CURRICULUM AND SYLLABI

B. Tech.

in

BIOTECHNOLOGY

COURSES

(I to VIII Semesters)

(Applicable to 2017 admission onwards)

SCHOOL OF BIOTECHNOLOGY
NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
CALICUT - 673601
KERALA, INDIA

The Program Educational Objectives (PEOs) of B. Tech. in Biotechnology

PEO1	To prepare students to excel in industry/technical profession and/or higher education by providing a strong foundation in mathematics, physical sciences, biological sciences and engineering fundamentals.
PEO2	To train students with good scientific background in biological sciences coupled with and engineering expertise so as to comprehend, analyze, design and create novel products and solutions to biological problems that are technically sound, economically feasible and socially acceptable
PEO3	To Exhibit professionalism, ethical attitude, communication skills, team work in their profession multidisciplinary approach and an ability to relate engineering issues to broader social context
PEO4	To nurture inherent talent and capacities to provide leadership for promoting science, technology and social development for the benefit of mankind.

The Programme Outcomes (POs) of B. Tech. in Biotechnology

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice.
PO9	**Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The Programme Specific Outcomes (PSOs) of B. Tech. in BIOTECNOLOGY

PSO1	Gain sound knowledge in biological sciences to formulate, analyze and comprehend biotechnology problems which are of paramount significance in health, food processing, agricultural sectors.
PSO2	Conceive, design and execute experiments for drug development, biomedicines, cell processing. Acquisition of in-depth knowledge in bioinformatics tools and its further development and programming for protein and DNA-based drug design.
PSO3	Utilization and development of genetic, genomics and proteomic tools for manipulating bacteria and other higher eukaryotes for drug screening, investigating unknown biological processes and testing the putative drugs.
PSO4	Develop the capacity to become independent thinker for carrying out any challenging project in the field of biotechnology. Also develop communicative skills, team work spirit and ready to take up any professional and administrative responsibilities. Develop the urge for lifelong learning activities.

CURRICULUM

The total minimum credits for completing the B. Tech. programme in **Biotechnology** is **160 credits**.

MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES

The structure of B.Tech. programmes shall have the following Course categories:

Sl. No.	Course category	Number of Courses	Credits
1.	Mathematics	4	12
2.	Science	5	10
3.	Humanities	3	9
4.	Basic Engineering	6	15
5.	Professional Core	30	81
6.	Global Electives	2	6
7.	Departmental Electives	7	21
8.	Other Courses (OT)	4	6
	TOTAL	61	160

COURSE REQUIREMENTS

1. MATHEMATICS

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	MA1001D	Mathematics I	3	1	0	3
2.	MA1002D	Mathematics II	3	1	0	3
3.	MA2001D	Mathematics III	3	1	0	3
4.	MA2002D	Mathematics IV *	3	1	0	3
		Total				12

* Mathematics IV will be branch specific.

2. SCIENCE

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	PH1001D	Physics	3	0	0	3
2.	PH1091D	Physics Lab	0	0	2	1
3.	CY1001D	Chemistry	3	0	0	3
4.	CY1094D	Chemistry Lab	0	0	2	1
5.	BT1001D	Introduction to Life Science	2	0	0	2
		Total	8	0	4	10

3. HUMANITIES

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	MS1001D	Professional Communication	3	0	0	3
2.	MS3001D	Engineering Economics	3	0	0	3
3.	ME3104D	Principles of Management	3	0	0	3
		Total	9	0	0	9

4. BASIC ENGINEERING

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	ZZ1001D	Engineering Mechanics	3	0	0	3
2.	ZZ1003D	Basic Electrical Sciences	3	0	0	3
3.	ZZ1002D	Engineering Graphics	1	0	3	3
4.	ZZ1004D	Computer Programming	2	0	0	2
5.	ZZ1091D	Workshop I	0	0	3	2
6.	ZZ1092D	Workshop II	0	0	3	2
		Total	8	0	9	15

5. OTHER COURSES (OT)

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	ZZ1093D	Physical Education	0	0	2	1
2.	ZZ1094D	Value Education	0	0	2	1
3.	ZZ1095D	NSS	0	0	2	1
4.	BT3004D	Environmental Studies	3	0	0	3
		Total	3	0	6	6

6. PROFESSIONAL CORE

Sl.No.	Course Code	Course Title	Prerequisites	L	T	P	Credits
1.	BT2001D	Biochemistry	Nil	3	0	0	3
2.	BT2002D	Microbiology	Nil	3	0	0	3
3.	BT2003D	Biochemical Thermodynamics	Nil	3	0	0	3
4.	BT2004D	Unit Operations	Nil	3	0	0	3
5.	BT2005D	Process Calculations	Nil	3	0	0	3
6.	BT2091D	Biochemistry Laboratory	Nil	0	0	3	2
7.	BT2092D	Microbiology Laboratory	Nil	0	0	3	2
8.	BT2006D	Biostatistics	Nil	3	0	0	3
9.	BT2007D	Cell Biology	Nil	3	0	0	3
10.	BT2008D	Molecular Biology	Nil	3	0	0	3
11.	BT2009D	Bioenergetics & Metabolism	Nil	3	0	0	3
12.	BT2010D	Bioprocess Principles	Nil	3	0	0	3
13.	BT2093D	Molecular Biology Laboratory	Nil	0	0	3	2
14.	BT2094D	Bioprocess Laboratory	Nil	0	0	3	2
15.	BT3001D	Genetic Engineering	Nil	3	0	0	3
16.	BT3002D	Bioinformatics	Nil	3	0	0	3
17.	BT3003D	Downstream Processing	Nil	3	0	0	3
18.	BT3091D	Bioinformatics Laboratory	Nil	0	0	3	2
19.	BT3092D	Downstream Process Laboratory	Nil	0	0	3	2
20.	BT3007D	Immunology	Nil	3	0	0	3
21.	BT3005D	Enzyme kinetics & technology	Nil	3	0	0	3
22.	BT3006D	Instrumental Methods of Analysis	Nil	3	0	0	3
23.	BT3093D	Immunology Laboratory	Nil	2	0	3	2
24.	BT3094D	Mini Project	Nil	0	0	3	2
25.	BT4001D	Ethics & IPR	Nil	3	0	0	3
26.	BT4002D	Plant Biotechnology	Nil	3	0	0	3
27.	BT4091D	Plant Biotechnology Laboratory	Nil	0	0	3	2
28.	BT4092D	Seminar	Nil	0	0	2	1
29.	BT4093D	Project: Part I	Nil	0	0	8	4
30.	BT4094D	Project: Part II	Nil	0	0	8	4
Total							81

