BIOTECHNOLOGY

B.TECH. PROGRAMME

With effect from July 2018

.

2022-2026 batch

B.Tech. Biotechnology Curriculum (for 2022-2026 batch)

1st Year 1st Semester

A. THEORY							
Sl. No	**Course Code**	**Course Name**	**Contact Hours/ Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	PHYS1001	Physics	3	1	0	4	4
2	MATH1101	Mathematics I	3	1	0	4	4
3	CSEN1001	Programming for Problem Solving	3	0	0	3	3
Total of Theory			**9**	**4**	**0**	**11**	**11**
B. PRACTICAL/ LABORATORY							
1	PHYS1051	Physics Lab	0	0	3	3	1.5
2	CSEN1051	Programming for Problem Solving Lab	0	0	4	4	2
3	MECH1051	Workshop / Manufacturing Practices	1	0	4	5	3
Total of Practical			**1**	**0**	**11**	**12**	**6.5**
Total of Semester without Honours			**10**	**4**	**11**	**23**	**17.5**
C. HONOURS							
1	ECEN1011	Basic Electronics	3	0	0	3	3
2	ECEN1061	Basic Electronics Lab	0	0	2	2	1
Total Honours			**3**	**0**	**2**	**5**	**4**
Total of Semester with Honours			**14**	**0**	**13**	**30**	**21.5**

1st Year 2nd Semester

A. THEORY							
Sl. No	**Course Code**	**Course Name**	**Contact Hours/ Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	CHEM1001	Chemistry I	3	1	0	4	4
2	MATH1201	Mathematics II	3	1	0	4	4
3	ELEC1001	Basic Electrical Engineering	3	1	0	4	4
4	HMTS1202	Business English	2	0	0	2	2
Total of Theory			**11**	**3**	**0**	**14**	**14**
B. PRACTICAL/ LABORATORY							
1	CHEM1051	Chemistry I Lab	0	0	3	3	1.5
2	ELEC1051	Basic Electrical Engineering Lab	0	0	2	2	1
3	MECH1052	Engineering Graphics and Design	1	0	4	5	3
4	HMTS1252	Language Lab	0	0	2	2	1
Total of Practical			**1**	**0**	**11**	**12**	**6.5**
Total of Semester without Honours			**12**	**3**	**11**	**26**	**20.5**
C. HONOURS							
To be taken from MOOCS platforms (Swayam, NPTEL, Coursera, etc.)							**4**
Total of Semester with Honours							**24**

2nd Year 1st Semester

A. THEORY								
Sl No	**Course Code**	**Field**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	**EVSC2016**	Mandatory	Environmental Sciences	2	0	0	2	0
2	**HMTS2001**	Humanities	Human Values and Professional Ethics	3	0	0	3	3
3	**BIOT2101**	Basic Science	Chemistry of Biomolecules	3	0	0	3	3
4	**BIOT2102**	Prof. Core	Industrial Stoichiometry	3	0	0	3	3
5	**BIOT2103**	Prof. Core	Biochemistry	3	0	0	3	3
6	**BIOT2104**	Prof. Core	Microbiology	3	0	0	3	3
7	**MATH2101**	Basic Science	Mathematical & Statistical Methods	3	0	0	3	3
Total of Theory				**20**	**0**	**0**	**20**	**18**
B. PRACTICAL/ LABORATORY								
1	**BIOT2151**	Basic Science	Biomolecular Chemistry Lab	0	0	3	3	1.5
2	**BIOT2153**	Prof. Core	Biochemistry Lab	0	0	3	3	1.5
3	**BIOT2154**	Prof. Core	Microbiology Lab	0	0	4	4	2
Total of Practical				**0**	**0**	**10**	**10**	**5**
Total of Semester				**20**	**0**	**10**	**30**	**23**

2nd Year 2nd Semester

A. THEORY								
Sl No	**Course Code**	**Field**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	**BIOT2201**	Basic Science	Thermodynamics & Kinetics	3	0	0	3	3
2	**BIOT2202**	Prof. Core	Transfer Operation-I	3	0	0	3	3
3	**BIOT2203**	Prof. Core	Molecular Biology	3	0	0	3	3
4	**BIOT2204**	Prof. Core	Industrial Microbiology & Enzyme Technology	3	0	0	3	3
5	**CSEN2005**	Engg Science	Data Structure	3	0	0	3	3
Total of Theory				**15**	**0**	**0**	**15**	**15**
B. PRACTICAL/ LABORATORY								
1	**BIOT2252**	Prof. Core	Transfer Operation-I Lab	0	0	3	3	1.5
2	**BIOT2253**	Prof. Core	Molecular Biology Lab	0	0	2	2	1
3	**BIOT2254**	Prof. Core	Enzyme Technology & Fermentation Technology Lab	0	0	2	2	1
4	**CSEN2055**	Engg Science	Data Structure Lab	0	0	3	3	1.5
Total of Practical				**0**	**0**	**10**	**10**	**5**
Total of Semester without Honours				**15**	**0**	**10**	**25**	**20**
C. HONOURS								
To be taken from MOOCS platforms (Swayam, NPTEL, Coursera, etc.)								**4**
Total of Semester with Honours								**24**

3rd Year 1st Semester

A. THEORY								
Sl No	**Course Code**	**Field**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	**INCO3016**	Mandatory	Indian Constitution and Civil Society	2	0	0	2	0
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	**BIOT3131**	Prof. Elective 1	Food Biotechnology	3	0	0	3	3
	BIOT3132		Environmental Biotechnology					
	BIOT3133		Bioprocess & Process Instrumentation					
Total of Theory				**17**	**0**	**0**	**17**	**15**
B. PRACTICAL/ LABORATORY								
7	**BIOT3151**	Prof. Core	Genetics lab	0	0	2	2	1
8	**BIOT3152**	Prof. Core	Bioinformatics lab	0	0	2	2	1
9	**BIOT3153**	Prof. Core	Recombinant DNA Technology lab	0	0	2	2	1
10	**BIOT3154**	Prof. Core	Transfer Operation-II lab	0	0	2	2	1
11	**BIOT3181**	Prof. Elective 1	Food Biotechnology Lab	0	0	2	2	1
	BIOT3182		Environmental Biotechnology Lab					
	BIOT3183		Bioprocess & Process Instrumentation Lab					
Total of Practical				**0**	**0**	**10**	**10**	**5**
Total of Semester				**17**	**0**	**10**	**27**	**20**

3rd Year 2nd Semester

A. THEORY								
Sl No	**Course Code**	**Field**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	**HMTS3201**	Humanities	Economics for Engineers	3	0	0	3	3
2	**BIOT3201**	Prof. Core	Immunology	3	0	0	3	3
3	**BIOT3202**	Prof. Core	Bioreactor Design and Analysis	3	0	0	3	3
4	**CSEN3207**	Engg Science	RDBMS Concept and Computer Networking	3	0	0	3	3
5	**BIOT3231**	Prof. Elective 2	Molecular Modelling and Drug Designing	3	0	0	3	3
	BIOT3232		Biophysics of Macromolecules					
	BIOT3233		Biosensors and Diagnostics					
	BIOT3234		Bioseparation Technology					
6	**BIOT3221**	Emerging Area / Open Elective 1	Plant Biotechnology	3	0	0	3	3
	BIOT3222		Basics of Nanotechnology					
Total of Theory				**18**	**0**	**0**	**18**	**18**
B. PRACTICAL/ LABORATORY								
1	**BIOT3251**	Prof. Core	Immunology lab	0	0	2	2	1
2	**BIOT3252**	Prof. Core	Bioreactor Design lab	0	0	2	2	1
3	**CSEN3257**	Engg Science	RDBMS Concept lab	0	0	2	2	1
4	**BIOT3271**	Prof. Core	Plant Tissue Culture Lab	0	0	2	2	1
5	**BIOT3293**	Seminar	Term paper & Seminar	0	0	2	2	1
Total of Practical				**0**	**0**	**10**	**10**	**5**
Total of Semester without Honours				**18**	**0**	**10**	**28**	**23**
C. HONOURS								
To be taken from MOOCS platforms (Swayam, NPTEL, Coursera, etc.)								**4**
Total of Semester with Honours								**27**

4th Year 1st Semester

A. THEORY								
Sl No	**Course Code**	**Field**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	**HMTS4101**	Humanities	Principles of Management	3	0	0	3	3
2	**BIOT4131**	Prof. Elective 3	Biomaterials	3	0	0	3	3
	BIOT4132		Biofertilizers and Biopesticides					
	BIOT4133		Post-harvest Technology					
	BIOT4134		Biometallurgy					
	BIOT4135		Animal Cell Culture & Animal Biotechnology					
3	**BIOT4121**	Emerging Area / Open Elective 2	Proteomics and Protein Engineering	3	0	0	3	3
	BIOT4122		Human Genomics					
	BIOT4123		Biomedical Engineering					
	BIOT4124		Biosensor*					
4	**BIOT4126**	Open Elective 3	Biopolymer*	3	0	0	3	3
Total of Theory				**12**	**0**	**0**	**12**	**12**
B. SESSIONAL								
1	**BIOT4191**	Internship	Industrial Training / Internship	4 to 6 weeks				2
2	**BIOT4195**	Project	Project 1	0	0	8	8	4
Total of Sessional				0	0	8	**8**	**6**
Total of Semester without Honours				**12**	**0**	**8**	**20**	**18**
C. HONOURS								
To be taken from MOOCS platforms (Swayam, NPTEL, Coursera, etc.)								**4**
Total of Semester with Honours								**22**

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

**** To be offered as Open Elective-2 and Open Elective-3 for other departments***

4th Year 2nd Semester

A. THEORY								
Sl No	**Course Code**	**Field**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	**BIOT4231**	Prof. elective 4	Bioethics & IPR	3	0	0	3	3
	BIOT4232		Bio-entrepreneurship and Regulations					
	BIOT4233		Medical & Pharmaceutical Biotechnology					
2	**BIOT4241**	Prof. elective 5	Renewable Energy Technology	3	0	0	3	3
	BIOT4242		Tissue Engineering					
	BIOT4243		Metabolic Engineering					
	BIOT4244		Basic Process Equipment Design					
	BIOT4245		Bioprocess Modelling					
3	**BIOT4221**	Open elective 4*	Computational Biology	3	0	0	3	3
	BIOT4222		Non-conventional Energy					
	BIOT4223		Biology for Engineers					
Total of Theory				**9**	**0**	**0**	**9**	**9**
B. SESSIONAL								
4	**BIOT4295**	Project	Project-II	0	0	16	16	8
5	**BIOT4297**	Viva	Comprehensive Viva Voce	-	-	-	-	1
Total of Sessional				**0**	**0**	**16**	**16**	**9**
Total of Semester				**9**	**0**	**16**	**25**	**18**
C. HONOURS (only for Lateral Entry students)								
To be taken from MOOCS platforms (Swayam, NPTEL, Coursera, etc.)								**4**
Total of Semester with Honours (only for Lateral Entry students)								**22**

**** To be offered for other departments***

List of Open Electives offered by the Department of Biotechnology (for other departments)

A. THEORY (in semester 7)								
Sl No	**Course Code**	**Field**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	**BIOT4124**	Open Elective2	Biosensor	3	0	0	3	3
	BIOT4126	Open Elective 3	Biopolymer					
			Total of Theory				**3**	**3**

A. THEORY (in semester 8)								
Sl No	**Course Code**	**Field**	**Course Title**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
1	**BIOT4221**	Open Elective 4	Computational Biology	3	0	0	3	3
	BIOT4222		Non-conventional Energy					
	BIOT4223		Biology for Engineers					
			Total of Theory				**3**	**3**

Credit Point Summary for B.Tech from 2018-2019

Sl. No.	Course Type	Credit
1.	Humanities and Social Sciences including Management Courses	12
2.	Basic Science Courses	29.5
3.	Engineering Science Courses including Workshop, Drawing, Basics of Electrical / Mechanical / Computer etc.	24.5
4.	Professional Core Courses	50
5.	Professional Elective Courses relevant to chosen Specialization / Branch	16
6.	Open Subjects – Electives from other Technical and/or Emerging Subjects	12
7.	Project Work, Seminar and Internship in industry or elsewhere	16
8.	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge]	Non-credit
	Total	**160**
9	Honours Courses	20
	Grand Total	**180**

Definition of Credit (as per AICTE):

- 1 Hour Lecture (L) per Week = 1 Credit
- 1 Hour Tutorial (T) per Week = 1 Credit
- 1 Hour Practical (P) per Week = 0.5 Credits
- 2 Hours Practical (Lab) per Week = 1 Credit

Range of Credits (as per AICTE):

- A total of 160 credits will be necessary for a student to be eligible to get B Tech degree.
- A student will be eligible to get B Tech degree with Honours if he/she completes an additional 20 credits. These could be acquired through various Honours Courses offered by the respective departments.
- A part or all of the above additional credits may also be acquired through MOOCs. Any student completing any course through MOOCs will have to submit an appropriate certificate to earn the corresponding credit.
- For any additional information, the student may contact the concerned HODs.

