and submit a review report. Finally students will present the review by PPT in a departmental seminar during a period not exceeding 30 minutes. Performance of the candidates in the seminar shall be evaluated jointly by one External or all internal Examiners.

Subject Name: Animal Cell Culture and Animal Biotechnology					
Paper Code: BIOT4101					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of this course, student will be able to

1. Understand the fundamental scientific principles animal cell culture, describe the condition, media, special instruments and laboratory design required for animal cell culture.
2. Acquire knowledge for isolation, maintenance, counting, preservation and growth of animal cell, develop proficiency in establishing and maintaining of cell lines.
3. Acquire knowledge in animal cloning and its applications.
4. Understand and analyse growth kinetics and scale up of animal cell culture.Do analysis and solve problems related to animal cell culture.
5. Understand and explain the basics of animal biotechnology and the creation of transgenic animal with the help of modern gene targeting and editing technology.
6. Describe and demonstrate the application of animal cell culture and animal biotechnology in production of monoclonal antibody, organ transplantation, production of human and animal viral vaccines and pharmaceutical proteins, gene therapy, stem cell technology.

Module I: Animal cell culture [10L]

Introduction Animal Tissue Culture, Cell adhesion, proliferation, differentiation, senescence and apoptosis. Basci requirement of animal cell and tissue culture laboratory, biosafety levels, culture media and growth conditions. Development of primary culture, subculture and cell lines. Cell cloning and selection, Cell Differentiation into cancerous cells and role of protooncogenes, cell synchronization, senescence and apoptosis. cryopreservation; Common cell culture contaminants. Techniques for animal cell separation, characterization, quantitation, cytotoxicity and viability assays.

Module III: Growth and scale up of animal cell culture [10L]

Introduction to non-ideal reactor. Animal cell growth characteristics and kinetics, cell culture reactors, scale-up in suspension, scale and complexity, mixing and aeration, rotating chambers, perfused suspension cultures, fluidized bed reactors for suspension culture. Scale-up in monolayers, multisurface propagators, multiarray disks, spirals and tubes, roller culture, micro-carrier attached growth. Cell culture in continuous, perfusion and hollow fibre reactor, microencapsulation. Growth monitoring and mass transfer in mammalian cell culture.

Module III: Animal biotechnology [10L]

Micromanipulation of embryos: Introduction, basics and methodology of micromanipulations. Composition of *in vitro* fertilization (IVF) media, steps involved in IVF.

Transfection and transformation of animal cells. Transgenic animal production: concept of transgene and transgenic animals, gene transfer approaches for producing transgenic animals, techniques of creating transgenic mice, homologous recombination and knockout mice. Animal cloning using stem cells and other methods. Importance and applications of transgenic animals, study of model transgenic animals.

Module IV: Application of animal cell culture and animal biotechnology [10L]

Three dimensional culture technology: organ culture, histolytic culture, Organotypic culture, tissue engineering and its application. Cell fusion and hybridoma technology, regenerative medicine, tissue and organ transplantation, production of human and animal viral vaccines and pharmaceutical proteins, gene therapy, Stem cell technology, Marketable culture product, different medical applications for cell culture including expression system, therapeutics and others.

Textbook:

1. Culture of Animal Cells: A Manual of Basic Technique and Specialized application, 7th Edn.(2016) by R. Ian Freshney , pub- Wiley-Blackwell.
2. Basic Cell Culture 2nd Edn. (2005),by Davis. J.M, pub- Oxford University Press.
3. Animal Cell Culture: A Practical Approach (2000) by John Masters, pub- Oxford University Press.
4. Primrose & Twyman, Principles of Gene Manipulation and Genomics, 7th Edn, (2006)
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) by Glick, Pasternak, and Patten, pub- ASM Press,

Reference books :

1. Concepts in Biotechnology (1996) by Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman.
2. Text Book of Biotechnology, 4th Edn. (2007) Das. H.K., pub-Wiley Dreamtech.
3. Transgenic Animals: Generation and Use 5th Edition (1997) Louis-Marie Houdebine, pub- CRC Press.
4. Embryonic Stem cells by Kursad and Turksen. 2002. Humana Press.
5. Animal Biotechnology by P.Ramadas
6. In vitro cultivation of Animal cells by Dr.C.K.Leach, Butterworth and Heinnmamm Ltd.1994.

Subject Name:	Bioseparation Technology				
Paper Code:	BIOT4102				
Contact Hours Per Week	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes:

1. Students will acquire basic understanding of different bioseparation processes and design principle for commonly used process equipments.
2. Students will obtain knowledge about the basic principles and application of sedimentation, centrifugation and filtration.
3. Students will be able to explain the principles of extraction and membrane based separation of bioproducts and can apply the knowledge for calculations of extraction process.
4. Students will understand the principle of adsorption, chromatography and relation of adsorption with chromatography.
5. They will be able to apply different chromatographic techniques for separation of different Bioproducts.
6. Students will comprehend the knowledge of precipitation, drying, crystallization and will be able to solve numerical problems related to these processes.

Module I: Basic Concepts [10L]
Methodology and overview of bioseparation technology. Basic design principles of separation equipments; Sedimentation – Objectives, principles, sedimentation coefficient, Scale-up based on equivalent time, Bowl centrifuge, tubular centrifuge; Extraction -- Objectives, extraction principles, phase separation and partitioning equilibria, scale-up and design of extractor.

Module II: Fundamental methods: Chromatography, Adsorption and Precipitation [10L]
Chromatography and adsorption -- Objectives, adsorption equilibrium, column dynamics, fixed bed adsorption, related problems. Precipitation -- Objectives, protein solubility, structure, size, charge, solvent, initial mixing, nucleation, growth governed by diffusion, methods of precipitation, design of precipitation system,

Module III: Membrane based separation processes [10L]
Design, Scale-up and biological application of U F, M F and R O.

Module IV: Crystallization, drying and industrial applications of bioseparation techniques [10L]
Principles, fundamental objectives, design and scale-up of cryatallization and drying equipment.

Textbook :

1. Bioseparation Science and Engineering -- Indian Edition Roger G Harrison, Paul Todd, Scott R Rudge and Demerti P Petrides OXFORD University Press.