7. DEPARTMENT ELECTIVES

Sl.No.	Course Code	Course Title	Prerequisite	L	T	P	Credits
1.	BT3021D	Biopharmaceutical Technology	Nil	3	0	0	3
2.	BT3022D	Food Biotechnology	Nil	3	0	0	3
3.	BT3023D	Bioreactor Design and Analysis	Nil	3	0	0	3
4.	BT3024D	Mineral Biotechnology	Nil	3	0	0	3
5.	BT3025D	Cytogenetics	Nil	3	0	0	3
6.	BT3026D	Marine Biotechnology	Nil	3	0	0	3
7.	BT3027D	Bioconjugate Technology and Applications	Nil	3	0	0	3
8.	BT3028D	Biofuel Technology	Nil	3	0	0	3
9.	BT3029D	Structural Biology	Nil	3	0	0	3
10.	BT3030D	Metabolic Engineering	Nil	3	0	0	3
11.	BT3031D	Biomechanics	Nil	3	0	0	3
12.	BT4021D	Animal Biotechnology	Nil	3	0	0	3
13.	BT4022D	Biosensors and Diagnostics	Nil	3	0	0	3
14.	BT4023D	Nanobiotechnology	Nil	3	0	0	3
15.	BT4024D	Good Manufacturing Practice	Nil	3	0	0	3
16.	BT4025D	Protein Engineering	Nil	3	0	0	3
17.	BT4026D	Synthetic Biology	Nil	3	0	0	3
18.	BT4027D	Biopolymers	Nil	3	0	0	3
19.	BT4028D	Receptors and cell signalling	Cell Biology	3	0	0	3
20.	BT4029D	Pharmaceutical and Medicinal Chemistry	Nil	3	0	0	3
21.	BT4030D	Fundamental Neurobiology	Nil	3	0	0	3
22.	BT4031D	Biomaterials & Artificial Organs	Nil	3	0	0	3
23.	BT4032D	Cancer Biology	Nil	3	0	0	3
24.	BT4033D	Stem Cell Technology	Nil	3	0	0	3
25.	BT4034D	Human Physiology	Nil	3	0	0	3
Total							21

8. GLOBAL ELECTIVES

Two elective courses to be credited from other departments.

Course Structure

Semester I

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	MA1001D	Mathematics I	3	1	0	3	MA
2.	PH1001D/ CY1001D	Physics/Chemistry	3	0	0	3	BS
3.	MS1001D/ ZZ1003D	Professional Communication/ Basic Electrical Sciences	3	0	0	3	HL/BE
4.	ZZ1001D/ ZZ1002D	Engineering Mechanics/ Engineering Graphics	3/1	0	0/3	3	BE
5.	ZZ1004D/ BT1001D	Computer Programming / Introduction to Life Science	2	0	0	2	BE/BS
6.	PH1091D/ CY1094D	Physics Lab/Chemistry Lab	0	0	2	1	BS
7.	ZZ1091D/ ZZ1092D	Workshop I/Workshop II	0	0	3	2	BE
8.	ZZ1093D/ ZZ1094D/ ZZ1095D	Physical Education /Value Education/ NSS	-	-	-	3*	OT
	Total Credits		14/12	1	5/8	17+3*	

*Note: Three courses of 1 credit each has to be credited within the first four semesters.

Semester II

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	MA1002D	Mathematics II	3	1	0	3	MA
2.	CY1001D/ PH1001D	Chemistry/ Physics	3	0	0	3	BS
3.	ZZ1003D/ MS1001D	Basic Electrical Sciences/ Professional Communication	3	0	0	3	BE/HL
4.	ZZ1002D/ ZZ1001D	Engineering Graphics/ Engineering Mechanics	1/3	0	3/0	3	BE
5.	BT1001D/ ZZ1004D	Introduction to Life Science./Computer Programming	2	0	0	2	BS/BE
6.	CY1094D/ PH1091D	Chemistry Lab / Physics Lab	0	0	2	1	BS
7.	ZZ1092D/ ZZ1091D	Workshop II/ Workshop I	0	0	3	2	BE
8.							
	Total Credits		12/14	1	8/5	17	

Semester III

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	MA2001D	Mathematics III	3	1	0	3	MA
2.	BT2001D	Biochemistry	3	0	0	3	PC
3.	BT2002D	Microbiology	3	0	0	3	PC
4.	BT2003D	Biochemical Thermodynamics	3	0	0	3	PC
5.	BT2004D	Unit Operations	3	0	0	3	PC
6.	BT2005D	Process Calculations	3	0	0	3	PC
7.	BT2091D	Biochemistry Laboratory	0	0	3	2	PC
8.	BT2092D	Microbiology Laboratory	0	0	3	2	PC
	Total Credits					22	

Semester IV

Sl. No.	Course code	Course Title	L	T	P	Credits	Category
1.	MA2002D	Mathematics IV	3	1	0	3	MA
2.	BT2006D	Biostatistics	3	0	0	3	PC
3.	BT2007D	Cell Biology	3	0	0	3	PC
4.	BT2008D	Molecular Biology	3	0	0	3	PC
5.	BT2009D	Bioenergetics & Metabolism	3	0	0	3	PC
6.	BT2010D	Bioprocess Principles	3	0	0	3	PC
7.	BT2093D	Molecular Biology Laboratory	0	0	3	2	PC
8.	BT2094D	Bioprocess Laboratory	0	0	3	2	PC
	Total Credits					22	

Semester V

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	ME3104D	Principles of Management	3	0	0	3	HL
2.	BT3001D	Genetic Engineering	3	0	0	3	PC
3.	BT3002D	Bioinformatics	3	0	0	3	PC
4.	BT3003D	Downstream Processing	3	0	0	3	PC
5.	BT3*** D	Elective-I	3	0	0	3	DE
6.	BT3004D	Environmental Studies*	3	0	0	3	OT
7.	BT3091D	Bioinformatics Laboratory	0	0	3	2	PC
8.	BT3092D	Downstream Process Laboratory	0	0	3	2	PC
	Total Credits					22	

Semester VI

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	MS3001D	Engineering Economics	3	0	0	3	HL
2.	BT3005D	Enzyme kinetics & technology	3	0	0	3	PC
3.	BT3006D	Instrumental Methods of Analysis	3	0	0	3	PC
4.	BT3007D	Immunology	3	0	0	3	PC
5.	BT3*** D	Elective-II	3	0	0	3	PC
6.	BT3*** D	Elective-III	3	0	0	3	PC
7.	BT3093D	Immunology Laboratory	2	0	3	2	PC
8.	BT3094D	Mini Project	0	0	3	2	PC
	Total Credits					22	