BIOTECHNOLOGY

B.TECH. PROGRAMME

With effect from July 2018

1st yr 1st semester detailed syllabus

Subject Name: PHYSICS					
Paper Code: PHYS1001					
Contact Hours Per Week	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes:

1. To develop basic understanding of the modern science to the technology related domain.
2. Analytical & logical skill development through solving problems.
3. To impart idea of concise notation for presenting equations arising from mathematical formulation of physical as well as geometrical problems percolating ability of forming mental pictures of them.
4. Imparting the essence and developing the knowledge of controlling distant object like satellite, data transfer through optical fiber, implication of laser technology, handling materials in terms of their electrical and magnetic properties etc.

Module 1: Mechanics (7+5) = 12L

Elementary concepts of grad, divergence and curl. Potential energy function; F=-grad V, Equipotential surfaces and meaning of gradient; Conservative and non-conservative forces, Curl of a force field; Central forces ; conservation of angular momentum; Energy equation and energy diagrams; elliptical, parabolic and hyperbolic orbit; Kepler Problem; Application : Satellite manoeuvres .
Non-inertial frames of reference; rotating coordinate system; five term acceleration formula-centripetal and coriolis accelerations; applications: Weather system, Foucault pendulum.

Module 2: Optics = (4+3+5) = 12 L

Oscillatory Motion:
Damped harmonic motion – Over damped, critically damped and lightly damped oscillators; Forced oscillation and resonance. Electrical equivalent of mechanical oscillator, Wave equation, plane wave solution.

Optics:
Elementary features of polarization of light waves. Double refraction, Production and analysis of linearly, elliptic and Circularly polarized light, Polaroid and application of polarizations.: Polarimeter.

Laser & Fiber Optics:
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.

Fiber optics - principle of operation, numerical aperture, acceptance angle, Single mode , graded indexed fiber.

Module 3: **Electrostatics (8+4) = 12 L**

Electrostatics in free space

Calculation of electric field and electrostatic potential for a charge distribution, Divergence and curl of electrostatic field, Laplace's and Poisson's equation for electrostatic potential. Boundary conditions of electric field and electrostatic potential. Method of images , energy of a charge distribution and its expression in terms of electric field.

Electrostatics in a linear dielectric medium

Electrostatic field and potential of a dipole, Bound charges due to electric polarization, Electric displacement, Boundary conditions on displacement, Solving simple electrostatic problem in presence of dielectric – point charge at the centre of a dielectric sphere, charge in front of dielectric slab, Dielectric slab and dielectric sphere in uniform electric field.

Module 4: **(6+3+3) = 12L**

Magnetostatics :

Biot-Savart law, divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; equation for vector potential and it's solutions for given current densities .

Magnetostatics in a linear magnetic medium:

Magnetization and associated bound currents; Auxiliary magnetic field $\vec{H}$; boundary conditions on $\vec{B}$ and $\vec{H}$. Solving for magnetic field due to simple magnet like a bar magnet; Magnetic susceptibility ; ferromagnetic , paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Faraday's Law:

Differential form of Faraday's law expressing curl of electric field in terms of time derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi static approximation. Energy stored in a magnetic field.

Books of reference:

1. Optics – Eugene Hecht Pearson Education India Private Limited
2. Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited
3. Waves and Oscillations by N.K. Bajaj
4. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker , Wiley
5. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press
6. Classical mechanics, Narayan Rana, Pramod Joag, McGraw Hill Education
7. Introduction to Classical Mechanics, R Takwale, P Puranik, McGraw Hill Education
8. Optics, Ghatak, McGraw Hill Education India Private Limited
9. Refresher Course in B.Sc. Physics – Vol1 and Vol 2 – C.L.Arora

Subject Name: MATHEMATICS-I					
Paper Code: MATH1001					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Course Outcomes

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

The students will learn:

- to apply the notion of matrices for solving a system of linear simultaneous equations and some basic concepts of linear algebra in a comprehensive manner.
- to test the convergence of an infinite series
- some analytical techniques to solve ordinary differential equations that model physical processes.
- the concept of differentiation and integration for functions of several variables and some of their applications in Vector Calculus.

Module I [10L]

Matrix:

Inverse and rank of a matrix; Elementary row and column operations over a matrix; System of linear equations and its consistency; Symmetric, skew symmetric and orthogonal matrices; Determinants; Eigen values and eigen vectors; Diagonalization of matrices; Cayley Hamilton theorem; Orthogonal transformation.

Module II [10 L]

Vector Calculus:

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,

Infinite Series:

Convergence of sequence and series; Tests for convergence: Comparison test, Cauchy's Root test, D' Alembert's Ratio test(statements and related problems on these tests), Raabe's test; Alternating series; Leibnitz's Test (statement, definition); Absolute convergence and Conditional convergence.

Module III [10 L]

First order ordinary differential equations:

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Ordinary differential equations of higher orders:

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

Module IV [10L]

Calculus of functions of several variables

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,

Multiple Integration

Concept of line integrals, Double and triple integrals. Green's Theorem, Stokes Theorem and Gauss Divergence Theorem.

Suggested Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2000.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. K. F. Riley, M. P. Hobson, S. J. Bence. Mathematical Methods for Physics and Engineering, Cambridge University Press, 23-Mar-2006.
6. S. L. Ross, Differential Equations", Wiley India, 1984.
7. G.F. Simmons and S.G. Krantz, Differential Equations, McGraw Hill, 2007.
8. Vector Analysis(Schaum's outline series): M.R. Spiegel, Seymour Lipschutz, Dennis Spellman (McGraw Hill Education)
9. Engineering Mathematics: S. S. Sastry (PHI)
10. Advanced Engineering Mathematics: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP), Indian Edition.
11. Linear Algebra (Schaum's outline series): Seymour Lipschutz, Marc Lipson (McGraw Hill Education)

Course Name: PROGRAMMING FOR PROBLEM SOLVING					
Course Code: CSEN 1001					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Learning Objectives: 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:

On completion of this course, students are expected to be capable of solving problems using mathematics and generalize those solutions into flowcharts to form programs. This course is directed towards teaching the students, how to automate those solutions by implementing them in C programming language. It is expected that due to the use of C programming language, the students will learn the basics of how a high-level language works in tandem with memory. The students should be able to identify coding inefficiencies and errors in C code and turn those programs into efficient ones and remove programming bugs, primarily with manual inspection and later with the use of debuggers.

Module I: [10L]

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. Basic Concepts of Assembly language, High level language, Compiler and Assembler.

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).

Basic concepts of operating systems like MS WINDOWS, LINUX

How to write algorithms & draw flow charts.

Module II: [10L]

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.

Flow of Control:

Statement and blocks, if-else, switch-case, loops (while, for, do-while), break and continue, go to and labels.

Module III: [10L]
Program Structures in C

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.

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.

Module IV: [10L]
Data Handling in C

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(), fseek(), ftell().

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: PHYSICS LAB					
Course Code: PHYS1051					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Outcomes:

1. To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
2. To learn the usage of electrical and optical systems for various measurements.
3. Apply the analytical techniques and graphical analysis to the experimental data.
4. Understand measurement technology, usage of new instruments and real time applications in engineering studies.
5. To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

Minimum of six experiments taking at least one from each of the following four groups :

Group 1: Experiments in General Properties of matter

1. Determination of **Young's modulus** by **Flexure Method**
2. Determination of **bending moment** and **shear force** of a rectangular beam of uniform cross- section.
3. Determination of **modulus of rigidity** of the material of a rod by **static method**
4. Determination of **rigidity modulus** of the material of a **wire by dynamic method.**
5. Determination of **coefficient of viscosity** by Poiseulle's capillary flow method.

Group 2: Experiments in Optics

1. Determination of **dispersive power** of the material of a prism
2. Determination of wavelength of light by **Newton's ring** method.
3. Determination of wavelength of light by **Fresnel's biprism method.**
4. Determination of the **wavelength of a given laser** source by diffraction method

Group 3: Electricity & Magnetism experiments

1. Determination of **dielectric constant** of a given dielectric material.
2. Determination of resistance of **ballistic galvanometer by half deflection** method and study of variation of **logarithmic decrement** with series resistance.
3. Determination of the **thermo-electric power** at a certain temperature of the given thermocouple.
4. Determination of **specific charge (e/m)** of electron.

Group 4: Quantum Physics Experiments

1. Determination of **Planck's constant**.
2. Determination of **Stefan's radiation** constant.
3. Verification of **Bohr's atomic orbital** theory through **Frank-Hertz experiment**.
4. Determination of **Rydberg constant** by studying **Hydrogen/ Helium** spectrum.
5. Determination of **Hall co-efficient of semiconductors.**
6. Determination of **band gap** of semiconductors.
7. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells.

Course Name: PROGRAMMING FOR PROBLEM SOLVING					
Course Code: CSEN1051					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
per week	**0**	**0**	**4**	**4**	**2**

Software to be used: GNU C Compiler (GCC) with LINUX
NB: Cygwin (Windows based) may be used in place of LINUX

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

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

Course Name: WORKSHOP /MANUFACTURING PRACTICES					
Course Code: MECH 1051					
Contact Hours	L	T	P	Total	Credit Points
per week	1	0	4	5	3

Workshop/Manufacturing Practices [L: 1; T: 0; P: 0 (1 credit)]
(i) Lectures & videos: (13 hours)
Detailed contents

1. Introduction on Workshop and Safety Precautions. **(1 lecture)**
2. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods **(3 lectures)**
3. CNC machining, Additive manufacturing **(1 lecture)**
4. Fitting operations & power tools **(1 lecture)**
5. Electrical & Electronics **(1 lecture)**
6. Carpentry **(1 lecture)**
7. Plastic moulding, glass cutting **(1 lecture)**
8. Metal casting **(1 lecture)**
9. Welding (arc welding & gas welding), brazing **(2 lecture)**
10. **Viva-voce** **(1 lecture)**

Suggested Text/Reference Books:

(i) Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
(ii) Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
(iii)Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
(iv) Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
(v) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Course Outcomes

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

(ii) Workshop Practice :(52 hours)[L : 0; T:0 ; P : 4 (2 credits)]

1. Machine shop	**(12 hours)**
2. Fitting shop	**(8 hours)**
3. Carpentry	**(4 hours)**
4. Electrical & Electronics	**(4 hours)**
5. Welding shop **(Arc welding 4 hrs + gas welding 4 hrs)**	**(8 hours)**
6. Casting	**(4 hours)**
7. Smithy	**(4 hours)**
8. Plastic moulding& Glass Cutting	**(4 hours)**
9. Sheet metal Shop	**(4 hours)**

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Laboratory Outcomes

・Upon completion of this laboratory course, students will be able to fabricate components with their own hands.

・They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.

・By assembling different components, they will be able to produce small devices of their interest.

References:

1. Bhatt, N.D., Panchal V.M. & Ingle P.R., (2014) "Elementary Engineering Drawing" ; Charotan Publishing House.
2. Narayana, k.L. and Kannaaiah P "Engineering Graphics"; TMH.
3. Lakshminarayanan, V. and Vaish Wanar, R.s "Engineering Graphics" Jain Brothers.
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
5. Agarwal B. & Agarwal C. M. (2012), Engineering graphics, TMH Publications.

HONOURS COURSE

Course Title : Basic Electronics					
Course Code: ECEN1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

1. The students will learn the conduction phenomenon in materials and importance of p-and n-type conductors, AC to Dc conversion.
2. They will have knowledge of BJT and its use.
3. Students will be able to explain FET, MOS operation, IC fabrication basics.
4. They will learn about the Op-AMP, feedback and some special devices.

Module I [10 L]
Basic Semiconductor Physics:
Crystalline materials, Energy band theory, Conductors, Semiconductors and Insulators, Concept of Fermi Energy level, intrinsic and extrinsic semiconductors, drift and diffusion currents in semiconductor

Diodes and Diode Circuits:
Formation of p-n junction, Energy Band diagram, forward & reverse biased configurations, V-I characteristics, load line, breakdown mechanisms, Zener Diode and its Application.
Rectifier circuits: half wave & full wave rectifiers: ripple factor, rectification efficiency.

Module II [8 L]
Bipolar Junction Transistors (BJT):
PNP & NPN BJT structures, current components in BJT, CE, CB, CC configurations, V-I Characteristics of CB & CE modes, regions of operation, Base width modulation & Early effect, thermal runaway, Concept of Biasing: DC load line, Q-point, basics of BJT amplifier operation, current amplification factors, different biasing circuits: fixed bias, collector to base bias, voltage divider bias.

Module III [9 L]
Field Effect Transistors (FET):
n-channel Junction Field Effect Transistor (JFET) structure & V-I characteristics.

Metal Oxide Semiconductor Field Effect Transistor (MOSFET): enhancement & depletion type MOSFETs (for both n & p channel devices), drain & transfer characteristics.

MOSFET as a digital switch, CMOS inverter, voltage transfer characteristic (VTC), NAND & NOR gate realization using CMOS logic.

Moore's Law, evolution of process node, state of integration (SSI, MSI, LSI, VLSI, ULSI), Classification of Integrated circuits (IC) and their applications.

Module IV [9 L]

Feedback in amplifiers :

Concept of feedback, advantages of negative feedback (qualitative), Barkhausen criteria.

Operational Amplifier:

Ideal OPAMP characteristics, OPAMP circuits: inverting and non-inverting amplifiers, Adder, Subtractor, Integrator, Differentiator, Basic Comparator.