Reference books:

1. Schuler & Kargi, Bio-process Engg. PHI
2. Bailey & Olis, Biochemical Engg. Fundamentals, McGraw-Hill, 1990
3. Mukhopadhyay, S.N. Process Biotechnology Fundamentals, Viva Books Pvt. Ltd. 2001.
4. Muni Cheryan, Handbook of Ultrafiltration
5. Perry, Chilton & Green, Chemical Engineers' Handbook, McGraw-Hill
6. Ho, W.S.W. & K. K. Sirkar, Membrane Handbook, Van Nostrand Reinhold, N.Y.(1992)

Subject Name: Food Biotechnology					
Paper Code: BIOT4141					
Contact Hours Per Week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing this course, students will be able to:

1. Apply different food preservation techniques.
2. Know different food processing techniques.
3. Analyse different processed food.
4. Application of enzymes in food industry.
5. Detect adulteration and toxic components of food.
6. Gain knowledge on different functional food and GMO

Module I: Food Preservation Technology [10L]
Spoilage of food: fruits, vegetables, meat, milk and milk products, fats and oils.
Food poisoning: Botulism, Staphylococcal intoxication and fungal toxins: disease manifestation and mechanism of action of toxins: Food preservation techniques: physical methods: canning, heating, refrigeration, irradiation, dehydration.

Module II: Food Production Technology [10L]
Fermented and semi fermented food products: Fermentation of fruits and vegetables (e.g., sauerkraut, Dill pickle), dairy products.Production of single cell protein: Mushroom cultivation Genetically modified crop: production technology and safety aspects

Module III: Enzymes in Food Industry [10L]
Enzymes in bakery and cereal products, Enzymes in fruit juice production, Enzymes in fat/oil production, Enzymes in cheese making and beverage production

Module IV: Food Additives, Food Safety and Packaging [10L]
Food preservative: natural and synthetic, Other additives: Food colour, food flavor enhancers, nutritional suppliments, Probiotics, Chemical safety measurement: heavy metals, fungal toxins, bacterial toxins, herbicide, pesticide.

Textbook:

1. Jay, Modern Food Microbiology, CBS Publishers, 1987
2. Frazier, Food Microbiology, Tata McGraw Hill, 2004

References:

1. Meyer, Food Chemistry, CBS Publishers, 2004
2. Shakuntala Manay, Foods: Facts and Priciples, New Age Publication, 2005

Subject Name: Environmental Biotechnology					
Paper Code: BIOT4142					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

After completing this course, students will be able to:

1. Describe different methods of sampling and controlling air pollutants.
2. Analyze the characteristics of wastewater and understand the principles of physical and chemical treatment of it.
3. Design different processes for biological treatment of wastewater and solve numerical problems related to them.
4. Explain the processes of solid waste management and apply the knowledge in waste to energy conversion.
5. Understand the principle of biodegradation and bioconversion of natural and xenobiotic compounds.
6. Apply the knowledge of bioremediation for controlling and removal of heavy metals in contaminated wastewater.

Module I: Air Pollution: Control Methods and Equipment [10L]
Primary and secondary air pollutants, effects of air pollutants on health, basic ideas of air pollution control equipments- bag filter, electrostatic precipitators, cyclone separators, wet-scrubbers, bio- scrubbers.

Module II: Water Pollution: Control Methods and Equipments [10L]
Sources -- municipal and industrial wastewater. Characterization of wastewater. Treatment principles: primary, secondary, tertiary. Activated sludge process, extended aeration, trickling filter, mechanically aerated lagoons, waste stabilization ponds, upflow anaerobic sludge blanket (UASB) reactor. Common effluent treatment plant- fundamental and case studies. Membrane based treatment processes – fundamental and case studies. Numerical problems on parameters and their determination methods.

Module III: Solid Waste Management [10L]
Sources and types; Treatment: Landfilling, Composting and Vermiculture, Biopiling, Incineration; Energy production from solid waste.

Module IV: Bioremediation [10L]
Preliminary ideas of Bioremediation—in-situ and ex-situ, Biodegradation of xenobiotics, polycyclic aromatic hydrocarbons, Persistent Organic Pollutants (POP), pesticides. Factors affecting the degradation of organics and removal of heavy metals (Mercury, Chromium, Arsenic etc.) by microbes.

Textbook:

1. Rao, C.S., Environmental Pollution Control Engineering, New Age International, 1999
2. S. P. Mahajan, Pollution Control in Industries, TMG

Reference books:

1. Omasa,Air pollution & plant biotechnology, Springer
2. Metcalf & Eddy, Wastewater Engineering – Treatment, Disposal and Reuse, 4th ed., TMG
3. Arceiwala, S.J., Wastewater treatment for pollution control, 2nd Ed. TMH
4. Introduction to Environmental Engineering and Sciences by Gilbert M.

Subject Name: Bioprocess and Process Instrumentation					
Paper Code: BIOT4143					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course outcomes:

At the end of this course students will be able to:

1. Understand the mechanism of enzyme action on a substrate explicitly.
2. Apply the above concepts to solve problems in the enzyme technology field.
3. Comprehend and solve any problem regarding sterilization of the medium used in fermentation.
4. Compare between a batch process and a continuous process regarding microbial growth.
5. Classify a microbial product and determine its productivity.
6. Appreciate the operation of different process instruments used for measuring various operating parameters of a bioprocess.

Module-I: Principles of enzyme catalysis [10L]

Introduction to enzymes, mechanistic models for simple enzyme kinetics, rate parameters, models for allosteric enzyme kinetics, effect of pH and temperature, methods of immobilization, diffusional limitations in immobilized enzyme systems.

Module-II: Fundamentals of sterilization [10L]

Media for industrial fermentation, medium formulation, medium optimization, Sterilization, design of batch and continuous sterilization process. Effect of operating variables of sterilization on nutrient quality in media. Air sterilization.

Module-III: Mixed Culture kinetics [10L]

Microbial growth kinetics in batch and continuous culture. Product productivity. Introduction, classification. Kinetics and application of mixed culture.

Module-IV; Fundamental of measuring instruments [10L]

Basic principles and operations of measuring instruments for measurement of temperature, flow pressure, DO level.

Text books:

1. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.

2. P.F. Stanbury, A. Whitaker, S.J. Hall, Principles of Fermentation Technology. Butterworth-Heinemann, 1995.

Reference Books:

1. Pauline M. Doran. Bioprocess Engineering Principles. Academic Press. 1995.
2. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals. Mc-Graw Hill Education. 2nd edition, 1996.
3. Shuichi Aiba, Arthur E. Humphrey & Nancy F. Millis. Biochemical Engineering. Academic Press. 1965.