Semester VII

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	BT4001D	Ethics & IPR	3	0	0	3	PC
2.	BT4002D	Plant Biotechnology	3	0	0	3	PC
3.	BT4*** D	Elective-IV	3	0	0	3	DE
4.	BT4*** D	Elective-V	3	0	0	3	DE
5.	Global Elective	Global Elective- I	3	0	0	3	GE
6.	BT4091D	Plant Biotechnology Laboratory	0	0	3	2	PC
7.	BT4092D	Seminar	0	0	2	1	PC
8.	BT4093D	Project: PART I	0	0	8	4	PC
	Total Credits					22	

Semester VIII

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	BT4*** D	Elective-VI	3	0	0	3	PC
2.	BT4*** D	Elective- VII	3	0	0	3	PC
3.	Global Elective	Global Elective- II	3	0	0	3	GE
4.	BT4094D	Project: PART II	0	0	8	4	PC
	Total Credits					13	

Notes:

1. For the successful completion of B.Tech programme, a student must complete the minimum number of courses of each category specified in the curriculum of the specific programme. In addition to the above, the student must have acquired a minimum of **** credits.
2. A student may be permitted to credit overload up to ****courses per semester in the normal case.
3. A student who completes all the course requirements (except the project) before the final semester may be permitted to undertake project at an institute/industry outside with the consent of the department.

Pre-requisites: Nil

Total hours: 39

MA1001D MATHEMATICS I

L	T	P	C
3	1	0	3

Course Outcomes:

Students will be able to:

CO1: Find the limits, check for the continuity and differentiability of functions of a single variable as well as several variables.

CO2: Test for the convergence of sequences and series of numbers as well as functions.

CO3: Formulate different mensuration problems as multiple integrals and evaluate them.

CO4: Use techniques in vector differential calculus to solve problems related to curvature, surface normal and directional derivative.

CO5: Find the parametric representation of curves and surfaces in space and will be able to evaluate the integral of functions over curves and surfaces.

Module 1: (13 Lecture hours)

Real valued function of real variable: Limit, Continuity, Differentiability, Local maxima and local minima, Curve sketching, Mean value theorems, Higher order derivatives, Taylor's theorem, Integration, Area under the curve, Improper integrals.

Function of several variables: Limit, Continuity, Partial derivatives, Partial differentiation of composite functions, Differentiation under the integral sign, Local maxima and local minima, Saddle point, Taylor's theorem, Hessian, Method of Lagrange multipliers.

Module 2: (13 Lecture hours)

Numerical sequences, Cauchy sequence, Convergence, Numerical series, Convergence, Tests for convergence, Absolute convergence, Sequence and series of functions, point-wise and uniform convergence, Power series, Radius of convergence, Taylor series.

Double integral, Triple integral, Change of variables, Jacobian, Polar coordinates, Applications of multipleintegrals.

Module 3: (13 Lecture hours)

Parameterised curves in space, Arc length, Tangent and normal vectors, Curvature and torsion, Line integral, Gradient, Directional derivatives, Tangent plane and normal vector, Vector field, Divergence, Curl, Related identities, Scalar potential, Parameterised surface, Surface integral, Applications of surface integral, Integral theorems: Green's Theorem, Stokes' theorem, Gauss' divergence theorem, Applications of vector integrals.

References:

1. H. Anton, I. Bivensand S. Davis, Calculus, 10th edition, New York: John Wiley & Sons, 2015.
2. G. B. Thomas, M.D. Weirand J. Hass, Thomas' Calculus, 12th edition, New Delhi, India: Pearson Education, 2015.
3. E. Kreyszig, Advanced Engineering Mathematics, 10th edition, New York: John Wiley & Sons, 2015.
4. Apostol, CalculusVol 1, 1st ed. New Delhi: Wiley, 2014.

MA1002D MATHEMATICS II

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes

Students will be able to:

CO1: Test the consistency of system of linear equations and then solve it.

CO2: Test for linear independence of vectors and perform orthogonalisation of basis vectors.

CO3: Diagonalise symmetric matrices and use it to find the nature of quadratic forms.

CO4: Formulate some engineering problems as ODEs and hence solve them.

CO5: Use Laplace transform and its properties to solve differential equations and integral equations.

Module 1: (16 Lecture hours)

System of Linear equations, Gauss elimination, Solution by LU decomposition, Determinant, Rank of a matrix, Linear independence, Consistency of linear system, General form of solution.
Vector spaces, Subspaces, Basis and dimension, Linear transformation, Rank-nullity theorem, Inner-product, Orthogonal set, Gram-Schmidt orthogonalisation, Matrix representation of linear transformation, Basis changing rule.
Types of matrices and their properties, Eigenvalue, Eigenvector, Eigenvalue problems, Cayley-Hamiltonian theorem and its applications, Similarity of matrices, Diagonalisation, Quadratic form, Reduction to canonical form.

Module 2: (13 Lecture hours)

Ordinary Differential Equations (ODE): Formation of ODE, Existence and uniqueness solution of first order ODE using examples, Methods of solutions of first order ODE, Applications of first order ODE.
Linear ODE: Homogenous equations, Fundamental system of solutions, Wronskian, Solution of second order non-homogeneous ODE with constant coefficients: Method of variation of parameters, Method of undetermined coefficients, Euler-Cauchy equations, Applications to engineering problems, System of linear ODEs with constant coefficients.

Module 3: (10 Lecture hours)

Gamma function, Beta function: Properties and evaluation of integrals.
Laplace transform, Necessary condition for existence, General properties, Inverse Laplace transform, Transforms of derivatives and integrals, Differentiation and Integration of transform, Unit-step function, Shifting theorems, Transforms of periodic functions, Convolution, Solution of differential equations and integral equations using Laplace transform.

References:

1. E. Kreyszig, Advanced Engineering Mathematics, 10th edition, New Delhi, India: Wiley, 2015.
2. G. Strang, Introduction to Linear Algebra, Wellesley MA: Cambridge Press, 2016.
3. R. P. Agarwal and D. O 'Regan, An Introduction to Ordinary Differential Equations, New York: Springer, 2008.
4. V. I. Arnold, Ordinary Differential Equations, New York: Springer, 2006.
5. P. Dyke, An Introduction to Laplace Transforms and Fourier Series, New York: Springer,2014.

PH1001D PHYSICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
Students will be able to:

CO1: To enable students to apply relevant fundamental principles of modern physics to problems in engineering.

CO2: To develop knowledge of basic principles of Quantum Physics

CO3: Acquire knowledge of the basic physics of a collection of particles and the emergent macroscopic properties.