Special Semiconductor Devices:

Light Emitting Diode (LED), Silicon Controlled Rectifier (SCR), Photodiode: Operations, characteristics & applications.

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 Title : Basic Electronics Laboratory					
Course Code: ECEN1061					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

Course Outcomes:

1. The students will correlate theory with diode behavior.

2. They will design and check rectifier operation with regulation etc.

3. Students will design different modes with BJT and FET and check the operations.

4. They will design and study adder, integrator etc. with OP-AMPs.

List of Experiments (from)

1. Familiarization with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multi-meters etc.
2. Familiarization 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 and Differentiators.

1st yr 2nd semester detailed syllabus

Course Name: CHEMISTRY-1					
Course Code: CHEM1001					
Contact Hours per week	L	T	P	Total	Credit Points
	3	1	0	4	4

The course outcomes of the subject are

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 analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.for engineering applications.
4. Have knowledge of synthesizing nano materials and their applications in industry, carbon nanotube technology is used in every industry now-a-days.
5. Understanding of bulk properties and processes using thermodynamic considerations.
6. Elementary knowledge of IR, UV, NMR and X-ray spectroscopy is usable in structure elucidation and characterisation of various molecules.
7. Knowledge of electronic effect and stereochemistry for understanding mechanism of the major chemical reactions involved in synthesis of various drug molecules.

MODULE-I

Atomic structure and Wave Mechanics (3L)

Brief outline of the atomic structure, Duel character of electron, De Broglies's equation, the Heisenberg uncertainty principle, brief introduction of quantum mechanics, the Schrodinger wave equation, Hermitian operator, solution of the Schrodinger equation for particle in a one dimensional box, interpretation of the wave function Ψ, concept of atomic orbital.

Thermodynamics (3L)

Carnot cycle, 2nd law of thermodynamics, entropy, Clausius inequality, free energy and work function, Clausius Clapeyron Equation, Chemical Potential, Activity and Activity coefficient. Gibbs Duhem Relation.

Spectroscopic Techniques & Application (4L)
Electromagnetic spectrum: EMR interaction with matter - absorption and emission of radiation.
Principle and application of UV- visible and IR spectroscopy
Principles of NMR Spectroscopy and X-ray diffraction technique

MODULE-II
Chemical Bonding (5L)
Covalent bond, VSEPR Theory, hybridization, molecular geometries, Dipole moment, Intermolecular forces, V.B. and M.O. Theory and its application in Homo and Heteronuclear diatomic molecules, Band theory of solids, Pi-molecular orbitals of ethylene and butadiene.

Periodicity (3L)
Effective nuclear charge, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro-negativity, inert pair effect.

Ionic Equilibria (2L)
Acid Base Equilibria, Salt Hydrolysis and Henderson Equation, Buffer solutions, pH indicator, Common ion Effect, Solubility product, Fractional Precipitation.

MODULE-III
Conductance (3L)
Conductance of electrolytic solutions, Strong and Weak electrolytes, effect of temperature and concentration. Kohlrausch's law of independent migration of ions, transport numbers and hydration of ions. Application of conductance Acid-base and precipitation titration.

Electrochemical Cell (4L)
Thermodynamic derivation of Nernst equation, Electrode potential and its application to predict redox reaction; Standard Hydrogen Electrode, Reference electrode, cell configuration, half cell reactions, evaluation of thermodynamic functions; Reversible and Irreversible cells; Electrochemical corrosion.
Electrochemical Energy Conversion: Primary & Secondary batteries, Fuel Cells.

Reaction dynamics (3L)
Rate Laws, Order & Molecularity; zero, first and second order kinetics. Pseudo-unimolecular reaction, Arrhenius equation.
Mechanism and theories of reaction rates (Transition state theory, Collison theory).
Catalysis: Homogeneous catalysis (Definition, example, mechanism, kinetics).

MODULE-IV
Stereochemistry (4L)
Representations of 3- dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

Structure and reactivity of Organic molecule (3L)
Inductive effect, resonance, hyperconjugation, electromeric effect, carbocation, carbanion, free radicals, aromaticity.

Organic reactions and synthesis of drug molecule (3L)
Introduction to reaction mechanisms involving substitution, addition, elimination and oxidation-reduction reactions. Synthesis of commonly used drug molecules.

TEXT BOOKS

1. Atkins' Physical Chemistry, P.W. Atkins (10th Edition)
2. Organic Chemistry, I. L. Finar, Vol-1 (6th Edition)
3. Engineering Chemistry, Jain & Jain,(16th Edition)
4. Fundamental Concepts of Inorganic Chemistry, A. K. Das, (2nd Edition)
5. Engineering Chemistry -I, Gourkrishna Dasmohapatra, (3rd Edition)

REFERENCE BOOKS

1. General & Inorganic Chemistry, R. P. Sarkar
2. Physical Chemistry, P. C. Rakshit, (7th Edition)
3. Organic Chemistry, Morrison & Boyd , (7th Edition)
4. Fundamentals of Molecular Spectroscopy, C.N. Banwell, (4th Edition)
5. Physical Chemistry, G. W. Castellan, (3rd Edition)
6. Basic Stereo chemistry of Organic Molecules, Subrata Sen Gupta, (1st Edition)

Course Name: MATHEMATICS-II					
Course Code: MATH1201					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
per week	**3**	**1**	**0**	**4**	**4**

Course Outcomes

The objective of this course is to familiarize the students with numerical techniques, integral transforms, graph theory and probability. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.

The students will learn:

- the ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
- numerical techniques to solve problems which in general have no analytic solution.
- to apply techniques of integral transforms for advanced engineering problems.
- to represent certain physical problems as graphs and find out the shortest path between two vertices.

Module-I Fundamentals of Probability (10L)

- Random experiment, Sample space and events
- Classical and Axiomatic definition of probability
- Addition and Multiplication law of probability
- Conditional probability
- Bayes' Theorem
- Random variables
- General discussion on discrete and continuous distributions
- Expectation and Variance
- Examples of special distribution: Binomial and Normal Distribution

Module-II Numerical Methods (10L)

- Solution of non-linear algebraic 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, Matrix Inversion Method.

- Solution of Ordinary differential equations: Euler's and Modified Euler's Method , Runge-Kutta Method of 4^{th} order.

Module-III Basic Graph Theory (10L)

- 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
- Definition and properties of a tree
- 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-IV Laplace Transformation (10L)

- Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations.
- Introduction to integral transformation
- Functions of exponential order, Definition and existence of Laplace Transform(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

Suggested Books:

1. Advanced Engineering Mathematics , *E.Kreyszig*, Wiley Publications
2. Introduction to Probability and Statistics for Engineers and Scientists, *S.Ross*, Elsevier
3. Introductory methods of Numerical Analysis, *S.S. Sastry*, PHI learning
4. Introduction to Graph Theory, *D. B. West*, Prentice-Hall of India
5. Engineering Mathematics, *B.S. Grewal,* S. Chand & Co.

Course Name: BASIC ELECTRICAL ENGINEERING					
Course Code: ELEC1001					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Course Outcomes

After attending the course, the students will be able to

- Study and analyze the basic concept of DC and AC electric circuits.
- Understand and analyze the concept of basic magnetic circuits.
- Study the working principles of different electrical machines.

Module-I:

DC Network Theorem: Kirchhoff's laws, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Star-Delta conversion. [6L]

Electromagnetism: Review of magnetic flux, Force on current carrying conductors, Magnetic circuit analysis, Self and Mutual inductance, B-H loop, Hysteresis and Eddy current loss, Lifting power of magnet. [5L]

Module-II

AC single phase system: Generation of alternating emf, Average value, RMS value, Form factor, Peak factor, representation of an alternating quantity by a phasor, phasor diagram, AC series, parallel and series-parallel circuits, Active power, Reactive power, Apparent power, power factor, Resonance in RLC series and parallel circuit. [10L]

Module-III

Three phase system: Generation of three-phase AC power, Balanced three phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams, power measurement by two wattmeter method. [4L]

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. [7L]

Module-IV

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, Introduction to three phase transformer. [6L]

Three-phase induction motor: Concept of rotating magnetic field, Principle of operation, Construction, Equivalent circuit and phasor diagram, torque-speed/slip characteristics. [4L]

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: BUSINESS ENGLISH					
Course Code: HMTS1201					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
per week	**2**	**0**	**0**	**2**	**2**

Course Outcome

After attending the course, the students will be able to

1. Acquire competence in using English language to communicate.
2. Be aware of the four essential skills of language usage-listening, speaking, reading and writing.
3. Be adept at using various modes of written communication at work.
4. Attain the skills to face formal interview sessions.
5. Write reports according to various specifications.
6. Acquire the skill to express with brevity and clarity.

Module- I (6hrs.)

Grammar (Identifying Common Errors in Writing)

- Subject-verb agreement
- Noun-pronoun agreement
- Misplaced Modifiers
- Articles
- Prepositions
- Redundancies

Module- II (6hrs.)

Basic Writing Strategies

Sentence Structures

- Use of phrases and clauses in sentences
- Creating coherence
- Organizing principles–accuracy, clarity, brevity
- Techniques for writing precisely
- Different styles of writing: descriptive,narrative, expository
- Importance of proper punctuation

Module- III (8hrs)

Business Communication- Scope & Importance

Writing Formal Business Letters: Form and Structure-Parts ofa Business letter, Business Letter Formats, Style and Tone, Writing strategies.

Organizational Communication: Agenda & minutes of a meeting, Notice, Memo, Circular

Organizing e-mail messages, E-mail etiquette

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 of Chronological and Functional Resume, Content of the Resume: Heading, Career Goal or Objectives, Education, Work Experience, Summary of Job Skills/Key Qualifications, Activities, Honors and Achievements, Personal Profile, Special Interests, References

Module- IV (6hrs)

Writing skills

- Comprehension: Identifying the central idea, inferring the lexical and contextual meaning, comprehension passage - practice
- Paragraph Writing: Structure of a paragraph, Construction of a paragraph, Features of a paragraph, Writing techniques/developing a paragraph.
- Précis: The Art of Condensation-some working principles and strategies. Practice sessions of writing précis of given passages.
- Essay Writing:Characteristic features of an Essay, Stages in Essay writing, Components comprising an Essay, Types of Essays-Argumentative Essay, Analytical Essay, Descriptive Essays, Expository Essays, Reflective Essays

References:

1. Theories of Communication: A Short Introduction, Armand Matterlart and Michele Matterlart, Sage Publications Ltd.
2. Professional Writing Skills, Chan, Janis Fisher and Diane Lutovich. San Anselmo, CA: Advanced Communication Designs.
3. Hauppauge, Geffner, Andrew P. Business English, New York: Barron's Educational Series.
4. Kalia, S. &Agarwal,S. Business Communication,Wiley India Pvt. Ltd., New Delhi, 2015
5. Mukherjee, H.S., Business Communication- Connecting at work., , Oxford University Press.2nd Edition.2015
6. Raman, M. and Sharma, S., Technical Communication: Principles and Practice, 2nd Ed., 2011.

Course Name: CHEMISTRY-I LAB					
Course Code: CHEM1051					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**3**	**3**	**1.5**

The subject code CHEM1051 corresponds to chemistry laboratory classes for the first year B. Tech students. This course enhances the students' experience regarding handling of various chemicals along with various laboratory equipments. Hands on experiments increase the depth of knowledge that is taught in the theory classes as well as it increases research aptitude in students because they can see the direct application of theoretical knowledge in practical field. The course outcomes of the subject are:

1. Knowledge to estimate the hardness of water which is required to determine the usability of water used in industries.

2. Estimation of ions like Fe^{2+}, Cu^{2+} and Cl^{-} present in water sample to know the composition of industrial water.

3. Study of reaction dynamics to control the speed and yield of various manufactured goods produced in polymer, metallurgical and pharmaceutical industries.

4. Handling physico-chemical instruments like viscometer, stalagmometer, pH-meter, potentiometer and conductometer.

5. Understanding the miscibility of solutes in various solvents required in paint, emulsion, biochemical and material industries.

6. Knowledge of sampling water can be employed for water treatment to prepare pollution free water.

List of experiments:

1. Estimation of iron using KMnO4 self indicator.
2. Iodometric estimation of Cu2+.
3. Determination of Viscosity.
4. Determination of surface tension.
5. Adsorption of acetic acid by charcoal.
6. Potentiometric determination of redox potentials.
7. Determination of total hardness and amount of calcium and magnesium separately in a given water sample.
8. Determination of the rate constant for acid catalyzed hydrolysis of ethyl acetate.
9. Heterogeneous equilibrium (determination of partition coefficient of acetic acid in n-butanol and water mixture).
10. Conductometric titration for the determination of strength of a given HCl solution against a standard NaOH solution.
11. pH-metric titration for determination of strength of a given HCl solution against a standard

NaOH solution.
12. Determination of chloride ion in a given water sample by Argentometric method (using chromate indicator solution)

Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis-G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney.
2. Advanced Practical Chemistry- S. C. Das
3. Practicals in Physical Chemistry- P. S. Sindhu

Course Name: BASIC ELECTRICAL ENGINEERING LABORATORY					
Course Code: ELEC1051					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
per week	**0**	**0**	**2**	**2**	**1**

Course Outcomes: The students are expected to

- Get an exposure to common electrical apparatus and their ratings.
- Make electrical connections by wires of appropriate ratings.
- Understand the application of common electrical measuring instruments.
- 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 GRAPHICS & DESIGN					
Course Code: MECH1052					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	1	**0**	**4**	**5**	**3**

Course Outcomes:

After going through the course, the students will be able

- To understand the meaning of engineering drawing.
- To have acquaintance with the various standards (like lines, dimensions, scale etc.) and symbols followed in engineering drawing.
- To represent a 3-D object into 2-D drawing with the help of orthographic and isometric projections.
- To read and understand projection drawings.
- To use engineering drawing software (CAD).