Subject Name: Modeling and Simulation of Bioprocesses					
Paper Code: BIOT4161					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course outcomes:

At the end of this course students will be able to:

1. Understand the basic concepts of modeling and simulation.
2. Differentiate between modeling and simulation.
3. Classify mathematical models into deterministic and stochastic, structured and unstructured, segregated and non-segregated models.
4. Derive mathematical models for various processes in the biological system.
5. Apply different numerical techniques towards simulation of bioprocesses.
6. Develop mathematical models for a given bioprocess

Module-I: Fundamentals of Modeling & Simulation [10L]
Introduction to modeling and simulation, classification and examples of kinetic models: Deterministic and stochastic, structured and unstructured, segregated and non-segregated.

Module-II: Modeling of Bioprocess-I [10L]
Product formation model; genetically structured models, modeling of extra cellular enzyme production.

Module-III: Modeling of Bioprocess-II [10L]
Modeling of: continuous sterilization of medium; activated sludge process, anaerobic digestion, biochemical reaction with respect to external mass transfer, internal diffusion and kinetics.

Module –IV: Process Simulation techniques in Bioprocess Engineering [10L]
Program-based numerical methods: algebraic equations, Newton Raphson, interpolation, solution of differential equations- Euler method, Fourth order Runga–Kutta method, etc. Application of simulation techniques in bioprocess.

Texts/References:

1. Bailey, J.E and D.F Ollis, Biochemical Engineering fundamentals , 2nd ed. McGraw Hill Book Co. , 1988.
2. Blanch, H.W and I.J. Dunn, "Modeling and Simulation in Biochemical Engg" in Advances in Biochemical Engineering.
3. Michael L. Shuler and Fikret Kargi, "Bioprocess Engineering: Basic Concepts, 2nd Edition".
4. William L. Luyben, "Process Modelling, Simulation and Control for Chemical Engineers".

Subject Name: Biomaterials					
Paper Code: BIOT4162					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course outcomes:

At the end of this course students will be able to:

1. Students will be able to explain the fundamentals of Biomaterials.
2. Students will be able to apply the knowledge of sterilization of Biomaterials in tissue regeneration.
3. Students will be able to illustrate the structure, production process and applications of protein based Biomaterials.
4. Students will be able to describe structure, production process and applications of carbohydrate based Biomaterials.
5. Students will be able to describe structure, production process and applications of industrially important Biomaterials.
6. Students will be able to illustrate the properties of different Biomaterials.

Module I: Fundamentals of Biomaterials [10L]

Fundamentals of biomaterial science: Biocompatibility, types, basic properties and applications of Biomaterials; Disinfection and sterilization of biomaterials; Biodegradable polymers and tissue regeneration scaffolds; Collagen and Fibroin: Structure, production (conventional and cloning method), properties and its use.

Module II: Carbohydrates as Biomaterials [10L]

Carbohydrate (Starch, Alginate, Chitin, Agarose etc.) and modified carbohydrates (modified starch, polydextrose, chitosan etc.): Structure, production, properties and applications.

ModuleIII: Industrial Biopolymers [10L]

Structure, properties, production and applications of polyphenol resins, Polycaprolactone (PCL), Polyhydroxybutyrate (PHB), copolymer of Polyhydroxybutyrate and polyhydrovaleric acid (PHB-PHV), polylactic acid (PLA), Dextran and hyaluronate polymers.

Module IV: Properties of Biopolymer [10L]

Physical properties: Molecular weight of polymers; Mechanical properties: Size, shape, microstructure, texture, porosity, elasticity, viscosity and visco-elasticity; Thermal Properties: Glass transition temperature, thermal diffusivity, coefficient of thermal expansion; Chemical Properties: Solubility and erosion, leaching of constituents, corrosion.

References:

1. Ratledge C and Kristiansen B, Basic Biotechnology, Cambridge University Press, 2nd Edition, 2001
2. Doi Y, Microbial Polyesters, VCH Weinheim, 1990

Subject Name: Proteomics and Protein Engineering					
Paper Code: BIOT4164					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course outcomes:

After completion of this course, students will be able to

1. Describe different large scale protein separation, estimation, identification and sequencing techniques. Apply the knowledge to solve and analysis of in proteome.
2. Understand the *in vivo* and *in vitro* protein-protein interactions techniques.
3. Describe the techniques for Structural proteomics and apply knowledge of proteomics in drug discovery.
4. Describe the basics and significance of protein engineering; demonstrate the modification and design of protein according to the demand of industry and application.
5. Understand the stability of protein structure and mechanism of protein folding; apply this knowledge in study of protein misfolding related diseases.
6. Analyze and solve problems related to proteomics and protein engineering technology.

Module I: Proteomics [10L]

Introduction to proteomics, Techniques of proteomics: protein separation and quantitation (2D-gel electrophoresis, liquid chromatography), protein identification (mass spectrometry, protein sequencing and others), protein-protein interactions (Yeast two hybrid and others), post translational modification. Application of proteome analysis.

Module II: Structural proteomics and proteomics in drug discovery [10L]

Structural proteomics: Crystallography and X-ray diffraction, NMR spectroscopy, Cryo-EM and others, Proteomics in drug discovery: pharmaceutical proteomics (drug development, drug delivery**),** diseases diagnosis; functional genomics (reverse genetics**,** transcription and replication of negative strand viruses).

Module III: Protein engineering [10L]

Introduction to steps of protein engineering, solid phase peptide synthesis, production of novel proteins; random and site directed mutagenesis; Methods for expressing recombinant proteins. Industrial applications: engineering of protein stability, affinity for substrate, protease specificity, cofactor requirements.

Module IV: Protein stability and folding [10L]

Overview of protein structure, protein stability, protein folding: mechanism, folding kinetics, molten globule, role of molecular chaperones in *E.coli,* Human. Techniques to study protein folding: CD spectroscopy and others. Protein degradation; Protein misfolding and disease state: Prions, Alzheimer's, Cystic Fibrosis and others. Polyketides and non-ribosomal peptides, application of protein folding towards new drug design.

Textbooks

1. R.M. Twyman: Principles of Proteomics, Bioscientific Publishers.
2. Proteins: Structure & Function by David Whitford, Wiley Blackwell Publishers.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) by Glick, Pasternak and Patten, ASM Press.