CO4: Apply principles of quantum and statistical physics to understand properties of materials

Module 1: (12 hours):
Particle nature of radiation – Photoelectric effect, Compton effect, Wave nature of matter – matter waves, wave packets description, phase and group velocity, uncertainty principle. Formulation of Schrödinger equation, physical meaning of wave function, expectation values, time-independent Schrödinger equation, quantization of energy for bound particles. Application of time-independent Schrödinger equation to free particle, infinite well, finite well, barrier potential, tunneling.

Module 2: (14 hours):
Simple Harmonic Oscillator, two-dimensional square box, the scanning tunneling microscope. Wave function for two or more particles, indistinguishable particles, symmetry and anti-symmetry under exchange of particles, Pauli's exclusion principle, electronic configurations of atoms. Quantum model of a solid – periodicity of potential and bands, E – k diagram, effective mass, band gap.

Module 3: (13 hours):
Microstates and macrostates of a system, equal probability hypothesis, Boltzman factor and distribution, ideal gas, equipartition of energy, Maxwell speed distribution, average speed, RMS speed, Quantum distributions - Bosons and Fermions, Bose-Einstein and Fermi-Dirac distribution, applications.

References:

1. Kenneth Krane, Modern Physics, 2nd Ed., Wiley (2009)
2. Arthur Beiser, Concepts of Modern Physics, 6th Ed., Tata Mc Graw –Hill Publication (2009)
3. Robert Eisberg and Robert Resnick, Quantum Physics of atoms, Molecules, Solids, Nuclei and Particle, 2nd Ed., John Wiley(2006)
4. David Halliday, Robert Resnick and Jearl Walker, Fundamentals of Physics, 6th Ed., Wiley (2004)

CY1001D CHEMISTRY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Acquire knowledge about separation strategies, identification and characterization of molecules
CO2: Understand the causes and mechanism of corrosion and understand its prevention methods
CO3: Attain knowledge about electrochemical reactions and their current applications
CO4: Comprehend the principles of industrial catalytic processes and enzyme catalysis

Module 1: (14 hours)

Spectroscopy – General Principles, Infrared, group frequencies, Electronic spectroscopy of conjugated molecules, Woodward-Fieser Rule.
Chromatography – Retention and Separation factors, Theoretical plates, Instrumentation and uses of Gas Chromatography and High Performance Liquid Chromatography
Thermal analysis – Thermogravimetry, Differential Scanning Calorimetry and Differential Thermal Analysis

Module 2: (12 hours)

Electrochemical corrosion – Mechanisms, control and prevention.
Cyclic voltammetry, Switching potentials, Cathodic and anodic peak currents Potentiometry, Fuel cells – Types and applications
Liquid crystals – Phase types, uses in displays and thermography.

Module 3: (13 hours)

Catalysis – Homogeneous and heterogeneous catalysis, Organometallic compounds, 18-electron rule, Oxidative addition, Reductive elimination, insertion and Elimination reactions, Wilkinson's catalyst in alkene hydrogenation, Zeigler-Natta catalysis in polymerization of olefins.
Enzyme catalysis – Mechanisms, significance of Michaelis – Menten constant, Turnover number, Co-enzymes and cofactors

References:

1. C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, 4th edition, Tata McGraw Hill, New Delhi, 2010.
2. D. A. Skoog and D. M. West, F. J. Holler and S. R. Crouch, *Fundamentals of Analytical Chemistry*, Brooks Cole, Florence, 2004.
3. H. H. Williard, L. L. Merrit, J. A. Dean and F. A. Settle, *Instrumental Methods of Analysis*, Wadsworth Publishing Company, Belmont, California, 1986.
4. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry,* Vishal Publishing, New Delhi, 2000.
5. J. E. Huheey, E.A. Keiter and R.L. Keiter, *Inorganic Chemistry, Principles of Structure and Reactivity*, 4th Ed, Harper Collins College Publishers, New York, 1993.
6. C. Elschenbroich, *Organometallics*, 3rd edition, Wiley-VCH Verlag GmbH, Weinheim, 2006.

MS1001D PROFESSIONAL COMMUNICATION

Pre-requisites: Nil.

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Ability to distinguish the different types of meaning for constructive criticism, by developing a comprehensive understanding of the extensive vocabulary and usage in formal English language.

CO2: Learn and practice principles related to good formal writing.

CO3: Develop competence in group activities such as group discussions, debates, mock interviews, etc. by practicing the integration of unique qualities of nonverbal and verbal styles.

CO4: Deliver clear and effective presentation of ideas in the oral / written medium and to acquire the ability to modify it according to the target audience.

Module 1: (12 hours)

Role and importance of verbal communication, Everyday active vocabulary, Common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension- skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations.

Module 2: (15 hours)

Fundamental grammar, Simple structures, passivizing the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open –ended and close- ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing and good netiquette. Writing for internships and scholarships.

Module 3: (12 hours)

Kinesics, Proxemics, Haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming and activities on the same. Different types of interviews, and presentation- oral, poster, ppt. Organizing ideas for group discussions, the difference between GD and debates.

References:

1. Duck, Steve and David T. Macmahan. *Communication in Everyday Life*. 3rd Ed. Sage, 2017.
2. Quintanilla, Kelly M. and Shawn T. Wahl. *Business and Professional Communication*. Sage, 2016.
3. Gamble, Kawl Teri and Michael W. Gamble. *The Public Speaking Playbook*. Sage, 2015.
4. Tebeaux, Elizabeth and Sam Dragga. *The Essentials of Technical Communication*, 3rd Ed. OUP, 2015
5. Raman, Meenakshi and Sangeetha Sharma. *Technical Communication: Principles and Practice*, OUP, 2015
6. MacLennan, Jennifer. *Readings for Technical Communication*. OUP, 2007.

ZZ1003D BASIC ELECTRICAL SCIENCES

Pre-requisites: None

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Design simple resistive circuits for various applications in Electrical and Electronics engineering.
CO2: Design simple magnetic circuits and inductive components for signal and power processing.
CO3: Carry out design verification calculations, power and power loss calculations, voltage drop calculations etc. in single phase ac circuits.
CO4: Analyze Amplifiers and Digital Circuits in terms of critical parameters and complexity.
CO5: Design sub modules for systems/ Solutions for real life problems using suitable sensors /transducers, amplifiers, data converters and digital circuits.