Lecture Plan (13 L)

1. Importance and principles of engineering drawing (1 L)
2. Concepts of lettering, dimensioning and Scale (2 L)
3. Conic sections (1 L)
4. Orthographic projection (2 L)
5. Definitions of different solids and their projections (1 L)
6. Section of solids and sectional view (1 L)
7. Isometric projection (2 L)
8. Introduction to CAD (2 L)
9. Viva Voce (1 L)

Detailed contents of Lab hours (52 hrs)

Module 1: Introduction to Engineering Drawing covering,

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lines, lettering & dimensioning, Conic section like Ellipse (General method only); Involute; Scales – Plain, Diagonal.

(4 hrs + 4 hrs)

Module 2: Orthographic Projections covering,

Principles of Orthographic Projections - Conventions - Projections of Points and lines inclined to both planes; Projections on Auxiliary Planes. Projection of lamina.

(4 hrs + 2 hrs)

Module 3: Projections of Regular Solids covering,

those inclined to both the Planes- Auxiliary Views.

(2 hrs + 4 hrs)

Module 4: Sections and Sectional Views of Right Angular Solids covering,

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids.

(4 hrs + 2 hrs)

Module 5: Isometric Projections covering

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.

(2 hrs + 4 hrs)

Module 6: Overview of Computer Graphics covering

listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids.

(4 hrs)

Module 7: Customisation & CAD Drawing

consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

(4 hrs + 2 hrs)

Module 8: Annotations, layering & other functions covering

applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation.

(2 hrs + 4 hrs)

Module 9: Demonstration of a simple team design project that illustrates

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame.

(4 hrs)

References:

1. Bhatt, N.D., Panchal V.M. & Ingle P.R. (2014) “Elementary Engineering Drawing”; Charotan Publishing House.
2. Narayana, K.L. and Kannaaiah P. “Engineering Graphics”; TMH.
3. Lakshminarayanan, V. and Vaish Wanar, R.s “Engineering Graphics”, Jain Brothers.
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
5. Agarwal B. & Agarwal C. M. (2012), Engineering graphics, TMH Publications.

Course Name: LANGUAGE LAB					
Course Code: HMTS1251					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**2**	**2**	**1**

Course Outcome

After going through the course, the students will be able to:

1. Acquire the techniques to become an effective listener.
2. Acquire the skill to become an effortless speaker.
3. Organize and present information for specific audience.
4. Communicate to make a positive impact in professional and personal environment.
5. Engage in research and prepare authentic, formal, official documents.
6. Acquire reading skills for specific purpose.

Module- I (4hrs)

Listening Skills

- Principles of Listening: Characteristics, Stages.
- Types of Listening: Passive listening, Marginal or superficiallistening, Projective Listening, Sensitive or Empathetic Listening, Active or Attentive listening.
- Guidelines for Effective Listening
- Barriers to Effective Listening
- Listening Comprehension

Module- II (8hrs)

- Interviewing
  Types of Interviews, Format for Job Interviews: One-to-one and Panel Interviews, Telephonic Interviews,Interview through video conferencing.
- Interview Preparation Techniques, Frequently Asked Questions, Answering Strategies, Dress Code, Etiquette, Questions for the Interviewer, Simulated Interviews.

Module- III (6hrs)

- Public Speaking:TheSpeech Process: The Message, The Audience, The Speech Style, Encoding, Feedback.
- Characteristics of a good speech : content and delivery, structure of a speech
- Modes of delivery in public speaking: Impromptu, Extemporaneous, Prepared or Memorized, Manuscript.

- Conversation: Types of conversation: formal and informal, Strategies for effective conversation, Improving fluency.
- Situational conversation practice: Greetings and making introductions, Asking for information and giving instructions, agreeing and disagreeing.
- Conversational skills in the business scenario: One-to-one and Group communication, Gender and Culture Sensitivity, Etiquette, Sample Business Conversation, Telephonic Conversation

Module- IV (8hrs)

Presentation Skills

- Speaking from a Manuscript, Speaking from Memory, Impromptu Delivery, Extemporaneous Delivery, Analyzing the Audience, Nonverbal Dimensions of Presentation
- Organizing the Presentation: The Message Statement, Organizing the Presentation: Organizing the Speech to Inform, The Conclusion, Supporting Your Ideas – Visual Aids: Designing and Presenting Visual Aids, Selecting the Right Medium.
- Project Team/Group Presentations

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. Sen, S.,Mahendra,A. &Patnaik,P.,Communication and Language Skills, Cambridge University Press, 2015
5. Locker,Kitty O. Business and Administrative Communication McGraw-Hill/ Irwin.
6. Chaney,L.andMartin,J., Intercultural Business Communication. Prentice Hall

2nd yr 1st semester detailed syllabus

Course Name : Environmental Sciences					
Course Code: EVSC2016					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	0	0	2	0

Course outcome for the subject code EVS2016

The subject code EVS2016 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 1

Socio Environmental Impact
6L

Basic ideas of environment and its component
Population growth: exponential and logistic; resources; sustainable development.
3L
Concept of green chemistry, green catalyst, green solvents
Environmental disaster and social issue, environmental impact assessment, environmental audit, environmental laws and protection act of India.
3L

Module 2
6L
Air Pollution

Structures of the atmosphere, global temperature models
Green house effect, global warming; acid rain: causes, effects and control.
3L
Lapse rate and atmospheric stability; pollutants and contaminants; smog; depletion of ozone layer; standards and control measures of air pollution.
3L

Module 3
6L
Water Pollution
Hydrosphere; pollutants of water: origin and effects; oxygen demanding waste; thermal pollution; pesticides; salts.
Biochemical effects of heavy metals; eutrophication: source, effect and control.
2L
Water quality parameters: DO, BOD, COD.
Water treatment: surface water and waste water.
4L

Module 4
6L
Land Pollution
Land pollution: sources and control; solid waste: classification, recovery, recycling, treatment and disposal.
3L
Noise Pollution
Noise: definition and classification; noise frequency, noise pressure, noise intensity, loudness of noise, noise threshold limit value; noise pollution effects and control.
3L

Text/Books

1. GourKrishna Das Mahapatra, Basic Environmental Engineering and Elementary Biology, Vikas Publishing House P. Ltd.
2. A. K. De, “Environmental Chemistry”, New Age International.
3. A. K. Das, Environmental Chemistry with Green Chemistry, Books and Allied P. Ltd.

References/Books

1. S. C. Santra, Environmental Science, New Central Book Agency P. Ltd.
2. D. De, D. De, Fundamentals of Environment & Ecology, S. Chand & Company Ltd.

Course Name : Human Values and Professional Ethics					
Course Code: HMTS2002					
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 :

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 (10 L)

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,Utilitarianism, 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, Gilligan'stheory (consensus and controversy)
Code of Professional Ethics Sample Code of ethics like ASME, ASCE. IEEEInstitute 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 (6L)

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 : Chemistry of Biomolecules					
Course Code: BIOT2101					
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. 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 and lipids [10L]

Introduction: Structure of water molecules, weak inter-molecular interactions in biomacromolecules, concepts of pKa, pH, buffer**.** Chemistry of Carbohydrates: Definition, classification, structure and chemical properties of: monosaccharides, disaccharides and polysaccharides. Chemistry of Lipids: Definition, classification. structure, reactions and characterization of: lipids, phospholipids, glycolipids, cholesterol, steroids and carotenoids. Stereochemistry of carbohydrates and lipids: configuration, conformation, nomenclature of optical isomers of carbohydrates and geometrical isomers lipids.

Module-II: Chemistry of Amino Acids and Proteins [10L]

Chemistry of amino acids: Classification, structure, pH titration curve and important chemical reactions of amino acids. Chemistry of proteins: Peptide bond, four levels of structures (primary, secondary, tertiary and quaternary structure with example of: RNaseA, keratins, collagen, lectins, myoglobin, and haemoglobin) and conformation (Ramachandran plot, domains, motif and folds), of proteins. Identification and separation methods of proteins based on structure and chemical properties. Stability of protein, denaturation and renaturation of proteins.

Mod III: Chemistry of Nucleotides and Nucleic Acids [10L]

Chemistry of nucleoside and nucleotides: Classification, structure, nomenclature of nucleoside, nucleotides. Chemistry of nucleic acids: Four levels structures of nucleic acids (primary, secondary, tertiary and quaternary structure), conformations (A-, B-, Z-,DNA), t-RNA, micro-RNA. Nucleotide sequence composition of DNA and RNA. Supercoiled structure of DNA, stability of nucleic acids, denaturation and renaturation kinetics of DNA. Identification, isolation, separation and analysis of nucleic acids.

Module-IV: Techniques for analysis and structure determination of biomolecules [10L]

Principles and types of spectroscopy, Lambert–Beer law**.** Basic concepts and principles of analytical techniques: spectroscopy- UV and visible, fluorescence, infrared, circular dichroism, optical rotatory dispersion, surface plasmon resonance, electron spin resonance. Structure determination techniques: Nuclear Magnetic resonance spectroscopy, X-ray diffraction, crystallography; Microscopy: atomic force (AFM), Electron microscopy (SEM, STM, 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. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8thedn. (2018) by Andreas Hofmann, Samuel Clokie.
5. Biochemical Calculations by Irwin H. Segel, John Wiley & Sons.

Course Name : Industrial Stoichiometry					
Course Code: BIOT2102					
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. 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 1: Basic Chemical Calculations [10L]
Dimension – Systems of units, engineering FPS, Engineering MKS & SI systems – Conversion from one system to the other – composition of mixtures and solutions - mass fraction, mole fraction, mass ratios, molarity, molality, normality, ppm, composition by density. Ideal and actual gas equations, application to pure gas & gas mixtures – partial pressures, partial volumes. 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: 2nd 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	0	0	3	3

Course Outcomes

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

1) Explain the basic concepts of enzymes.
2) Understand and apply mathematical knowledge to solve Enzymatic Kinetics particularly related to Michaelis-Menton Equation.
3) Understand and grasp knowledge about main principles behind how various cell signalling works.
4) Explain the basic concepts of how extracellular matrix works.
5) Explain the basis behind lipid synthesis and lipid β oxidation pathways.
6) Understand how Cholesterol synthesis happens.

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 Ketonbodies 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, extracellular matrix.

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	0	0	3	3

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: Historical aspect.

Cell structure with subcellular functional organelles. Bacteria, Yeast, Fungi, Algae and Virus: General morphology and subcellular structure, growth and reproduction.

Biochemical & Molecular Taxonomical identification of microorganisms.

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

Microscopy: 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 (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. Nod genes, nitrogenase complex, leghaemoglobin.

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 : Mathematical & statistical Methods					
Course Code: MATH2101					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

After completing the course, students will be able to:

MATH2101.1 Apply numerical methods to obtain approximate solutions to mathematical problems where analytic solutions are not possible.

MATH2101.2 Implement appropriate numerical methods for solving advanced engineering problems dealing with interpolation and integration.

MATH2101.3 Design stochastic models to predict the outcomes of events.

MATH2101.4 Recognize the significance of the expansion of a function in Fourier Series.

MATH2101.5 Provide deterministic mathematical solutions to physical problems through partial differential equations.

MATH2101.6 Employ statistical methods to make inferences on results obtained from an experiment.

MODULE-I – PARTIAL DIFFERENTIAL EQUATIONS (10L)

- Introduction to partial differential equations
- Formation of partial differential equations
- Lagrange's and Charpit's method of solution.
- Second order partial differential equations with constant coefficients.
- Solution by the method of separation of variables.
- Solution to the wave equation in two dimensions.

MODULE-II – NUMERICAL METHODS FOR INTERPOLATION AND INTEGRATION (10L)

- Basics of interpolation ,
- Newton's Forward and Backward Interpolation Method.
- Lagrange's Interpolation.
- Central difference interpolation: Striling's formula.
- Divided difference and their properties.

- Numerical Interpolation : Trapezoidal and Simpson's 1/3rd rule.

MODULE-III – FOURIER SERIES (10L)

- Definite Integral ,Orthogonality of Trigonometric Functions , Power Series and its convergence.
- Periodic Functions , Even and Odd Functions , Dirichlet's Conditions.
- Euler Formulas for Fourier coefficients.
- Fourier series representation of a function, e.g. Periodic square wave, Half wave rectifier, Unit step function.
- Half Range series: Sine and Cosine ,Parseval's Identity.