Reference Books

1. Biochemistry & Molecular Biology Practical by Wilson and Walker.
2. B.Alberts,D.Bray, J.Lewis et al, Molecular Biology of the Cell, Garland Pub. N.Y. 1983.
3. Richard J. Simpson, Proteins and Proteomics, I.K. International Pvt Ltd.
4. Branden, C., Tooze, R., Introduction of Protein structure, Garland, 1st Edition, 1993.
5. Lilia Alberghina., Protein Engineering in Industrial Biotechnology, Harwood Academic pub, 2003.
6. Protein engineering and design by Paul R. Carey, academic press, 1996, 361 pages.
7. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edn. Pearson Education (2007).
8. Primrose & Twyman, Principles of Gene Manipulation and Genomics, 7th Edn, Blackwell (2006).
9. Daniel C. Liebler, Introduction to Proteomics. Humana Press.

Subject Name: Human Genomics					
Paper Code: BIOT4165					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

At the end of this course students will be able to

1. Develop a concept of the different genome mapping techniques and the genome assembly methods.
2. Understand the usage of functional genomics tools, different methods of gene transfer and applications of comparative genomics.
3. Understand the background of the Human Genome Project along with its findings on genome anatomy, gene family, gene diversity and gene markers.
4. Analyze the haplotypes and SNPs by various quantitative techniques.
5. Interpret the findings of Human Genome Project in the domain of pharmacogenomics and polygenic disorders.

Module I: Genome mapping and assembly [10L]

Genome mapping techniques: physical and cytologic mapping; Genome sequencing: Clone-by-clone sequencing, Whole genome shotgun sequencing, Hybrid sequencing and high throughput sequencing methods; Gene identification using positional and functional cloning approach; Genome sequence assembly and annotation.

Module II: Functional Genomics and comparative genomics [10L]

Functional genomics tools: sequence based approaches, whole genome alignment.
Comparative Genomics: overview of prokaryotic and eukaryotic genomes, C-value, number of genes and complexity of genomes, conservation and diversity of genomes, lateral gene transfer, role of comparative genomics in gene mapping and study of human disease genes.

Module III: Human genome project and its implications [10L]

HGP: Background, timeline, findings, Ethical Legal and Social Implications (ELSI); Patterns of Genome organization: mitochondrial genome, gene density, CpG islands, RNA encoding genes, functionally identical/ similar genes, diversity in size and organization of genes, gene families; Human genetic diversity study: Biochemical/molecular genetic markers; tracing human migrations with autosomal, Y-chromosomal and mitochondrial markers.

Module IV: Applications of Genomics research [10L]

SNPs and Haplotype maps; Linkage Disequilibrium (LD) and association studies; Quantitative Trait Locus (QTL) mapping; SNP genotyping methods; Personalized medicine and Pharmacogenomics; basics of gene transfer technologies and their applications; Genomic basis of polygenic disorders – diabetes, cardiovascular disease, obesity.

Textbook:

1. Introduction to Genomics. Arthur M. Lesk, 2nd edition, Oxford University Press.

Reference Books:

1. T. A. Brown, Genomes 3, John Wiley & Sons.
2. Singer. M, and Berg. P, Genes and genomes, Blackwell Scientific Publication, Oxford.
3. Primrose and Twyman, Principles of Gene Manipulation and Genomics, 7th edition, Blackwell Publishing Co.
4. Glick and Pasternak, Molecular Biotechnology, Principles and Applications of Recombinant DNA Technology, ASM Press.
5. Cantor & Smith, Genomics, John Wiley & Sons.
6. Strachan & Read, Human Molecular Genetics, 3rd edition, Garland Science.
7. Gibson G. and Spencer V.M. A Primer of Genome Science, 2nd edition, Sinauer Associates Inc.

Subject Name: Biosensors					
Paper Code: BIOT4181					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

At the end of this course students will be able to

1. State types of bio-recognition elements and describe the fundamental components required to make a viable biosensor.
2. Illustrate types of enzyme immobilization methods used to make a biosensor and immobilize it to a transducer for the construction of biosensor.
3. Describe each types of biosensing element in relation to their uses in biosensors.
4. Understand the classification, construction and working principle of various transducers.
5. Understand the concepts, types, working principles and practical applications of important biosensors.
6. Explain the working principle of different types of inhibition based biosensors.

Module I: Introduction to biological system and Biosensors [10L]
Biosensor: principle, general characteristics; Proteins and enzymes: basic properties, denaturation and renaturation, immbobilization of enzymes; Advantages and limitations of biosensors; Classification of biosensors based on bioreceptor; Immobilization and coupling of bioreceptors.

Module II: Bio-recognition based sensors [10L]
Principle, operation and limitation of: Microbial sensor, Immunological sensor, Nucleic acid sensor. Other bioreceptors (e.g. animal, plant tissue); Different types of inhibitors: principles, operations, applications and limitations.

Module III: Biosensor based on transducer [10L]
Classification of biosensor based on transducer; Calorimetric, Electrochemical (potentiometric, amperometric), Optical, Piezoelectric, Semiconductor biosensor: principle, construction, calibration and limitations.

Module IV: Application of biosensor [10L]
Clinical and diagnostics sector, Industrial sector: Food, Environmental, defense sector; Commercially available biosensor.

Reference books:

1. Biosensors by Tran Minh Canh. London. Chapman and Hall, 1993.
2. Turner, A.P.F, Karube.I.,and Wilson,G.S, Biosensors Fundamentals and applications, Oxford Univ. Press.
3. Engineering biosensors, kinetics and design applications by Ajit Sadana..San Diego, Academic Press, 2002.
4. D.Thomas and J.M. Laval – Enzyme Technology in concepts in Biotechnology by Balasubramaniam et al, Univ. Press, 1996.

Subject Name: Biopolymers					
Paper Code: BIOT4182					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

At the end of this course students will be able to

1. Students will acquire basic knowledge of biopolymer and can classify biopolymer according to their composition.
2. Students will get familiar with the structures, properties and applications of different protein based biomaterial.
3. Students will be able to explain the structures, properties and applications of different carbohydrate based biomaterial.
4. Students will comprehend the knowledge of different type and applications of bioplastics.
5. Students will learn about the different composite material that can be used as biomaterial. They will be familiar with the applications, advantages and disadvantages of bioplastics and composite materials.
6. Students will classify biodegradable polymer and will analyze the biodegradation techniques.

Module-I: Introduction to biopolymers and protein biopolymers [10L]

Classification of Biopolymers; Collagen, Keratin and Fibroin: Structure, production (conventional and cloning method), properties and its use (Tissue regeneration scaffolds and others)

Module II: 1Carbohydrates as Biomaterials [10L]

Carbohydrate (Starch, Alginate, Chitin, Agarose) and modified carbohydrates (modified starch, polydextrose, chitosan etc.): Structure, production, properties and applications.