Module 1: (11 hours)
Analysis of Resistive Circuits: v-i relationship for Independent Voltage and Current Sources
Solution of resistive circuits with independent sources- Node Voltage and Mesh Current Analysis, Nodal Conductance Matrix and Mesh Resistance Matrix and symmetry properties of these matrices
Source Transformation and Star-Delta / Delta-Star Conversions to reduce resistive networks
Circuit Theorems - Superposition Theorem, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.
Magnetic Circuits: MMF, Magnetic Flux, Reluctance, Energy stored in a Magnetic Field, Solution of Magnetic Circuits.
Two Terminal Element Relationships: Inductance - Faraday's Law of Electromagnetic Induction, Lenz's Law, Self and Mutual Inductance, Inductances in Series and Parallel, Mutual Flux and Leakage Flux, Coefficient of Coupling, Dot Convention, Cumulative and Differential Connection of Coupled Coils.
Capacitance – Electrostatics, Capacitance, Parallel Plate Capacitor, Capacitors in series and parallel, Energy stored in Electrostatic Field, v-i relationship for Inductance and Capacitance

Module 2: (9 hours)
Single Phase AC Circuits:
Alternating Quantities - Average Value, Effective Value, Form and Peak factors for square, triangle, trapezoidal and sinusoidal waveforms.
Phasor representation of sinusoidal quantities - phase difference, Addition and subtraction of sinusoids, Symbolic Representation: Cartesian, Polar and Exponential forms.
Analysis of a.c circuits - R, RL, RC, RLC circuits using phasor concept, Concept of impedance, admittance, conductance and susceptance.
Power in single phase circuits - instantaneous power, average power, active power, reactive power, apparent power, power factor, complex power, solution of series, parallel and series parallel a.c circuits.

Module 3 (11 hrs)
Sensors and Transducers: principles of piezoelectric, photoelectric, thermoelectric transducers, thermistors, strain gauge, LVDT, etc, Measurement of temperature, pressure, velocity, flow, pH, liquid level, etc.
Basics of Signal Amplification: (Explanation based on two port models is only envisaged) – voltage gain, current gain and power gain, amplifier saturation, types of amplifiers (voltage, current, transconductance and transresistance amplifiers) and relationship between these amplifier models, frequency response of amplifiers, single time constant networks.
Operational amplifier basics: Ideal op-amp, inverting, noninverting, summing and difference amplifiers, integrator, differentiator.

Module 4 (8 hrs)
Digital Electronics: Review of number systems and Boolean algebra, Logic Gates and Truth Tables, Simplification of Boolean functions using Karnaugh map (upto 4 variable K-maps), Implementation of Simple combinational circuits (Adder, Code Converters, 7-Segment Drivers, Comparators, Priority

Encoders, etc) - MUX-based implementation of combinatorial circuits , Sequential circuits: SR,JK, T and D filpflops, counters and registers using D flip flops, Basics of data converters (at least one ADC and DAC).

References:

1. J.W. Nilsson and S.A. Riedel, *Electric Circuits*, 8th ed., Pearson, 2002
2. K.S. Suresh Kumar, *Electric Circuits & Networks*, Pearson Education, 2009
3. C. A. Desoer and E. S. Kuh, *Basic Circuit Theory*, McGraw Hill, 2009
4. J. A. Edminister, *Electric Circuit Theory*, Schaum's Outline series: 6th ed., McGraw Hill, 2014
5. A. D. Helfrick and W. D. Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, Prentice Hall of India, 2003
6. A. S. Sedra and K. C. Smith, *Microelectronics*, 6thed.,Oxford University Press, 2013
7. C. H. Roth and L. L. Kinney, *Fundamentals of Logic Design*,7thed., Cengage Learning,2014

ZZ1001D ENGINEERING MECHANICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Course Outcomes:

Students will be able to:

CO1: Determine the resultants of a force system
CO2: Solve rigid body statics problems using equations of equilibrium and principle of virtual work
CO3: Perform kinematic analysis of a particle
CO4: Solve particle dynamics problems using Newton's laws, energy methods and momentum methods

Module 1: Basic Concepts (13 hours)

Introduction: idealizations of mechanics, vector and scalar quantities, equality and equivalence of vectors, laws of mechanics, elements of vector algebra.

Important vector quantities: position vector, moment of a force about a point, moment of a force about an axis, the couple and couple moment, couple moment as a free vector, moment of a couple about a line.

Equivalent force systems: translation of a force to a parallel position, resultant of a force system, simplest resultant of special force systems, distributed force systems, reduction of general force system to a wrench.

Module 2: Statics (13 hours)

Equations of equilibrium: free-body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium, static indeterminacy.

Applications of equations of equilibrium: Trusses: solution of simple trusses using method of joints and method of sections; Friction forces: laws of Coulomb friction, simple contact friction problems; Cables and chains.

Properties of surfaces: first moment and centroid of plane area, second moments and product of area for a plane area, transfer theorems, rotation of axes, polar moment of area, principal axes.

Method of virtual work: principles of virtual work for rigid bodies and its applications.

Module 3: Dynamics (13 hours)

Kinematics of a particle: introduction, general notions, differentiation of a vector with respect to time, velocity and acceleration calculations in rectangular coordinates, velocity and acceleration in terms of path variables and cylindrical coordinates, simple kinematical relations and applications.

Dynamics of a particle: introduction, Newton’s law for rectangular coordinates, rectilinear translation, Newton’s law for cylindrical coordinates, Newton’s law for path variables, energy and momentum methods: introduction, conservative force field, conservation of mechanical energy, alternative form of work-energy equation, impulse and momentum relations, moment-of-momentum equation.

References:

1. I. H. Shames, *Engineering Mechanics—Statics and Dynamics*, 4th Edition, Prentice Hall of India, 1996.
2. F.P. Beer and E.R. Johnston, *Vector Mechanics for Engineers – Statics,* McGraw Hill Book Company, 2000.
3. J.L. Meriam and L.G. Kraige, *Engineering Mechanics – Statics*, John Wiley & Sons, 2002.
4. R.C Hibbler, Engineering Mechanics—Statics and Dynamics, 11th Edition, Pearson, India, 2009

ZZ1002D ENGINEERING GRAPHICS

Pre-requisites: Nil

L	T	P	C
2	0	2	3

Total hours: 52

Course Outcomes:
Students will be able to:
CO1: Make use of the Indian Standard Code of Practice in Engineering Drawing.
CO2: Represent any engineering object by its orthographic views.
CO3: Convert orthographic views of an engineering object into its isometric view.
CO4: Enhance the capacity of visualization of engineering objects.

Module 1: (15 hours)

Introduction; drawing instruments and their uses; lines, lettering and dimensioning; geometrical construction; constructions of plain, diagonal and vernier scales; orthographic projection—first and third angle projections; orthographic projection of points on principal, profile, and auxiliary planes.