MODULE-IV – PROBABILITY DISTRIBUTIONS AND STATISTICS (10L)

- Special Distributions: Hypergeometric, Poisson, Uniform, Exponential, Gamma and Normal.
- Measures of Central Tendency and Dispersion
- Mean, Median, Mode and Standard Deviation for grouped and ungrouped frequency distribution.
- Moments: Skewness and Kurtosis.
- Simple Correlation and Regression, rank correlation coefficient.

Suggested Books:

1. Miller & Freund's Probability and Statistics for Engineers, R.A.Johnson, Prentice Hall of India.
2. Numerical Methods (Problems and Solution) Jain, Iyengar ,& Jain,New Age International Publisher.
3. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons.
4. Higher Engineering Mathematics, B. V. Ramana, Tata McGraw-Hill.
5. Advanced Engineering Mathematics, Kreyszig, Wiley Publications.
6. Numerical Methods (Problems and Solution), Jain, Iyengar & Jain, New Age International Publishers

Course Name : Biomolecular Chemistry Lab					
Course Code: BIOT2151					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	1.5

Course Outcomes:

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

1. Determine the presence of carbohydrates, proteins and lipids 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 lipds.

List of experiments:

1. Qualitative tests For Carbohydrates, Amino acids, Proteins and Lipids.
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: BIOT2153					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	1.5

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 2154					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	4	4	2

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.

2nd yr 2nd semester detailed syllabus

Course Name : Thermodynamics and Kinetics					
Course Code: BIOT2201					
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. 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: Concepts and Laws of Thermodynamics[10L]
Review of basic concepts – systems, surroundings, processes, properties (extensive/intensive), components (single/multi). Zeroth, first, second laws and their consequences. Refrigeration process. Thermodynamic functions and free energy concept, chemical potential, Maxwell's relations. Review of ideal gas, non-ideal gas, PVT behaviour, virial and cubic equations of state, generalized correlations, residual properties.

Module II: Thermodynamics and Bioenergetics[10L]
Partial molar properties, fugacity, ideal and non-ideal solutions, activity coefficient, Gibbs-Duhem equation. Phase rule, criteria for phase equilibrium, VLE for pure component, Transport across membrane-bioenergetics.

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.

Textbooks:

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	0	0	3	3

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, repair and Recombination 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. DNA damage and mechanisms of different types of DNA repairs, SOS repair. Repair defects and human diseases. Recombination: mechanism of general and 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, 5'-Cap formation; 3'-end processing and polyadenylation; Splicing (different types); RNA editing; RNA transport. Inhibitors of transcription; reverse transcription.

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 translation: structure and function of ORF, tRNA, rRNA, ribosomes, RBS, aminoacylsynthetases. 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]

Organization of genes and its nomenclature. Principle of gene regulation: negative and positive regulation. 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 remodelling, gene silencing and epigenetic regulation. Regulations at level of translation, riboswitch, ribozyme. Structure and function of gene regulatory proteins.

Text books:

1. Molecular Biology of the Gene, 7th Editio (2017), - by J.D. Watson, Baker TA, Bell SP, Gann Alexander, Levine M, Losick R., Pub: Pearson Education.
2. Lewin's GENES XII (2017) by J. E. Krebs (Author), E. S. Goldstein (Author), S. T. Kilpatrick, Pub: Jones and Bartlett.
3. Freifelder's Essentials of molecular Biology, (2015) by Malacinski and Pub: Jones and Bartlett.

Reference books:

1. Molecular Biology of the Cell, 6th edn. (2014)by Bruce Alberts (Author), A D. Johnson, J Lewis, D Morgan, M Raff , K. Roberts, Pub: W. W. Norton & Company.
2. Molecular Cell Biology 8th edn. (2016) by H. Lodish, A. Berk , C.A.Kaiser, , A. Amon , H. Ploegh, A. Bretscher , M. Krieger, K C. Martin, pub: WH Freeman.
3. Cell and molecular Biology, Concepts and experiments by Gerald Karp, John Wiley & Sons.
4. Molecular and Cellular Biology- by Stefen Wolfe, Wordsworth Publishing Co.
5. Genomes, by T. A. Brown, John Wiley and Sons PTE Ltd.
6. The Cell - A molecular approach, by G. M. Cooper, ASM Press.
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**
	3	0	0	3	3

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 strain improvement [10L]

Definition and scope, Basic idea on fermentation process, submerged and 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: Production by fermentation [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.

Module III: Enzyme Technology [10L]

Enzyme : brief overview, 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. Stable enzymes : selection of extremophilic producer, 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.

Module IV: Industrial applications of enzymes [10L]

Commercial enzymes: Industrial applications of food processing enzymes; Analytical, diagnostic and medicinal applications of enzymes.

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 : Data Structure					
Course Code: CSEN2005					
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):

Concepts of data structures (Data, data structure, Abstract Data Type), Need of data structure, Basic idea of pseudo-code, algorithm analysis and 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 (Creation, insertion at different positions, deletion from different positions of the 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 and linked list), applications.

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

Recursion (2L):

Principles of recursion – Design of recursive algorithms, differences between recursion and iteration, merits and demerits of recursion, Tail recursion.

Module -III. Nonlinear Data structures [12L]

Trees (9L):
Basic terminologies, tree representation (using array and linked list).
Binary trees - binary tree traversal (pre-order, in- order, post- order), threaded binary tree.
Binary search tree and its operations (creation, insertion, deletion, searching).
Height balanced binary tree – AVL tree and its operations (insertion, deletion with examples only).
B- Trees and its operations (insertion, deletion with examples only).
Graphs (3L):
Basic terminologies, Graph representations/storage implementations (using adjacency matrix and adjacency list)
Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS).

Module - IV Searching, Sorting, Hashing [10L]

Sorting Algorithms (6L):
Bubble sort, Insertion sort, Selection sort, Merge sort, Quick sort, Heap sort and their comparisons.
Searching (1L):
Linear search, binary search and their comparisons.

Hashing (3L):
Basic terminologies, Different hashing functions, Collision resolution techniques (Open addressing and Chaining).

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 Andersonfreed.
3. "Classic Data Structures" by D.Samanta.
4. "Data Structures in C" by Aaron M. Tanenbaum.
5. "Data Structures" by S. Lipschutz.

Course Name : Transfer Operations-I Lab					
Course Code: BIOT2252					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	1.5

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. Study of working characteristics of a Jaw Crusher, calculation of the energy consumption as a function of size reduction and compare it with the actual energy requirements.
8. Study of working characteristics of a Ball Mill, calculate the energy consumption as a function of size reduction and determine the critical speed.
9. Determination of 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: BIOT2253					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

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 and purification of proteins from bacterial cells and separation by SDS-PAGE.
8. Induced mutation by: (a) Chemical (b) Ultraviolet light.
9. Study of gene regulation by *lac* operon.
10. Phage Titration.

Text Book:

1. Molecular Cloning – A laboratory manual: 4th Edition (2013) Vol. 1-3. by Michael R Green , Sambrook J, CSHL Press, New York

Reference

1. Biochemical calculation 2nd edn (2010) by I. Segel, Pub: Wiley.
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8th edn. 2018) by A. Hofmann, S. Clokie, Pub: Cambridge University Press.
3. Biochemical Methods (3rd edn. 2018) by S. Sadasivam. Publishers New Age Intern. Pvt. Ltd.

Course Name : Enzyme Technology & Fermentation Technology Lab					
Course Code: BIOT2254					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	1.5

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 : Data Structure Lab					
Course Code: CSEN2055					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	3	3	1.5

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.
3. Evaluation of expressions operations on stacks.
4. Implementation of linked lists: inserting, deleting, and inverting a linked list.
5. Implementation of stacks & queues using linked lists
6. Polynomial addition.
7. Addition of Sparse matrices.
8. Traversal of Trees.
9. DFS and BFS implementation.
10. Sorting and searching algorithms.

3rd yr 1st semester detailed syllabus

Course Name : Indian Constitution and Civil Society					
Course Code: INCO 3016					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	0	0	2	0

Course Outcomes

The learner will be able to

1. Analyse the historical, political and philosophical context behind the Indian Constitution-making process
2. Appreciate the important principles characterizing the Indian Constitution and institute comparisons with other constitutions
3. Understand the contemporaneity and application of the Indian Constitution in present times
4. Critique the contexts for constitutional amendments in consonance with changing times and society
5. Establish the relationship between the Indian Constitution and civil society at the collective as well as the individual levels
6. Consciously exercise the rights and the duties emanating from the Indian Constitution to one's own life and work

Module 1- 6L

Introduction to the Constitution of India-Historical Background
Making of Indian Constitution -the process of framing the constitution, the constituent assembly

Module II-6L

Salient Features of the Indian constitution
Comparison with the constitutions of other countries

Module III-6L

Relevance of the Constitution of India
Constitution and Governance
Constitution and Judiciary
Constitution and Parliament-Constitutional amendments

Module IV-6L

Constitution and Society- democracy, secularism, justice
Constitution and the individual citizen- Fundamental Rights, Directive Principles of state policy and Fundamental Duties

Reference Books

1. C.M.Elliot, (ed.), Civil Society and Democracy, OUP, Oxford, 20012..
2. David Held et.al (ed),The Idea of the Modern State, Open Univ. Press, Bristol, 1993
3. Neera Chandoke, State and Civil Society, Sage, Delhi, 19953

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 in human, Drosophila and plants; 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 I: Introduction to Bioinformatics and its Applications; Resources and Databases in bioinformatics [10L]

Definition of bioinformatics as a subject; applications of bioinformatics to biological research/biology; introduction to databases/portals; primary, secondary and specialized databases (e.g. NCBI and its sub-databases; PDB, EMBL-EBI, KEGG)

Module II: Sequence analysis of proteins and nucleic acids [10L]

Introduction to sequence analysis; Basic concepts of of sequence homology, similarity and identity; orthology and paralogy of sequences; pairwise sequence alignment using global and local alignment procedures; Needleman-Wunsch and Smith-Waterman algorithms; Use of substitution matrices (PAM and BLOSUM); Multiple sequence alignment using progressive alignment (e.g. Clustal W); Brief introduction to gene prediction(special emphasis:prokaryotic gene prediction)

Module III: Scripting languages in Bioinformatics (e.g PERL, Python) [10L]

Difference between traditional programming languages and scripting languages in bioinformatics; role of interpreted languages; PERL: usage of modules like Bio-PERL :

translation of nucleic acid sequences to protein sequences; reading frames, regular expressions; sequences and strings: Variables, Arrays, files, string operators; subroutines , command line arguments ;Data structures and algorithms for biology; Introduction to Python and Python programming applications in biology;

Module IV: Protein structure prediction and drug design applications [10L]

SCOP and CATH classification databases;Secondary structure prediction of proteins using generation based algorithms (e.g GORIV, SSPro); Neural Network and Hidden Markov Model algorithms and applications; 3D protein structure prediction using homology modeling, fold recognition, ab-initio methods; CASP; Drug design applications: Receptor-ligand binding sites and interactions, molecular docking, Virtual screening; Structure and Ligand based drug design; concepts of QSAR and ADMET.

Textbook(s):

1. Essential Bioinformatics by Jin Xiong, (2006)Cambridge University Press
2. Introduction to Bioinformatics, by Arthur M. Lesk, International Fourth Edition, (2014), Oxford University Press
3. Bioinformatics – Principles and Applications – Z.Ghosh and R.Mallick (2012), Oxford University Press
4. Beginning PERL for Bioinformatics –James Tisdall, SPD Publishers

Reference books:

1. Introduction to Bioinformatics, C. Atwood, Pearson Education.
2. A practical Guide to the Analysis of Genes and Proteins-A.D. Baxevanis.
3. Molecular Modelling and Drug Design –K. Anand Solomon-1st edition (2011) –MJP Publishers.
4. Molecular Modelling-Principles and Applications-by Andrew Leach, Pearson Education.

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 of 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; ELISA, Chip assay, Sitedirected 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, SiRNA, miRNA, and ribozyme technology); Molecular marker 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 (microbes, plant and animal); Gene targeting and genome editing: CRISPR technology, Large scale gene expression analysis. Biosafety.

Textbook:

1. Principles of Gene Manipulation& Genomics, (7th Ed, 2006) Old and Primrose, Pub: Blackwell.
2. Introduction to Genetic Engineering, S. Rastogi and N. Pathak, Pub: Oxford Univ. Press.
3. Wilson and Walker's principles and techniques of biochemistry and molecular biology (8^{th} edn. 2018) by Hofmann and Clokie.
4. Molecular Cloning: A Laboratory Manual (3-volume set 4th Edn.): (2012) by Michael R. Green, Joseph Sambrook , Pub: CSHL press.
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th Edn. (2017) by Glick, and Patten. Pub: ASM press

Reference books:

1. 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.
2. H.K. Das, Text Book of Biotechnology, 4th ed, 2010, Wiley Publishers.
3. Genetics a Molecular Approach, 7th Ed (2010) by Brown, T.A., pub: Chapman and Hall.
4. Genomes, 3rd ed (2006) by Brown TA, Pub: Garland Science.
5. 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, 5th edition.

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.