Module III: Application of Bioplastics and composite materials [10L]

Definition of bioplastics, Types of bioplastics such as starch-based, cellulose-based plastics and some aliphatic polyesters (PLA, PHB), polyamides, bio-based composites from soybean oil and chicken feathers, bio-derived polyethylene and genetically modified bioplastics. Composite theory of fiber reinforcement (short and long fibers, fibers pull out); applications and limitations of bioplastics and composite materials.

Module IV: Polymer biodegradation [10L]

Classification of biodegradable polymers (Natural, Synthetic and modified naturally modified); Techniques for analysis of biodegradation of polymers- Enzyme assays, Plate test, Respiratory test, Gas evolution test (CO_2 & CH_4), Field trial

References:

1. Ratledge C and Kristiansen B, Basic Biotechnology, Cambridge University Press, 2nd Edition, 2001
2. Doi Y, Microbial Polyesters, VCH Weinheim, 1990.

Subject Name: Food Biotechnology Lab					
Paper Code: BIOT4151					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**3**	**3**	**2**

Course Outcomes:

After performing this lab, students will be able to:

1. Detect microbial spoilage of food
2. Apply standard techniques quality testing
3. Measure the efficiency of Pasteurization
4. Isolation and identification of microbes from different food sample
5. Estimate different food ingredients
6. Gain knowledge on food preservation techniques

List of Experiments:

1. Detection of microbial load of milk by standard plate count method.
2. Detection of microbial load of milk by MBRT method.
3. Determination of effectiveness of pasteurization by alkaline phosphatase assay.
4. Identification and characterization of food fermenting organism from idly batter.
5. Determination of lactose content of milk.
6. Determination of ascorbic acid content of fruit juice.
7. Determination of food colour/ adulterant.

Subject Name: Environmental Biotechnology Lab					
Paper Code: BIOT 4152					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**0**	**3**	**2**

Course Outcomes:

After performing this lab, students will be able to:

1. Estimate basic environmental parameters in water and soil samples.
2. Estimate organic pollutants in a water sample
3. Demonstrate toxic effects of pollutants.
4. Apply regular methods for removal of organic / inorganic pollutants.
5. Apply microorganisms for degradation of organic pollutants

List of Experiments:

1. Determination of Total Suspended Solid in water
2. Determination of Hardness of water
3. Determination of Chloride content of water
4. Determination of BOD of waste water
5. Determination of COD of waste water
6. Estimation of POP organic pollutant (phenol) in waste water
7. Adsorptive removal of Heavy metals from waste water

Subject Name: Bioprocess & Process Instrumentation lab					
Paper Code: BIOT4153					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**3**	**3**	**2**

Course Outcomes:

At the end of this course students will be able to:

1. Determine the specific growth rate and doubling time for cell (pure/mixed) growth
2. Calculate Arrhenius constant and activation energy for cellular growth
3. Determine kinetic constants in free and immobilized enzyme systems/cellular systems
4. Determine optimum pH for an enzyme reaction.
5. Determine optimum temperature for an enzyme reaction.
6. Study the performance of continuous flow bioreactors (Packed-bed and Plug-flow)

List of Experiments:

1. Determination of specific growth rate and doubling time from cell (pure/mixed) growth kinetics profile.
2. Determination of Arrhenius constant and activation energy for cellular growth from growth kinetics data.
3. Determination of kinetic constants in free and immobilized enzyme systems.
4. Determination of kinetic constants in free and immobilized cellular systems
5. Study of effect of pH on enzyme reaction.
6. Study of effect of temperature on enzyme reaction.
7. Performance study of continuous flow bioreactors (Packed-bed and Plug-flow)

Subject Name: Professional Development					
Paper Code: HMTS4121					
Contact Hours Per Week	L	T	P	Total	Credit Points
	3	0	0	3	2

Course Outcomes:

At the end of this course students will be able to:

1. Map their skills according to the basic job profile.
2. Upgrade and enhance generic and specific skills according to Washington Accord.
3. Undertake research and identify industry specific job opportunities and enhance career growth.
4. Aware of the startup eco system in India.
5. Acquire tools to take up entrepreneurship as a career opportunity.
6. Achieve work-life balance by managing both organizational and personal crisis.

Module I: Professional Growth [10L]

- Goal Setting- Characteristic of goals, Short-term and long-term goals, Goal-achievement timeline
- Skill identification and Skill up gradation- Washington Accord and Skills for engineers (generic and specific), Local and global skills, Knowledge sources such as MOOC, NPTEL
- Career Planning- Vision and mission, Skill mapping to job profile, Basic and add-on qualifications, Career growth, Self-appraisal, Lifelong learning

Assessment - Activity (20 marks)

Module II: Entrepreneurship [10L]

- The start-up ecosystem in India- Why entrepreneurship?, Indian tech start-up landscape, Stand-up India policies, funding agencies, market development, trends and best practices
- E-Commerce- India as a growing E-commerce market, Possibilities of growth, funding, niche retailers
- Make in India- New processes, Investments, Focus sectors, Makers of Make In India, Opportunities, Policies

Assessment-Project (30 marks)

Module III: Industry specific opportunities [10L]

- Industry prospects in India and Beyond
- Industry-specific job opportunities
- Research & Development
- Other opportunities

Assessment---Presentation (30 marks)

Module IV: Working and living happily [10L]

- Managing crisis- Organisational and personal crisis, Analysing crisis, Turnaround strategies, Learning from crisis as opportunity
- Work-life balance- Performance-expectation management, Personal and professional goal- mapping
- Understanding happiness- Components, Conflicts, Happiness Index

Assessment: Activity/case (20 marks)

Suggested Reading:

1) Basic Managerial Skill for All by E. H. McGrath.SJ. Pub:PHI, New Delhi.
2) The Start-up Equation by Steven Fisher and Jae-Nae Duane. Pub: Mc Graw Hill Education (India) Pvt. Ltd. New Delhi.
3) Live Happily, Work Happily by Siddhartha Ganguli. Pub: Allied Publishers Pvt. Ltd. New Delhi.
4) Crisis Management: Planning for the Inevitable by Steven Fink. Pub: iUniverseInc.USA.
5) Influencer:The New Science of Leading Change by Joseph Grenny&Kerey Patterson. Pub: McGraw Hill Education , USA.