Module 2: (17 hours)

Orthographic projection of straight line in simple and oblique positions; application of orthographic projection of line; orthographic projection of planes in simple and oblique position on principal and profile planes; orthographic projection of lines and planes on auxiliary planes.

Module 3: (20 hours)

Orthographic projection of solids in simple and oblique positions on principal and profile planes; orthographic projections of solids in oblique position using auxiliary plane method; orthographic projection of spheres; orthographic projection of solids in section; development of surfaces of solids; method of isometric projection.

References:

1. N. D. Bhatt, Engineering Drawing, 53rd ed. Anand, India: Charotar Publishing House, 2016.
2. Basant Agrawal and C M Agrawal, Engineering Drawing, 2nd ed. New Delhi, India: McGraw Hill Education (India), 2014.

ZZ1004D Computer Programming

Pre-requisites: Nil.

L	T	P	C
2	0	0	2

Total hours: 26

Course Outcomes:
Students will be able to:
CO1: Design of algorithms for simple computational problems.
CO2: Express algorithmic solutions in the C programming language.

Module 1: (10 hours)
Data Types, Operators and Expressions: Variables and constants - declarations - arithmetic and logical operators – Assignment operator – Input/Output.
Control Flow: Statements and blocks – if-else, switch, while, for and do-while statements – break and continue – goto and labels.

Module 2: (08 hours)
Functions and Program structure: Basics of functions, Parameter passing – scope rules – recursion.

Module 3: (08 hours)
Aggregate data types: Single and multidimensional arrays, structures and unions – Pointers to arrays and structures – passing arrays and pointers as arguments to functions.

References:
1. B.S. Gottfried, *Programming with C (Schaum's Outline Series)*, 2nd ed. McGraw-Hill,1996.
2. B. W. Kernighan and D. M. Ritchie, *The C Programming Language*, 2nd ed. Prentice Hall, 1988.
3. W. Kernighan, *The Practice of Programming*, Addison-Wesley, 1999.

BT1001D INTRODUCTION TO LIFE SCIENCE

Pre-requisites: Nil

L	T	P	C
2	0	0	2

Total hours: 26

Course Outcomes:

CO1: Comprehend the chemical and molecular basis of life.

CO2: Summarize about the basic molecules of life- proteins, lipids, DNA, and RNA

CO3: Develop idea about cell, its structure, functions and significance of compartmentalization

CO4: Students will describe the concepts in ecology and biodiversity and its impact on global change

Module 1: (09 hours)

Origin and evolution of life, Biogenesis and Louis Pasteur, Oparin-Haldane hypothesis, Darwin's view on natural selection. unity and diversity of life, Chemistry of life, introduction to structure and function of the biological macromolecules like carbohydrates, proteins, lipids, DNA and RNA

Module 2: (09 hours)

Prokaryotic and eukaryotic cells, structure and organization of cells, intracellular compartmentalization, functions of various organelles. Extracellular components and cell-cell communication, overview of Mitosis and Meiosis, basic concepts in energy transformation and photosynthesis.

Module 3: (08 hours)

Principles of Mendelian inheritance and chromosomal basis of heredity, linked genes, genetic disorder. Ecosystems and restoration ecology, energy flow, chemical and nutrient cycling, primary production in ecosystems, conservation of biodiversity.

References:

1. L. A. Urry, M. L. Cain, S. A. Wasserman, P. V. Minorsky, and J. B. Reece, *Campbell Biology*, 11th Edn. Pearson 2017
2. D. L. Nelson, and M. M. Cox, *Lehninger Principles of Biochemistry*, 4th Edn, WH Freeman and Company, 2005.
3. C. Starr, C. Evers, L. Starr, *Biochemistry, Biology: Concepts and Applications*, 10th Edn, 2017.
4. J.M. Berg, J.L. Tymoczko, and L. Stryer, *Biochemistry*, 6th Edn., W H Freeman and Company, 2007.
5. H. Lodish, A. Berk, C. A. Kaiser, and M. Krieger, *Molecular Cell Biology*, 6th Edn., W. H. Freeman, 2007.

BT1001D INTRODUCTION TO LIFE SCIENCE

Pre-requisites: Nil

L	T	P	C
2	0	0	2

Total hours: 26

Brief Syllabus:

Different hypotheses on the origin and evolution of life, Diversity of Life, Chemistry of life, structure and functions of biological macromolecules, structure and organization of cells, compartmentalization and its significance, cell division, energy transformation, Mendel’s Law of inheritance, Ecosystems and restoration ecology.

PH1091D PHYSICS LAB

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 26

Course Outcomes:

Students will be able to:

CO1: To develop experimentation skills and understand importance of measurement practices in Science & Technology.

CO2: Develop analytical skills for interpreting data and drawing inferences.

CO3: Estimate the nature of experimental errors and practical means to obtain errors in acquired data.

CO4: Develop skills for team work and technical communication and discussions.

CO5: Apply theoretical principles of modern physics to analysis and measurements performed in the laboratory.

LIST OF EXPERIMENTS

1. Magnetic Hysteresis loss - Using CRO
2. Band gap using four probe method
3. Hall effect- determination of carrier density, Hall coefficient and mobility
4. Solar cell characteristics
5. Double refraction – measurement of principle refractive indices.
6. Measurement of N.A & Attenuation
7. Measurement of e/m of electron – Thomson's experiment
8. Determination of Planck's constant
9. Measurement of electron charge – Millikan oil drop experiment
10. Determination of magnetic field along the axis of the coil
11. Newton's rings
12. Laurent's Half shade polarimeter –determination of specific rotatory power
13. Study of P-N junction
14. Study of voltage-current characteristics of a Zener diode.
15. Laser – measurement of angle of divergence & determination of λ using grating
16. Measurement of magnetic susceptibility- Quincke's Method / Gouy's balance.
17. Mapping of magnetic field
18. Temperature measurement by using thermocouple

NOTE: Any 8 experiments have to be done.