Subject Name: Food Biotechnology					
Paper Code: BIOT3131					
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 and Food Safety [10L]

Food preservative: natural and synthetic, Other additives: Food colour, food flavor enhancers, nutritional supplements, Probiotics, Chemical safety measurement: heavy metals, fungal toxins, bacterial toxins, herbicide, pesticide, adulterant, introduction to FSSAI

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: BIOT3132					
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 Equipments [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: BIOT3133					
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. Mixed Culture: classification, kinetics and application.

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.

Course Name : Genetics lab					
Course Code: BIOT3151					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

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: BIOT3152					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

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: BIOT3153					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

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. Agarose gel electrophoresis and 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 recombinant vector.
6. Primer design for standard PCR and amplification of DNA by standard PCR.
7. Expression of cloned gene.
8. Southern/Western/Northern blotting.
9. Protein purification by chromatography (any one type).
10. Reporter enzyme assay (β-gal etc.)

Reference book:

1. Wilson and Walkers principles and techniques of biochemistry and molecular biology (8th edn. 2018) by Hofmann and Clokie.
2. Molecular Cloning: A Laboratory Manual (3-volume set 4th Edn.): (2012) by Michael R. Green, Joseph Sambrook, Pub: CSHL press.

Course Name : Transfer Operations – II lab					
Course Code: BIOT3154					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

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

Subject Name: Food Biotechnology Lab					
Paper Code: BIOT3181					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**2**	**2**	**1**

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: BIOT3182					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**2**	**2**	**1**

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: BIOT3183					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**2**	**2**	**1**

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)

3rd yr 2nd semester detailed syllabus

Course Name : Economics for Engineers					
Course Code: HMTS3201					
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 : 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, primary and secondary immune response; 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; 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 : Bioreactor Design and Analysis					
Course Code: BIOT3202					
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 System [10L]

Introduction to batch reactor data for Reversible reaction, Differential and integral methods of analysis of data, Parallel and multiple reactions; Ideal batch, mixed flow and plug flow reactors and their analysis.

Module III: Non-ideal Bioreactor systems [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 : RDBMS Concept and Computer Networking					
Course Code: CSEN3207					
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 model 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. Understand the topology, transmission mode of computer networks and explains key networking protocols in the context of a conceptual model, such as the OSI and TCP/IP framework.
6. Understand 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: [12L]

Computer Networking: Introduction, topology, transmission mode, LAN/MAN/WAN, Communication Techniques, OSI 7 layer Model: Basic functions of the different layers, TCP/IP reference model: basic functions of the different layers, Comparison between OSI and TCP/IP models.

Module IV: [8L]

Basic concepts of Inter-Networking, WWW, URLs, Search engines, Electronic mails, Basic concepts of Distributed Database System.

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:

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

Course Name : Molecular Modeling & Drug Designing					
Course Code: BIOT3231					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course outcomes:

After completion of the course the registered student will be able to

1. Understand the principles of molecular simulation techniques of Monte Carlo, molecular dynamics and energy minimization methods and their application to studying equilibrium and dynamic properties of biological macromolecules and their interactions.
2. Understand principles of classical molecular mechanics and physicochemical properties to understand the interactions between potential drugs (small molecule ligands) and their targets (proteins, nucleic acids).
3. Understand the physicochemical basis and criteria necessary for application of molecular modelling principles to computer aided drug design.
4. Application of pharmacokinetic and pharmacodynamic principles to the process of computer aided drug design.
5. Understand the concepts and steps in molecular docking tools/algorithms and analyse the data obtained from them.
6. Application of principles and concepts of molecular modelling and computer aided drug design to real life examples of drug discovery and development.

Module I: Molecular Modelling: (10L)

Basic concepts in molecular modelling; Molecular simulation techniques-Monte Carlo methods-Metropolis Monte Carlo algorithm, other types of Monte Carlo algorithms and flow calculations in Metropolis Monte Carlo algorithm with examples; basic concepts of molecular dynamics and molecular dynamics simulations-integration of dynamical equations; structural information from molecular dynamics, Monte Carlo calculations and Energy minimization methods.

Module II: Molecular Mechanics: (10L)

Introduction to molecular mechanics; intra molecular interactions; physicochemical parameters in drug design: hydrophobicity, electronic effects; ionization constants, chelation, solubility and partition co-efficient; overview of molecular descriptors with respect to drug design.

Module III: Drug discovery; Design and Development: (10L)

Introduction to diseases, drugs and drug targets; 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 and Analysis: (10L)

Overview of computer aided drug design tools (in public and proprietary domains); Force fields: definition, parameterization and applications (e.g. CHARMM, AMBER); molecular docking: measurables and algorithms for docking ofligand/protein, ligand/nucleic acid and protein/protein systems;rigid and flexible docking; public domain molecular docking tools (e.g. Autodock, Modeller); pharmacophore development; analysis of docking and virtual screening using parameters like scoring functions; drug target discovery & validation; QSAR and lead optimization; use of computer aided drug design highlighted through examples in real lifedrug discovery anddevelopment.

Textbooks:

1. Molecular Modelling, Principles and Applications, 2nd Edition, (copyright 2003, first impression 2009) , Pearson
2. Introduction to Medicinal Chemistry (2013) by G.L. Patrick, Pub: Oxford University Press

Reference books:

1. Guidebook on Molecular Modelling in Drug Design (1996); Ed. Neil.R. Cohen, Academic Press.
2. Drug Discovery and Design (2001) by James Scolnick; Pub: Academic Press.
3. Textbook of Drug Design and Drug Discovery, 3rd Edition (2002) by Lilljefors, Krogsgarrd, Larsen; Pub: CRC Press.
4. Biophrmaceuticals-Biochemistry and Biotechnology, 2nd edition (copyright 2003), Pub: Wiley.

Course Name : Biophysics of Macromolecules					
Course Code: BIOT3232					
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. 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 [10L]

Methods for study of biomolecule structure and surface morphology: X-ray diffraction and X-ray crystallography, 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
4. Practical Biochemistry Principles and techniques: Editor Wilson and Walker, Cambridge University Press

References books:

1. Physical Biochemistry: David Friefelder, 5th Ed, PHI
2. Physical Biochemistry: Kensal E van Holde. PHI
3. Proteins: Structure and Function: David Whitford: John Wiley &Sons

Course Name : Biosensors and Diagnostics					
Course Code: BIOT3233					
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. State principle and characteristics biosensors and describe the fundamental components required to make a biosensor.
2. Illustrate types of enzyme immobilization methods used to make a biosensor and use the methods for the construction of biosensor.
3. Describe each types of biosensor based on different biosensing element in relation to their uses in biosensors.
4. Understand the classification of biosensor based on transducer and construction and working principle of various transducers.
5. Understand the concepts, types, working principles and applications of biosensors in different industrial sector.
6. Explain the working principle of inhibition based biosensors and their practical application.

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.

Subject Name: Bioseparation Technology					
Paper Code: BIOT3234					
Contact Hours 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. Acquire basic understanding of different bioseparation processes and design principle for commonly used process equipments.
2. Obtain knowledge about the basic principles and application of sedimentation, centrifugation and filtration.
3. Explain the principles of extraction and membrane based separation of bioproducts and can apply the knowledge for calculations of extraction process.
4. Understand the principle of adsorption, chromatography and relation of adsorption with chromatography.
5. Apply different chromatographic techniques for separation of different Bioproducts.
6. Comprehend the knowledge of precipitation, drying, crystallization and will be able to solve numerical problems related to these processes.

Module I: Introduction to Bioseparation [10L]
Overview of bioseparation technology;Basic design principles of separation equipments with its importance in biotechnology. Selection strategies of various purification methods based on different properties of biomolecules. Cell disruption for intracellular products by mechanical and non-mechanical methods: Chemical lysis, enzymatic lysis, physical methods. Sedimentation and Centrifugation– Objective, principle, applications;Principle of filtration, objective and methods, filtration at constant pressure and constant rate.

Module II: Extraction and Membrane based separation processes [10L]
Objective of extraction, extraction principles, phase separation and partitioning equilibria; Membrane separation - Factors affecting membrane separation processes, advantages of membrane separation processes over conventional separation techniques. Design principle and industrial application of Microfiltration, Ultrafiltration, Reverse osmosis, Dialysis, Electrodialysis, Diafiltration, Pervaporation, Structure and characteristics of membranes.

Module III: Adsorption and Chromatography[10L]
Principle of adsorption, adsorption equilibrium, adsorption isotherms;Chromatography- general theory, partition coefficient, resolution and other chromatographic terms and parameters,chromatographic method selection, adsorption and hydrophobic interaction chromatography (HIC), Gel filtration, molecular imprinting, Ion exchange chromatography, Chromatofocussing, Affinity chromatography, different type,Partition chromatography- Normal

phase, Reverse phase (RPC), HPLC, FPLC, GC,large scale purification of recombinant proteins,industrial application of chromatographic bioseparation methods.

Module IV: Precipitation, Crystallization, Drying [10L]

Objective of precipitation, protein solubility, structure, size, charge, solvent, initial mixing, nucleation, growth governed by diffusion, methods of precipitation;Principle of crystallization, solubility curve, Effect of heat on crystallization, Rate of crystal growth, design principle of crystallizer, industrial applications; Fundamental principle of drying, Relative humidity, heat and mass transfer, types of dryer - description and operation and application.

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)

Course Name : Plant Biotechnology					
Course Code: BIOT3221					
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, haploid culture, protoplast culture. 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 (using Arabidopsis as model) [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, pesticide (Bt gene). 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 : Basics of Nanotechnology					
Course Code: BIOT3222					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	0	0	3	3

Course Outcomes:

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

1. Explain the inception and development of nanotechnology
2. Understand and describe the various methods of nanomaterial synthesis
3. Analyze their properties and their characterization by physico-chemical methods.
4. Understand the applications of nanoparticles in drug delivery, disease diagnosis and therapeutics.
5. Understand various applications of nanotechnology to the biomedical and life sciences and in the areas of environmental, food and agricultural biotechnology.

Module I: Nanotechnology –Introduction, Concepts and origin [10 L]

Introduction of nanotechnology, importance and role of nanoscale science and technology in the current context-pros and cons; history and development of nanotechnology –contribution of scientists and technologists. Cellular Nanostructures; Nanopores; Biomolecular motors; Silicon based technology and molecular manufacturing; nanotech device developments (e.g. nanotubes, biosensors, solar cells). Criteria for suitability of nanostructures for biological applications

Module II: Techniques for Synthesis and Characterization of NanoMaterials [10 L]

Synthesis and properties of nanomaterials: nanochemistry including self-assembly of materials; nanoparticles, carbon nanotubes, nanocomposites. Basic characterization techniques: X-ray diffraction (XRD), Electron microscopy: SEM/TEM – high resolution imaging – defects in nanomaterials – Spectroscopy: – electron energy-loss mechanisms – electron filtered imaging – prospects of scanning probe microscopes, optical spectroscopy: FTIR. Atomic force microscopy; Photon correlation spectroscopy; Gas phase synthesis process, Nanomaterial synthesis by hybrid techniques through biochemical engineering.

Module III: Nanotechnology in biomedical and Life Sciences [10 L]

Biological nanoparticles production - plants and microbial; Application of Nanotechnology: nanomedicine; nanocapsule; nanorobots; nanopharmacology; Treatment of Infectious Diseases (Viral & Fungal), In Chronic Diseases-I; Cardiovascular Diseases; Hypertension; Nanotechnology Applications In Cancer Diagnosis, Imaging & Therapy; Targeted drug Delivery; Functionalized Gold Nanoparticles for Protein Delivery. Nanobiosensor for detection of small molecules and biomolecules, Biochip. Ethical isssues of nanotechnology.

Module IV: Nanotechnology in Environmental, Food & Agricultural Biotechnology [10 L]
Nanotechnology In Environment, Environmental Remediation, Applications of Carbon Nanotube in Food Contaminant Detection, Detection of Pathogens In Food. Opportunities for Nanotechnology in Food Industry, Nanaotechnology In Food Preservation, Risk Analysis of the use of Nanotechnology In Food Industry. Nanotechnology in agriculture – Fertilizer and pesticides.

Text books:

1. Basic Principles of Nanotechnology (2018) by W C Sanders, Pub: CRC Press
2. Nanotechnology in Biology and Medicine: Methods, Devices and Applications, (2nd Edn, 2018) by Tuan Vo-Dinh, Pub: CRC Press
3. Textbook of Nanoscience and Nanotechnology (2013) by B S Murthy, P Shankar, baldev Raj, B B Rath, James Murday, Pub: Springer-Verlag

Reference books:

1. Nano: The Essentials by T.Pradeep. Tata McGraw Hill, New Delhi (2007)
2. Introduction to Nanotechnology by Charles P Poole Jr and Frank J Ownes, John Wiley Sons, Inc (2003)
3. Nanocomposite Science and Technology by Pulickel m.Ajayan, Linda S.Schadler, Paul V.Braun, Wiley – VCH
4. Nanotechnology: Basic sciences and emerging technologies by Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkar Raguse, Overseas Press (2005)
5. Instrumental Methods of Analysis by Willard, 2000.
6. Instrumental Methods for Chemical Analysis by Ewing. et al 2000
7. Nanoscale Technology in Biological Systems by Cooper, Springer Verlag.
8. Nanostructures & Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao
9. Surface Science : Foundations of Catalysis and Nanoscience by Kurt W. Kolasinski
10. Self-Assembled Nanostructures by G. Carotenuto
11. Integrated Chemical Systems: A Chemical Approach to Nanotechnology (Baker Lecture Series) by Allen J. Bard
12. C.M. Niemeyer, C. A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, Wiley – VCH, (2004).
13. Introduction to Nanoscience & Nanotechnology by K.K.Chattopadhyay & A.N.Banerjee PHI publication

Course Name : Immunology lab					
Course Code: BIOT3251					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

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 : Bioreactor design Lab					
Course Code: BIOT3252					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

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 Residence 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 of exit age distribution curve for CSTR.
2. Development of flow pattern from the tracer output data in an external loop airlift reactor.
3. Determination of RTD in 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 : RDBMS Concept Lab					
Course Code: CSEN3257					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

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, HAVING clause, ORDER BY Clause, Nested Sub-Queries

Computer Networking Lab:

Basic Networking Commands

Course Name : Plant Tissue Culture Lab					
Course Code: BIOT3271					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	0	2	2	1

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
5. Plant cell as biofactories for the production of Secondary metabolites.