Subject Name: Bioethics & IPR					
Paper Code: HMTS4203					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

Course Outcomes:

At the end of this course students will be able to:

1. Interpret basics of biosafety and bioethics and its impact on all the biotechnology and the quality of human life.
2. Describe and analyze the different ethical, legal and social issues of biotechnology.
3. Understand the historical background , importance and levels of biosafety at laboratory and industrial scale and explain the biosafety-regulatory framework in India & International Level.
4. Gain an understanding of the basic concepts of patents, trademarks, copy rights, geographical indications and patent data baseand their protection in biotechnology.
5. Apply the different objectives and fundamentals of entrepreneurship in biotechnology.
6. Recognize importance of protection of new knowledge and innovations and its role in business.

Module- 1: Bioethics [10L]

Introduction to ethics and bioethics, roots of honours and integrity in science; the responsible conducts of biotechnological research; research with human beings (Nuremberg code, declaration of Helsinki, Belmont report and others); societal obligation of a biotechnologist; Ethics and the natural world: environmental ethics. Ethical legal social issues (ELSI) in biotechnology: Biotechnology/ biomedicine application: genetic engineering, biomedical science, Human genome project, genetic information, patenting human genes, cloning, genetic testing and screening, human gene therapy and genetic modification, stem cell research, genetically modified foods and organism, Biopiracy**.**

Module II: Biosafety [10L]

Introduction to Biosafety**.** The legal and socioeconomic impact of biotechnology, public education of the process of biotechnology involved in generating new forms of life for informed decision making, r-DNA guidelines, experimental protocol approvals, different levels of: containment, biosafety and risk groups. Biosafety regulation, national and international guidelines of: WHO, DBT (India), an informed consent. Different regulatory bodies in India. Convention of Biological Diversity (CBD): Cartagena Protocol, Kyoto protocol, Nagoya protocol and others; Case studies

Module-III: Intellectual Property Rights (IPR), Patents and protection [10L]

Concept of intellectual property and property rights. History and different forms of IPR: duties Patents (history, criteria and patentability, compulsory licensing), industrial designs, trade secret, confidential information, trademarks, geographical indications, copyrights; Distinctions among the various forms of IPR, infringement, Indian patent act and rules, traditional knowledge (TK), traditional knowledge digital library (TKDL), WTO, TRIPS, Biodiversity, and farmer rights, Budapest treaty. Case studies on-patents (basmati rice, turmeric, neem and others.)

Module-IV: Bioentrepreneurship [10L]

Concept of entrepreneurship**,** role of bioentrepreneur; fundamentals of marketing and selling of biotechnological products and services; technical aspects; entrepreneurship skill: vision, product idea, risk taking, problem solving, team building and organizational abilities. Business plan: products/ services; financial and human resources: the art of negotiation, workable marketing and the strength of distribution; opportunities in international marketing and lessons to be learned; steps involved in commercialization of a biotechnological product; case studies.

Text Books:

1. Bioethics and biosafety in biotechnology (2007) by V. Shree Krishna, Pub: New Age Int. Ltd.
2. Bioethics and biosafety in biotechnology (2008) by M.K. Sateesh, Pub: I. K. Int.
3. IPR, Biosafety and Bioethics - Deepa Goel, Shomini Parashar, Pub: Pearson
4. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies (2014) (1st Edn) by Craig Shimasaki
5. Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science (4th Edn.) (2013) by Yali Friedman
6. Biotechnology Entrepreneurship from Science to Solutions -- Start-Up, Company Formation and Organization, Team, Intellectual Property, Financing, (1st Edn.) (2010) by Michael L. Salgaller.

References:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. ND.
2. Sasson A, Biotechnologies and Development, UNESCO Publications.
3. Intellectual Property Rights and Bio-Technology (Biosafety and Bioethics) (2011) by N. P.House, Delhi
4. Regulatory Framework for GMOs in India (2006) Ministry of Environment and Forest, Government of India, ND.
5. Cartagena Protocol on Biosafety (2006) Ministry of Environment and Forest, Government of India, New Delhi.
6. P.K. Gupta, Biotechnology and Genomics, Rastogi Publications
7. Patent Strategy For Researches & Research Manegers- Knight, Wiley Publications.
8. Agriculture & Intellectual & Property Rights, V. Santaniello & R E Evenson, University Press.
9. Intellectual Property Protection & Sustainable Development, Phillipe Cullet, Ldexix Nexis Butterworths.
10. Biotechnology & Safety Assessment, Thomas, Ane/Rout Publishers.

Subject Name: Renewable Energy Technology					
Paper Code: BIOT4241					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Course outcomes:

At the end of this course students will be able to:

1) Distinguish the different types of biomass and explain its uses
2) Explain the conversion of biomass to clean fuels and also conversion of petrochemical substitutes to useful products by physiochemical/fermentation processes
3) Explain how ethanol and methane can be produced from biomass to produce bio-ethanol
4) Describe how biopolymer and biosurfactants can be used for microbial recovery of petroleum
5) Describe and understand how solar energy can be harnessed for useful purposes such as production of photovoltaic cells and for chemical storage purposes
6) Analyze and understand how other renewable energy sources can be harnessed for other productive purposes

Module I: Biomass [10L]

Sources and types of biomass – forest, agricultural and animal residues, industrial and domestic organic wastes, conversion of biomass to clean fuels and petrochemical substitutes by physicochemical and / or fermentation processes.

Module II: Biofuels [10L]

Biogas from anaerobic digestion; ethanol and methane from biomass. Hydrogen production by photosynthetic bacteria, biophotolysis of water. Microbial recovery of petroleum by biopolymers (Xantham gum), biosurfactants.

Module III: Solar energy [10L]

Description and design aspect of solar collectors, solar pond, photovoltaic cell and chemical storage.

Module IV: Other conventional energy [10L]

Introduction to geothermal, wind, tidal wave energy; Use of geothermal energy; Operating principles, application and design aspect of wind energy mills; Nuclear energy- types of nuclear reactors and their safety aspects.

Texts/References:

1. J.E. Smith, Biotechnology, 3rd ed. Cambridge Univ Press
2. S. Sarkar, Fuels and combustion, 2nd ed., University Press.
3. Donald L. Klass, Biomass for renewable energy, fuels and chemicals, Academic Press.