References:

1. A.C. Melissinos, J. Napolitano, Experiments in Modern Physics, Academic Press (2003)
2. Avadhanulu, Dani and Pokley, Experiments in Engineering physics, S. Chand & Company ltd (2002).
3. S.L. Gupta and V. Kumar, Practical physics, Pragathi Prakash (2005)

CY1094D CHEMISTRY LAB

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 26

Course Outcomes:
Students will be able to:
CO1: Acquire practical knowledge on the separation of mixtures and their identification
CO2: Understand chirality and the specific rotation of a compound
CO3: Attain practical experience in the synthesis of new molecules
CO4: Apply different techniques to quantitatively determine the amount of components

List of Experiments:

1. Determination of specific rotation by polarimetry
2. Potentiometric titrations
3. Estimation of ions using complexometry
4. Determination of strength of an acid using pH meter
5. Analysis of organic and inorganic compounds
6. Conductometric titrations using acid or mixture of acids
7. Separation of compounds using chromatography
8. Colorimetric estimations
9. Determine the eutectic temperature and composition of a solid two component system
10. Synthesis of organic/inorganic compounds and their characterizations
11. Determination of molecular weight of polymers

Note: Selected experiments from the above list will be conducted

References:

1. G. H. Jeffery, J. Bassett, J. Mendham and R.C. Denny, *Vogel's Text Book of Quantitative Chemical Analysis*, Longmann Scientific and Technical, John Wiley, New York,1989.
2. A. I. Vogel, *Elementary Practical Organic Chemistry – Small Scale Preparations*, Pearson India, New Delhi, 2011.
3. A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hannaford and P. W. G. Smith, *Vogel's Text Book of Practical Organic Chemistr*y, Longman and Scientific Technical, New York, 1989.

ZZ1091D Workshop I

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes (COs):
Students will be able to:
CO1: Perform experiments to ascertain the quality requirements and quality testing procedures of selected building material, viz., cement, fine aggregate, coarse aggregate, concrete, timber and steel.
CO2: Identify and evaluate various driver characteristics as driver of a vehicle.
CO3: Acquire knowledge about basic civil engineering practices of brick masonry, plumbing and surveying.
CO4: Perform wiring estimation and costing for simple building/commercial electrical wiring systems.
CO5: Use commonly employed wiring tools and lighting and wiring accessories.
CO6: Adopt electrical safety measures in using and servicing household appliances.

Civil Engineering Workshop (24 hours)
1. Introduction to Surveying – Linear measurements – Hands on session on Setting out of a small residential building.
2. Introduction to Levelling – Hands on sessions using Dumpy level – Levelling exercise.
3. Introduction to Total Station – Hands on sessions - small exercises.
4. Tests on cement and aggregates: Demonstration of standard consistency, initial and final setting time of cement - Hands on sessions - Compressive strength test on cement mortar cubes and sieve analysis for coarse and fine aggregates.
5. Tests on hardened concrete, brick, timber and steel: Demonstrations on hardness tests (Rockwell hardness), impact tests (Charpy and Izod) on steel specimens-demonstration on properties of timber – Hands on sessions - Compression test on concrete cubes, bricks and tension test on mild steel specimen.
6. Masonry: Hands on sessions - English bond, Flemish bond – wall junction – one brick – one and a half brick - Arch construction.
7. Water supply and sanitation: Study of water supply pipe fittings – tap connections – sanitary fittings
8. Various tests on Driver characteristics – Visual acuity and colour blindness, peripheral vision, depth perception, driver reaction time.

Electrical Engineering Workshop (15 hours)

1. (a) Familiarization of wiring tools, lighting and wiring accessories, various types of wiring systems.
   (b) Wiring of one lamp controlled by one switch.
2. (a) Study of Electric shock phenomenon, precautions, preventions, Earthing.
   (b) Wiring of one lamp controlled by two SPDT Switches and one 3 pin plug socket independently.
3. (a) Familiarization of various types of Fuses, MCBs, ELCBs, etc.
   (b) Wiring of fluorescent lamp controlled by one switch with ELCB & MCB.
4. (a) Study of estimation and costing of wiring.
   (b) Wiring, control and maintenance of domestic appliances like Mixer machine, Electric Iron, fan, motor, etc.

References
1. T.P. Kanetkar, S.V. Kulkarni, *Surveying and Levelling - Part1*, Pune Vidyarthi Griha Prakashan, Pune, 1994.
2. B.C. Punmia, *Building Construction*, Laxmi Publications, New Delhi1999.
3. Satheesh Gopi, R. Sathikumar, N. Madh, *Advnaced Surveying*, Pearson Education,2007.
4. M.S. Shetty, *Concrete Technology*, S. Chand & Company, New Delhi,2005.
5. K. B. Raina & S. K. Bhattacharya, *Electrical Design Estimating and costing*, New Age International Publishers, New Delhi, 2005.
6. Khanna, S. K., and Justo, C. E. G., *Highway Engineering*, Nemchand and Bros, Roorkee,2001.
7. Uppal S. L., *Electrical Wiring & Estimating*, Khanna Publishers---5th edition, 2003.
8. John H. Watt, *Terrell Croft American Electricians' Handbook: A Reference Book for the Practical Electrical Man*, 9th ed. McGraw-Hill, 2002.

ZZ1092D WORKSHOP II

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes (COs):

Students will be able to:

CO1: Ability to select suitable material for a given purpose applying knowledge of material properties and processing.

CO2: Ability to use measuring devices like Vernier Calipers, Micrometers, etc.

CO3: Ability to fabricate simple components using basic manufacturing processes like Casting, Forming, Joining and Machining.

CO4: Ability to sequence various operations so as to execute the task within minimum time.

CO5: Perform diagnostic measurements using analog and digital meters for troubleshooting electronic systems.

CO6: Select appropriate electronic components for a given design task and assemble the prototype on breadboard.

CO7: Troubleshoot electronic boards used in various household appliances.

CO8: Perform cost estimation and costing of PCB soldering and carry out the soldering.

Mechanical Engineering Workshop (24 hours)

The course is intended to expose the student to various manufacturing processes through hands on training in different sections of Central Workshop. During the course, the student learns the properties and selection of different materials and acquires the skill in using various tools and measuring devices.

1. Carpentry: Study of tools and joints – plaining, chiseling, marking and sawing practice, one typical joint- Tee halving/Mortise and Tenon/ Dovetail
2. Fitting: Study of tools- chipping, filing, cutting, drilling, tapping, about male and female joints, stepped joints. Edge preparation for single V joint.
3. Welding: Study of arc and gas welding, accessories, joint preparation. Welding of a single V joint
4. Smithy: Study of tools. Forging of square or hexagonal prism/chisel/bolt
5. Foundry: Study of tools, sand preparation. Moulding practice using the given pattern.
6. Sheet Metal: Study of tools, selection of different gauge sheets, types of joints. Fabrication of a tray or a funnel
7. Machine Shop: Study of the basic lathe operations. Simple step turning exercise.