List of experiments:

1. Study of basic requirements for plant tissue culture lab.
2. Preparation of 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 : Principles of Management					
Course Code: HMTS4101					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

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 [10L]

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 [10L]

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 [10L]

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

Module IV [10L]

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 : Biomaterials					
Course Code: BIOT4131					
Contact hrs 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. Explain the fundamentals of Biomaterials.
2. Apply the knowledge of sterilization of Biomaterials in tissue regeneration.
3. Illustrate the structure, production process and applications of protein based Biomaterials.
4. Describe structure, production process and applications of carbohydrate based Biomaterials.
5. Describe structure, production process and applications of industrially important Biomaterials.
6. Illustrate the properties of different Biomaterials.

Module I: Fundamentals of Biomaterials [9L]

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 [9L]

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

ModuleIII: Industrial Biopolymers [9L]

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 [8L]

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.

Course Name : Biofertilizers and Biopesticides					
Course Code: BIOT4132					
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 [9L]

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 [9L]

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 [9L]

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 [8L]

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 : Post-harvest Technology					
Course Code: BIOT4133					
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. Determine various properties & parameters of agriculture products related to drying, using psychometric chart.
2. Define dryers and different types of dryers
3. Comprehend Engineering Properties / various post harvest process on agriculture produce and its applications.
4. Understand various processes of extraction and refining of different oil seeds and further processing methods.
5. Evaluate Engineering Properties / Management of storage structures and losses during Storage agricultural Produce
6. Understand technologies of post-harvest technology and its role in providing better quality produce to the consumer.

Module I: Cereals and Pulses [9L]
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 [9L]
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 [9L]
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 [8L]
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.

Course Name : Biometallurgy					
Course Code: BIOT4134					
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. Acquire the basic knowledge of biogeochemical reactions and the microbial factors affecting them.
2. Understand the kinetics of bioleaching.
3. Analyse the applications of biogeochemical processes in mining and metallurgy.
4. Learn about the reactor modeling for leaching for recovery and purification of different metals.
5. Get familiar with the applications of sulphate reducing bacteria.
6. Analyze the applications of microbes in environmental pollution control.

Module I [9L]
Introduction to Biotechnology applied to Raw Material processing, Biogeochemical reactions – chemical mechanisms and controlling factors, Microbial interventions, Nature and characteristics of biogeochemically important micro-organisms.

Module II [9L]
Kinetics of bioleaching; Applications of biogeochemical processes in mining and metallurgy, dump, heap and in-situ leaching.

Module III [9L]
Reactor modelling for leaching, beneficiation of ores and process residues: recovery of gold and silver, beneficiation of sulfidic tailings from tin processing; purification of ferroginous sand.

Module IV [8L]
Beneficiation of bauxite, applications of sulphate reducing bacteria; applications of sulphate reducing bacteria. Environmental pollution control: accumulation of metals by microbial cells; growth of microbial cells in water flowing pipelines; microbial degradation of water-based metal working fluids.

References:

1. M.E. Curtin, Microbial mining and metal recovery biotechnology, pp 229-235, 1983.
2. Woods D, Rawling D.E., Bacterial bleaching and biomining in marx J.L. (ed), Revolution in biotechnology, Cambridge University Press.

Course Name : Animal Cell Culture & Animal Biotechnology					
Course Code: BIOT4135					
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 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 analyze 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. Understand 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,. Basic requirement of animal cell and tissue culture laboratory, biosafety levels, culture media and growth conditions. Cell adhesion, proliferation, differentiation, cell differentiation into cancerous cells and role of proto-oncogene's, cell synchronization, senescence and apoptosis. Development of primary culture, subculture and cell lines. Cell cloning and selection, Cryopreservation of animal cells, common cell culture contaminants. Techniques for animal cell separation, characterization, quantitation, cytotoxicity and viability determination.

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

Introduction to animal cell growth characteristics and kinetics, product formation and effect of shear force. Animal 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]

Introductions to animal biotechnology. Micromanipulation of embryos: Introduction, basics and methodology of micromanipulations. *In vitro* fertilization (IVF) in human and animal. Animal cloning using stem cells and other methods. 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 animal by homologous recombination, knockout and knock-in animals. Gene targeting by CRISPR/Cas 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, Stem cell technology and regenerative medicine, tissue and organ transplantation, production of human and animal viral vaccines and pharmaceutical proteins, gene therapy, Marketable culture product, different medical applications for cell culture including expression system, therapeutics and others. Animal and animal cell as bioreactor for production of recombinant protein.

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 J.M, Davis. pub- Oxford University Press.
3. Animal Cell Culture: A Practical Approach (2000) by John Masters, pub- Oxford University Press.
4. Principles of Gene Manipulation and Genomics, (7th Edn, 2006) by Primrose & Twyman.
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th edn. 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.
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.

Course Name : Proteomics and Protein Engineering					
Course Code: BIOT4121					
Contact hrs 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. Understand different large scale protein separation, estimation, identification and sequencing techniques. Apply the knowledge to solve and analysis of 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 [9L]

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

Module II: Structural proteomics and proteomics in drug discovery [9L]

Structural proteomics: Crystallography and X-ray diffraction, NMR spectroscopy, CryoEM 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 [9L]

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. Case studies.

Module IV: Protein stability and folding [8L]

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

Textbooks

1. Principles of Proteomics (2^{nd} edn. 2013) by R.M. Twyman:, Bioscientific Publishers.
2. Proteins: Structure & Function (2005) by D. Whitford, Wiley Blackwell Publishers.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (4^{th} edn. 2009) by Glick, Pasternak and Patten, ASM Press.

4. Principles of Biochemistry & Molecular Biology Practical (7th edn. 2010) by Wilson and Walker, Pub: Cambridge Univ. Press

Reference Books

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (2018) by A. Hofmann, S. Clokie. Pub: Cambridge University Press
2. Molecular Biology of the Cell B.Alberts, D.Bray, J.Lewis et al, , Garland Pub. N.Y.
3. Proteins and Proteomics A Laboratory Manual by Richard J. Simpson, , I.K. International Pvt
4. Protein Engineering in Industrial Biotechnology by Lilia Alberghina., , Harwood Academic pub,
5. Protein engineering and design by Paul R. Carey, academic press,
6. Genomics, Proteomics and Bioinformatics (2007) by Campbell AM & Heyer LJ, Discovering,
7. Principles of Gene Manipulation and Genomics (2006) by Primrose & Twyman, Pub: Blackwell.
8. Introduction to Proteomics by Daniel C. Liebler. Humana Press.

Course Name : Human Genomics					
Course Code: BIOT4122					
Contact hrs 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 [9L]

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 [9L]

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 [9L]

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 [8L]

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, Oxford University Press, 3rd edition, 2017.

Reference Books:

1. Genomes 4, T. A. Brown, John Wiley & Sons. 3rd edition, 2018.
2. Genes and Genomes, Singer. M and Berg. P, Blackwell Scientific Publication, Oxford, 1996.
3. Principles of Gene Manipulation and Genomics, Primrose and Twyman, Blackwell Publishing Co., 7th edition, 2006.
4. Principles and Applications of Recombinant DNA Technology, Glick and Pasternak, ASM Press, 2002.
5. Genomics, Cantor & Smith, John Wiley & Sons, 1999.
6. Human Molecular Genetics, Strachan & Read, Garland Science, 3rd edition, 1996.
7. Primer of Genome Science, Gibson G. and Spencer V.M.A. Sinauer Associates Inc. 2nd edition, 2009.

Course Name : Biomedical Engineering					
Course Code: BIOT4123					
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. Comprehend the physiology of the heart, lung, kidney, blood circulation and respiration.
2. Apply different transducers and various sensing and measurement devices of electrical origin in biomedical applications.
3. Measure biomedical and physiological information.
4. Explain different medical imaging techniques.
5. Design and realize a biomedical device, component, or process to meet desired needs.
6. Understand the devices for biotelemetry, prosthetics and Orthotics

Module I: Introduction, physiology and transducers [9L]

Introduction to biomedical engineering. Cell and its structure, Membrane transport Resting and Action Potential. Fundamentals of human physiology: respiratory system, cardiovascular systems, Nervous system-functional organization of the nervous system, Structure of nervous system, neurons, synapse, transmitters and neural communication, skeletal systems, execratory system – kidney, kidney function, functional problems in kidney. Electrical, Mechanical and Chemical activities of different organ systems in human. Basic components of a biomedical system, Transducers, selection criteria, Piezo-electric, ultrasonic transducers, Temperature, measurements - Fiber optic temperature sensors.

Module II: Biomedical devices for cardiac and respiratory systems [9L]

For cardiac system: Electrocardiography, Electrocardiogram (ECG), Magnetocardiography (MCG); measurement of blood flow, blood pressure, cardiac output, cardiac rate, cardiac shock and response to exercise. Cardiac pacemaker, Heart sounds, Phonocardiograph, Echocardiograph. For respiratory system: Measurement of gas volume, respiratory transducers and instruments, respiratory therapy equipment, intermittent positive pressure breathing (IPPB) therapy, artificial mechanical ventilation, accessory devices used in respiratory therapy apparatus.

Module III: Biomedical devices for nervous and execratory systems, prosthetics, orthotics [9L]

Devices for Measurement of electrical activities in muscles and brain: Neuron potential, muscle potential, electromyograph, brain potentials, electromyography, electroencephalographs and others. Devices for execratory system: dialysis, haemodialysis, blood transfusion and others. Prosthetics: Biomedical application of biopolymers: Introduction to artificial kidney, Artificial heart, Heart lung machine, Limb prosthetics and orthotics elements of audio and visual aids.

Module IV: Biomedical sensors, imaging techniques, biotelemetry [8L]

Analytical instruments: Measurement of sugar, pH, sodium potassium ions, haemoglobin, oxygen (oximeter) and carbon dioxide concentration in blood, automation of chemical tests. Biomedical imaging techniques: X-ray radiography, CT; MRI; optical imaging by fluorescence and bioluminescence; nuclear imaging (PET and SPECT); and ultrasound imaging. Computer applications and biotelemetry: Remote data recording and management, telemedicine. Artificial intelligence in medical diagnosis (soft computing and genetic algorithm).

Text and Reference books:

1. Webster J.S Medical Instrumentation Application and Design.
2. 'Hand Book of Bio-Medical instrumentation', (2003) by R.S.Khandpur, Tata McGraw Hill Publishing Co Ltd., 2003.
3. 'Bio-Medical Instrumentation and Measurements', (2^{nd} edition, 2002) by Leslie Cromwell, Fred J.Weibell, Erich A. Pfeiffer, Pub: Pearson Education
4. 'Medical Instrumentation' (1995) by J.Webster, John Wiley & Sons, 1995.
5. 'Principles of Applied Bio-Medical Instrumentation', (1975) by L.A. Geddes and L.E.Baker, John Wiley & Sons,
6. Microsystem technology in Chemistry and Life Sciences. Ed. by Manz and Becker.

Course Name : Biosensor					
Course Code: BIOT4124					
Contact hrs 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 [9L]

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 [9L]

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 [9L]

Classification of biosensor based on transducer; Calorimetric, Electrochemical (potentiometric, amperometric), Optical, Piezoelectric, Semiconductor biosensor: principle, construction, calibration and limitations.

Module IV: Application of biosensor [8L]

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. Biosensors Fundamentals and applications, Turner, A.P.F, Karube.I. and Wilson, G.S, 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 : Bioploymer					
Course Code: BIOT4126					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

At the end of this course:

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 [9L] 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 [9L]

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 [9L] 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 [8L] 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.

Course Name : Bioethics & IPR					
Course Code: BIOT4231					
Contact hrs 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. Understand and analyze the different ethical, legal and social issues aspects related to biological, biomedical, health care, biotechnology and biotechnology research.
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 base and their protection in biotechnology.
5. Gain entrepreneurial skills to apply the different objectives and fundamentals of entrepreneurship in biotechnology.
6. Identify scope for entrepreneurship in biotechnology.