Subject Name: Tissue Engineering:					
Paper Code: BIOT4242					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Course outcomes:

At the end of this course students will be able to:

1. Explain the significance, current status and future potential of tissue engineering, identify requirements of tissue engineering, comprehend the structural organization of cells and tissues, the role of cell interaction, cell migration, wound healing and cellular processes.
2. Identify key challenges in tissue engineering of different human tissues, describe importance of cell signalling, angiogenesis in tissue engineering.
3. Describe the design, fabrication and biomaterials selection criteria for tissue engineering scaffolds.
4. Describe the sources, selection, potential manipulations, storage and challenges of using stem cells for tissue engineering.
5. Use simple models to quantify aspects of bioreactor design in the context of tissue engineering, understand the basics of 3D cell culture.
6. Discuss the challenges of in vivo implantation of biomaterials and scale-up issues relating to human clinical applications and explain the ethical and regulatory issues of significance in tissue engineering.

Module-I: Introduction to Tissue Engineering [10L]
Morphogenesis, generation of tissue in the embryo, Tissue homeostasis, Cellular signaling, extracellular matrix as scaffold for tissue engineering.

Module-II: Polymers in Tissue Engineering [10L]
Applications of natural polymers in tissue engineering, Degradable polymers for tissue engineering, Scaffold design and fabrication, Degradation of bioceramics, Biocompatibility.

Module-III: Cell Cultures in Tissue Engineering [10L]
Cell source, Stem cells, Cell culture harvest selection expansion and differentiation, Cell nutrition, Cryobiology, Bioreactors for tissue engineering.

Module-IV: Applications of Tissue Engineering [10L]
Controlled release strategies in tissue engineering, Tissue engineering for skin transplantation, Tissue engineering of cartilage, bone, nervous system, organ system, Ethical issues in tissue engineering.

Text Book:

1. Tissue Engineering (2008) by C. van Blitterswijk, P. Thomsen, J. Hubbell, R. Cancedda, J.D. deBruijn, A. Lindahl, J.Sohier, D. Williams Academic Press .

Ref. books:

1. Principles of Tissue Engineering (1997) by Robert Lanza, Robert Langer, Joseph P. Vacanti, Academic Press.
2. Tissue Engineering: Roles, Materials and Applications (2008) by Steven J. Barnes, Lawrence P. Harris, Nova publication

Subject Name: Post Harvest Technology					
Paper Code: BIOT4244					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Module I: Cereals and Pulses [10L]

Fundamentals of psychometry; fundamentals and methodology of parboiling, drying and milling, hydrothermal treatment of cereal grains and it's changes in physico-thermal and biochemical properties, milling of rice, corn, wheat and pulses.

Module II: Fruits and vegetables [10L]

Processing of fruits (banana, watermelon, papaya and mango) and vegetables (tomato, carrot, garlic and onion) processing: methodology of cleaning, product preparation and preservations (CAP and MAP).

Module III: Oil Seeds [10L]

Production of edible oil: Processing of oil seeds, extraction and refining of oil from different sources: sunflower, coconut, cotton seed, soyabean; Processing, extraction, refining and stabilization of rice bran.

Module IV: Storage [10L]

Storage principles, changes occurring in food grain--chemical, physical and biological, Grain storage, pests and their control, rodent control, food grain storage structures: bag and bulk storage, economics of storage and processing of rice, packaging concepts.

Texts/References:

1. A. Chakraborty, Post harvest technology of cereals, pulses and oil seeds, 1995.
2. G. Boumans, Grain Handlings and storage, Development in Agricultural Engg., Elsevier, Tokyo, 1988.
3. N.S. Rathore, G.K. Mathur, S.S. Chasta, Post-Harvest Management and Processing of Fruits and Vegetables.

Subject Name: Medical and Pharmaceutical Biotechnology					
Paper Code: BIOT4246					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Course outcomes:

At the end of this course students will be able to:

- Understand and apply principles and practices of drug development ofbiopharmaceuticals (e.g. insulin, interferons, EPO); pharmaceuticals of biological origin (e.g. corticosteroids) and microbial origin (e.g. antibiotics) including synthesis, biological and therapeutic characteristics (e.gPK/PD profiles) of such molecules.
- Understand the methodological and technological differences between formulation, delivery and post-production quality control of biopharmaceuticals versus small molecule pharmaceuticals.
- Understand the processes of discovery, technological developments and subsequent applications ofmonoclonal antibodies,DNA/RNA based diagnostics and protein based biomarkers.
- Understand principles and applications of the following topics with relevance to disease therapeutics: vaccines, gene therapy, proteomics techniques in drug development.
- Understand the principles of fabrication, operation and clinical applications of biosensors
- Understand and apply principles of enzymology for applications in microclinical diagnostics in kits or biochips.

Module 1: Drug Development [10L]
Principles of drug design and protein modification applied to biopharmaceuticals; pharmacokinetics and pharmacodynamics of biopharmaceuticals; generation of biopharmaceuticals from natural tissues and by recombinant methods (e.g. hormones, interferons, EPO and others); biosmilars; comparison with small molecule drugs; microbial transformations; antibiotics and steroids; techniques for development of new generation antibiotics; formulation, delivery and packaging of small and large molecule drugs.

Module II: Disease Diagnosis and Therapy [10L]
Monoclonal antibodies and their applications; CD Markers, FACS, HLA typing, Vaccines – features of an ideal vaccine: conventional and modern vaccine technologies; DNA and RNA based diagnostics and therapeutics: applications in PCR and others; Genotyping: case studies related to bacterial, viral and parasitic infections; Gene Therapy: status, problems and prospects of further development. Pharmacogenomics and Toxicogenomics; Stem cell therapy

Module III: Proteomics in Drug Development [10L]
Role of Proteomics and proteomics derived techniques to drug development; Discovery, analysis, technological developments and future prospects of protein based biomarkers for disease diagnosis (e.g. cancer biomarkers); Separation and identification technologies for proteomics (e.g. CE, HPLC-MS*)*; Enzyme immunoassays: types, their development and applications for clinical diagnosis.

Module IV: Clinical Diagnosis and Kit Development [10L]

Principles of diagnostic enzymology; use of enzymes in clinical diagnosis and kit development; determination; Biosensors: principles, types, clinical and biotechnological applications of biosensors; Noninvasive Biosensors in clinical analysis; Nanotechnological applications in biosensor development; Biochips: Introduction and applications in modern sciences, development of diagnostic kits for micro-clinical analysis.

Textbooks:

1. Biopharmaceuticals-Biochemistry and Biotechnology- By Gary Walsh, 2nd Edition, John Wiley, Inc.
2. Pharmaceutical Biotechnology- 3rd Edition- By R. Sambamurthy and T. Kar , Humana.