Syllabus:

Module-I: Bioethics [9L]

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. Ethical legal social issues (ELSI) in biotechnology: Health care / biomedicine: patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, human gene therapy, organ transplantation. ELSI in Biotechnology research: genetic engineering, cloning and stem cell research, Human and animal experimentation, animal rights/welfare, biomedical science, Human genome project, patenting human genes, Agricultural biotechnology - Genetically engineered food and organism, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy. Case studies.

Module-II: Biosafety [9L]

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 for biohazards, biosafety and risk groups. Risk analysis, good laboratory practice (GLP) and good manufacturing practice (GMP). Biosafety regulation, national and international guidelines of: DBT (India), different regulatory bodies in India and WHO. Convention of Biological Diversity (CBD): Cartagena Protocol, Kyoto protocol, Nagoya protocol and others; Case studies.

Module-III: Intellectual Property Rights (IPR), Patents and protection [9L]

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, traditional knowledge (TK); Distinctions among the various forms of IPR, infringement, Indian patent act and rules, traditional knowledge digital library (TKDL). International framework for the protection of IP: GATT, WTO, WIPO and TRIPS, Biodiversity, and farmer rights, Budapest treaty, Patent Cooperation Treaty (PCT). Case studies on-IPR.

Module-IV: Bioentrepreneurship [8L]

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. IPR, Biosafety and Bioethics – (2013) D. Goel, S. Parashar, Pub: Pearson
2. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies (2014) by Craig Shimasaki
3. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology (2017) by P Nambisan, Pub: Accademic press
4. Effective Entrepreneurial Management: Strategy, Planning, Risk Management, and Organization (2017) by R. D. Hisrich, and V. Ramadani, Pub: Springer.
5. Intellectual Property Law (2018) by L. Bently, B. Sherman, D. Gangjee, P. Johnson Pub: OUP

References:

1. Bioethics and biosafety in biotechnology (2007) by V. Shree Krishna, Pub: New Age Int. Ltd.
2. Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science (2013) by Yali Friedman.
3. Biotechnology and Patent protection by Beier, F.K., Crespi, R.S. and Straus, T.
4. Intellectual Property Rights and Bio-Technology (Biosafety and Bioethics) (2011) by N. P. House.
5. Regulatory Framework for GMOs in India (2006) Ministry of Environment and Forest, Govt. of India,
6. Cartagena Protocol on Biosafety (2006) Ministry of Environment and Forest, Govt. of India.
7. Patent Strategy For Researches & Research Manegers- Knight, Wiley Publications.
8. Agriculture & Intellectual & Property Rights, V. Santaniello & R.E. Evenson, University Press.
9. Bioethics Principles, Issues, and Cases (2016) by Lewis Vaughn, Pub: OUP.

Course Name : Bio-entrepreneurship and Regulations					
Course Code: BIOT4232					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcome:

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

1. Gain entrepreneurial skills.
2. Understand the various operations involved in venture creation.
3. Identify scope for entrepreneurship in biosciences.
4. Utilize the schemes promoted through knowledge centers and various agencies.
5. Build up a strong network within the industry.

Module-I: Bio-entrepreneurship [9L]

Introduction to bio-business, from the Indian context, SWOT analysis of bio-business. Ownership, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its barriers. Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Global bio business and industry future trends.

Module-II: Entrepreneurship opportunity biotechnology [9L]

Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agri waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agri management. Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost. Bio pesticide/insecticide production. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics.

Module-III: Project management, intellectual property, technology management and startup schemes [9L]

Building Biotech business challenges in Indian context-biotech partners (BICEPS, BIRAC, DBT, Incubation centers. Etc.,), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Startup schemes in Indian government, Business incubation support schemes, Successful start-ups-case study.

Module-IV: Regulatory affairs, bioethics & bio-safety [8L]

Regulatory affairs in Bio business-regulatory bodies and their regulations (ex.FDA, EU, DSIR, AYUSH, FSSAI etc.,) Public education of the process of biotechnology involved in generating new forms of life for informed decision-making. Ethical concerns of biotechnology research and innovation-Interference with nature fear of unknown, unequal distribution of risks. Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards. Biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management.

Textbooks:

1. Effective Entrepreneurial Management: Strategy, Planning, Risk Management, and Organization - Robert D. Hisrich and Veland Ramadani, Pub: Springer (2017).
2. Entrepreneurship- Theory, Process Practice –by Kuratko & Hodgetts, Thompson, Pub: South-Western Publication.
3. Entrepreneurship –by Robert D. Hisrich (9^{th} edition).

Reference Books:

1. Principles of Management by P. C.Tripathi, P.N. Reddy Tata McGraw Hill Fifth Edition, 2012.
2. Entrepreneurship Development by S.S.Khanka S.Chand & Co 2006.
3. Practical Approach to IPR by Rachana Singh Puri IK Intl. Ltd 2009.
4. Bioethics & Biosafety by R Rallapalli & Geetha Bali APH Publication 2007.
5. Bioethics & Biosaftey by Sateesh M K IK Publishers 2008.
6. Management Fundamentals - Concepts, Application, Skill Development Robers Lusier Cengage Learning 1996.
7. Intellectual Property Rights in the WTO and developing contry Watal Jayashree Oxford University Press 2001.

Course Name : Renewable Energy Technology					
Course Code: BIOT4241					
Contact hrs 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) 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 [9L]

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 [9L]

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 [9L]

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

Module IV: Other conventional energy [8L]

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 Universities Press.
2. S. Sarkar, Fuels and combustion, 2nd ed., University Press.
3. Donald L. Klass, Biomass for renewable energy, fuels and chemicals, Academic Press.

Course Name : Tissue Engineering					
Course Code: BIOT4242					
Contact hrs 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. 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; understand the importance of cell signaling, angiogenesis in tissue engineering.
3. Understand the design, fabrication and biomaterials selection criteria for tissue engineering scaffolds.
4. Understand 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 [9L]

Introduction, tissue organization, morphogenesis, generation of tissue in the embryo, tissue homeostasis, cellular signaling, extracellular matrix as scaffold for tissue engineering.

Module-II: Polymers in Tissue Engineering [9L]

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 [9L]

Cell source, Stem cells, cell culture harvest, selection, expansion and differentiation, cell migration and cellular fate processes, cell nutrition, cryobiology, bioreactors for tissue engineering.

Module-IV: Applications of Tissue Engineering [8L]

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 Books:

1. Tissue Engineering, (2014) by C. Van Blitterswijk, J. De Boer, Pub: Academic Press
2. Principles of Tissue Engineering (2020) by R. Lanza, R. Langer, J. P. Vacanti, A. Atala. Academic Press.
3. Tissue Engineering (2016) by Palsson and Bhatia, Pub: Pearson

Reference books:

1. Biomaterials Science and Tissue Engineering: Principles and Methods (2017) by Bikramjit Basu.
2. Tissue Engineering: Roles, Materials and Applications (2008) by Steven J. Barnes, Lawrence P. Harris, Nova publication.

Course Name : Metabolic Engineering					
Course Code: BIOT4243					
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 overview of cellular metabolism and connection between metabolic pathways.
2. Understand the metabolic pathway regulation at transcription and translation level.
3. Differentiate regulatory mechanisms involved in biosynthesis of primary and secondary metabolites
4. Apply the concept of auxotrophic mutations for the synthesis of primary and secondary metabolites
5. Understand the concept of bioconversions and its applications
6. Understand the concepts for developing heterologous pathways for production of value added compounds

Module-I: Introduction [9L]

Induction-Jacob Monod Model, catabolite regulation, glucose effect, camp deficiency, feedback regulation, regulation in branched pathways, differential regulation by isoenzymes, concerted feedback regulation, cumulative feed back regulation, amino acid regulation of RNA synthesis, energy charge, permeability control passive diffusion, facilitated diffusion, active transport group transportation.

Module-II: Synthesis of primary & secondary metabolites [9L]

Biosynthesis of Primary Metabolites: alteration of feedback regulation, limiting accumulation of end products, feedback, resistant mutants, alteration of permeability. Biosynthesis of Secondary Metabolites: precursor effects, prophophase, idiophase relationships, enzyme induction, feedback regulation, catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites.

Module-III: Bioconversions [9L]

Advantages of Bioconversions, specificity, yields, factors important to bioconversions, regulation of enzyme synthesis, mutation, permeability, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances.

Module-IV: Regulation of enzyme production [8L]

Strain selection, improving fermentation, recognizing growth cycle peak, induction, feed back repression, catabolite repression, mutants resistant to repression, gene dosage.

Text Books/References:

1. Metabolic Engineering: Principles and Methodologies by Gregory N. Stephanopoulus,
1. Aristos A. Aristidou, and Jens Nielsen.
2. Pathway Analysis and Optimization in Metabolic Engineering by Néstor V. Torres and Eberhard O. Voit.
3. The Metabolic Pathway Engineering Handbook by Christina D. Smolke.
4. Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark.
5. Fermentation and Enzyme Technology (1980) by Wang D. I. C., Cooney C. L., Demain A. L., Dunnil P., Humphrey A. E., Lilly M. D., John Wiles and Sons.,
6. Principles of Fermentation Technology (2005) by Peter, F. Stanbury., Stephen, J. Hall and Whitaker, A. Elsevier,
7. Biochemistry (1999) Zubay, G., McGraw Hill Publishers, 4th Edition,

Course Name : Basic Process Equipment Design					
Course Code: BIOT4244					
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 the basic idea of heat exchangers.
2. Understand mechanical stands of shell and tube heat exchangers.
3. Get familiar with the basic concept of evaporators
4. Study the basic knowledge to design different type of driers.
5. Analyze the operation of different types of separation equipments.
6. Conceptualize the process design of mass transfer columns (distillation and absorption).

Module 1: Process design of heat exchanger [9L]

Introduction, classification, and thermal design of double pipe heat exchanger, shell and tube heat exchanger and evaporator.

Module II: Design of dryers [9L]

Drying principles, types and design of dryers ----plate type, continuous, and rotary.

Module III: Design of separation equipments [9L]

Basic principles of distillation column, stage calculation, types of distillation column---Tray, bubble cap and others.

Module IV: Basic principles of different operation concepts [8L]

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.

Course Name : Bioprocess Modelling					
Course Code: BIOT4245					
Contact hrs 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 [9L]

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 [9L]

Product formation model; genetically structured models, modeling of extra cellular enzyme production.

Module-III: Modeling of Bioprocess-II [9L]

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 [8L]

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”.

Course Name : Computational Biology					
Course Code: BIOT4221					
Contact hrs 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 [9L]

Introduction to biochemistry and molecular biology; Biomolecules: structure, function and metabolic pathways.

Module-II: Scope of Computational Biology [9L]

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 [9L]

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 [8L]

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.

Course Name : Non-conventional Energy					
Course Code: BIOT4222					
Contact hrs 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 [9L]

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 [9L]

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 [9L]

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 [8L]

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.

Course Name : Biology for Engineers					
Course Code: BIOT4223					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

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

1. Understand the basic structure and function of cells and cellular organelles.
2. Understand the fundamental concepts of cellular reproduction and cell metabolism.
3. Characterize the different types of proteins, lipids and carbohydrates.
4. Analyze the mechanism of inheritance of characters through generations.
5. Understand and implement the working principles of enzymes and their applications in biological systems and industry.
6. Design and evaluate different environmental engineering projects with respect to background knowledge about bioresources, biosafety and bioremediation.

MODULE-I: Basic Cell Biology [9L]

Prokaryotic and Eukaryotic cells, Cell theory; Cell structure and function, Cell organelles, Structure and function of DNA and RNA, Central Dogma; Genetic code and protein synthesis, differences between eukaryotic and prokaryotic protein synthesis

MODULE-II: Biochemistry and Cellular Aspects of Life [9L]

Biochemistry of carbohydrates, proteins and lipids; Cell metabolism – Glycolysis, TCA cycle, Fermentation; Cell cycle and cell death; Stem cells and their applications, Basics of Mendelian Genetics

MODULE-III: Enzymes and Industrial Applications [9L]

Enzymes – significance, co-factors and co-enzymes, classification of enzymes; Enzyme kinetics, enzyme inhibition, models for enzyme action; Restriction enzymes; industrial applications of enzymes; enzymes in human gene therapy and disease diagnostics

MODULE-IV: Biodiversity and Bioengineering Innovations [8L]

Molecular motors, Basics of neural networks; Tissue Engineering; Basic concepts of environmental biosafety, bioresources, biodiversity, bioprospecting, bioremediation, biosensors; recent advances in engineering designs inspired by examples in biology

Text Books:

1. Wiley Editorial, “Biology for Engineers: As per Latest AICTE Curriculum,” Wiley-India, 2018.
2. S. ThyagaRajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, “Biology for Engineers,” Tata McGraw-Hill, New Delhi, 2012.

References:

1. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, “Biochemistry,” W.H. Freeman and Co. Ltd., 6th Ed., 2006.
2. Robert Weaver, “Molecular Biology,” McGraw-Hill, 5th Edition, 2012.
3. Jon Cooper, “Biosensors A Practical Approach” Bellwether Books**,** 2004.
4. Martin Alexander, “Biodegradation and Bioremediation,” Academic Press, 1994.
5. Kenneth Murphy, “Janeway's Immunobiology,” Garland Science; 8th edition, 2011.