Reference texts:

1. Alberghina, Lilia: Protein Engineering in Industrial and Pharmaceutical Biotechnology, Harwood Academic Publishers (2006).
2. Science to Operations: Questions, Choices and Strategies for Success in Biopharma" By Ralf Otto, Alberto Santagostino and Ulf Schrader, McKinsey and Company, Springer- Bonn.
3. Fundamentals of Enzymology-Nicholas C. Price and Lewis Stevens. Pub: Oxford Science Publications.

Subject Name: Basic Process Equipment Design					
Paper Code: BIOT4247					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Module 1: Process design of heat exchanger [10L]
Introduction, classification, and thermal design of double pipe heat exchanger, shell and tube heat exchanger and evaporator.

Module II: Design of dryers [10L]
Drying principles, types and design of dryers ----plate type, continuous, and rotary.

Module III: Design of separation equipments [10L]
Basic principles of distillation column, stage calculation, types of distillation column---Tray, bubble cap and others.

Module IV: Basic principles of different operation concepts [10L]
Extraction column and leaching, Design principle of adsorption/ absorption type column, cyclone separator, venture scrubber.

Books:

1. Process Equipment Design by Young Brownell
2. Joshi's Process Equipment Design 2016 by V.V. Mahajani
3. Chemical Process Equipment: Design and drawing –2012, By SC Maidargi
4. Computer aided Chemical Engineering Equipment Design -- BC Bhattacharyya
5. Introduction to Chemical Equipment Design --- BC Bhattacharyya. CBS Publication

Subject Name: Computational Biology					
Paper Code: BIOT4281					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course outcomes:

At the end of this course students will be able to:

1. Acquire basic understanding of structures and functions of different biomolecules.
2. Obtain knowledge about the different metabolic pathways.
3. Explain different biological data and biological databases.
4. Understand classification of databases and how the biological data are stored in those databases.
5. Obtain the knowledge of different algorithms and programming languages to manage biological data.
6. Apply different tools and software for analysis of biological data.

Module-I: Introduction to Biomolecules [10L]
Introduction to biochemistry and molecular biology; Biomolecules: structure, function and metabolic pathways.

Module-II: Scope of Computational Biology [10L]
Definition of computational biology; origin and development of computational biology; Nature and Types of biological data; Data Structures: Sequences (GENbank files), Secondary structures, Super-secondary structures (Motifs), Tertiary structures (Pubchem and PDB structure files); Interaction Networks, Photographic Data: Fingerprints (DNA and MS), Microarray data; Biological databases.

Module-III: Preferred Algorithms, Programming languages and Operating systems [10L]
Principles of Pattern recognition: Use of Hidden Markov Model and Artificial Neural Networks in computational biology; Significance of Python and C/C++; Operating system: Bio-Linux (Selected Bioinformatics packages)

Module-IV: Applications of Computational biology [10L]
Molecular Modeling and Dynamics: introduction to Open MM library; GROMACS as an example of GUI in the public domain; computer based drug design (public domain and proprietary); Mathematical modeling of cell growth kinetics; Embedded systems for computational biology: High throughput data collection, processing and analysis; LC-MS, DNA microarrays and other applications (e.g. mobile microscopy and high throughput micro-PCR); Systems biology and Metabolic Engineering.

Text books:

1. Introduction to Bioinformatics, by Arthur M. Lesk (International Fourth Edition) (2014), Oxford University Press.
2. Essential Bioinformatics, by Jin Xiong, Cambridge University Press (2006).

Reference books:

1. Biochemistry: Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, 7th edition, Academic Press.
2. Introduction to Bioinformatics: T K Attwood, D J Parry-Smith and S. Phukan (2008) Pearson.
3. Fundamentals of Database Systems, 5th Edition, R. Elmasri and S.B. Navathe (2009)
4. Bioinformatics-A Machine Learning Approach- By Baldi and Brunak, 2nd Edition (2006), John Wiley Inc.
5. Dynamics of Proteins and Nucleic Acids: J. Andrew McCammon and Stephen C. Harvey, Cambridge University Press (1998).
6. Molecular Modelling: Principles and Applications-2nd Edition, Andrew R. Leach-Pearson (2016)
7. Molecular Modelling and Drug Design-K.Anand Solomon-1st edition (2011)-MJP Publishers.

Subject Name: Non-conventional Energy					
Paper Code: BIOT4282					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course outcomes:

At the end of this course students will be able to:

1. Understand the concept and necessity of non-conventional energy as an alternative source of energy.
2. Comprehend and apply the concepts of solar energy to design Photovoltaic cells and wind energy to design wind turbine.
3. Classify and design different biogas production processes.
4. Design a production process for biodiesel.
5. Understand the concept of hydrogen energy as a clean fuel and characterize the hydrogen production process.
6. Comprehend the importance and classification of hydrogen fuel cells.

Module I: Non-conventional energy: Different forms [10L]

Solar energy: Solar energy balance, production of electricity, photovoltaic systems.
Wind Energy: Wind energy conversion systems, power generation. Calculations on wind turbine.
Hydro thermal energy: Basics of hydro thermal energy.
Energy from waves and tides.

Module II: Biogas [10L]

Biomass as a renewable energy source; types of biomass – forest, agricultural and animal residues, industrial and domestic organic wastes.
Classification of biogas production processes: combustion, pyrolysis, gasification and other thermo-chemical processes.
Production of alcohol and biogas from biomass. Biogas from anaerobic digestion.

Module III: Bio-diesel [10L]

Bio-diesel: Fundamentals; Trans-esterification of vegetable oils for biodiesel production; Characterization of biodiesel; Biodiesel from different sources; Economics, current trends and future prospects in usage of biodiesel.

Module III: Hydrogen as energy source [10L]

Hydrogen energy: Hydrogen energy system and analysis; Hydrogen infrastructure; Safety, codes and standards.
Hydrogen production: Electrolysis; Thermochemical; Hydrogen from fossil fuel, biomass and renewable sources of energy. Problems on combustion of fuels.
Hydrogen storage: Carbon storage materials; Metal hydrides and chemical hydrides; Cryogenic hydrogen storage.
Hydrogen fuel cells: Principle, importance and classification.

Texts/References:

1. J.E. Smith, Biotechnology, 3rd ed. Cambridge University Press.

2. S. Sarkar, Fuels and combustion, 2nd ed., University Press.

3. Donald L. Klass, Biomass for renewable energy, fuels and chemicals, Academic Press.