Electronics Engineering Workshop (15 hours)

1. (a) Familiarization of electronic components, colour code, multimeters.
   (b) Bread board assembling-Common emitter amplifier.
2. (a) Study of soldering components, solders, tools, heat sink.
   (b) Bread board assembling-phase shift oscillator.
3. (a) Soldering practice-Common emitter amplifier.
   (b) Soldering practice-Inverting amplifier circuit.
4. (a) Study of estimation and costing of soldering PCB, 3 phase connections.
   (b) PCB wiring and fault Identification of appliances like Electronic Ballast, fan regulator, inverter, UPS, etc.

References

1. W. A. J. Chapman, Workshop Technology - Parts 1 & 2, 4th ed. New Delhi, India, CBS Publishers & Distributors Pvt. Ltd., 2007.
2. Welding Handbook. 9th ed. Miami, American Welding Society, 2001.
3. J. Anderson, Shop Theory, New Delhi, India, Tata McGraw Hill, 2002.
4. J. H. Douglass, Wood Working with Machines, Illinois, McKnight & McKnight Pub. Co., 1995.
5. W.A. Tuplin, Modern Engineering Workshop Practice, Odhams Press, 1996.
6. P. L. Jain, Principles of Foundry Technology, 5th ed. New Delhi, India, Tata McGraw Hill, 2009.
7. John H. Watt, Terrell Croft, American Electricians' Handbook: A Reference Book for the Practical Electrical Man, 9th ed. McGraw-Hill, 2002.
8. G. Randy Slone, Tab Electronics Guide to Understanding Electricity and Electronics, 2nd ed. McGraw-Hill, 2000.
9. Jerry C Whitaker, The Resource Handbook of Electronics, CRC Press-2001.

ZZ1093D PHYSICAL EDUCATION

Pre-requisites: Nil

L	T	P	C
1	0	1	1

Total hours: 26 (13 L +13 P)

Course Outcomes

CO1: Select a game/ activity of his/ her choice to pursue on the campus to enjoy/ entertain and thereby develop good health and fitness which he/she would carry over to post-campus life for maintaining health, fitness and wellness.

CO2: Be more proficient in a game, which may lead him/her to a berth in the institute teams.

CO3: Gain exposure to professional training, so as to enable him / her to excel in sports activities.

CO4: Participate in intramural and open mass participation activities.

CO5: Participate and organise in-campus or off-campus sports activities.

UNIT – I - Introduction, definition, aims & objectives of Physical Education. Health, Physical fitness and wellness. Importance, scope and relevance of Physical Education in NITC curriculum.

UNIT – II - Physical fitness and components. Health related Physical fitness and components. Benefits of exercise – physical and physiological.

UNIT – III - Physical exercise and its principles. Activities for developing physical fitness – walking, jogging, running, weight training, stretching, yogasanas. Athletic injuries and their management. Nutritional balance.

UNIT – IV - Motivation and its importance in sports. Stress, anxiety, tension, aggression in sports. Personality, self-confidence and performance. Team cohesion and leadership in sports.

UNIT – V - Lifestyle diseases and its management, Diabetes and Obesity, Hypertension, Osteoporosis, Coronary heart diseases and cholesterol. Backpain, Postural deformities and their remedies.

UNIT – VI. - Olympic Values Education. Event & Crisis management.

References

1. Najeeb, A. M., Atul, M., Sumesh, D. and Akhilesh, E. “Fitness Capsule for university curriculum”, 2015

ZZ1094D VALUE EDUCATION

Pre-requisites: Nil

L	T	P	C
1	0	1	1

Total hours: 13 L +13 P

Course Outcomes:

CO1: Identify the purpose of education and the problems faced by mankind, in terms of socio economic and environmental issues.
CO2: Describe the social and intellectual needs to transform the society to a better one where everyone meets the basic economic and social security, freedom and atmosphere to live a meaningful life.
CO3: Practise a meaningful life avoiding all kinds of corrupt practices and develop unconditional love, universal brotherhood and simulate international peace and prosperity.
CO4: Persuade others to practise a righteous life, which would stimulate a synergy of universal harmony and peace.
CO5: Create an ideal society where everyone enjoys the fruits of love, peace and harmony.

Unit I (2 hours): **Social Justice** Definition –need-parameters of social justice –factors responsible for social injustice –caste and gender –contributions of social reformers.

Unit II (3 hours)**: Human Rights and Marginalized People** Concept of Human Rights-Principles of human rights-human rights and Indian Constitution-Rights of Women and children-violence against women–Rights of marginalized People-like women, children, dalits, minorities, physically challenged etc.

Unit III (3 hours): **Social Issues and Communal Harmony** Social issues–causes and magnitude-alcoholism, drug addiction, poverty, unemployment etc.-communal harmony-concept-religion and its place in public in public domain-separation of religion from politics-secularism role of civil society.

Unit IV (3 hours): **Media Education and Globalized World Scenario** Mass media-functions-characteristics-need and purpose of media literacy-effects and influence –youth and children-media power-socio cultural and political consequences mass mediated culture-consumerist culture-Globalization-new media –prospects and challenges-Environmental ethics

Unit V (2 hours): **Values and Ethics** Personal values –family values-social values-cultural values-professional values-and overall ethics-duties and responsibilities

Project: 13 hours

References:

1. Sharma, B. K., 'Human Rights Covenants and Indian Law', PHI Learning Pvt. Ltd, 2010
2. Law Commission of India, (1971), 'Indian Penal code', (http://lawcommissionofindia.nic.in/1-50/report42.pdf), accessed on February 14, 2018.
3. Srivastava, S. S., 'Central Law Agency's Indian Penal Code along with General Principles (IPC)', Central Law Agency, 2017
4. 'Gandhiji on Communal Harmony',Mani Bhavan Gandhi Sangrahalaya', Mumbai, 2003
5. 'Social Impact of Drug Abuse', UNDCP, ((https://www.unodc.org/pdf/technical_series_1995-03-01_1.pdf, accessed on February 14, 2018).
6. Bryfonski, D., 'The Global Impact of Social Media', Green Heaven Publications**,** 2012
7. Schmidtz, D. &Willott, E., 'Environmental Ethics: What Really Matters, What Really Works', Oxford University Press, 2012
8. Ranganathanda, S., 'Eternal Values for a Changing Society: Education for human excellence', BharatiyaVidyaBhavan, 1987
9. Rokeach, M., 'Understanding human values: Individual and Societal', The New Free Press, 1979

ZZ1095D NSS

Pre-requisites: Nil

L	T	P	C
0	0	3	1

Total hours: 39

Course Outcomes

CO1: Acquire awareness in social and environmental issues thereby improving social consciousness and commitment towards the community.
CO2: Participate in socially relevant activities that are aimed at betterment of the campus and the society, thereby instilling a helpful attitude
CO3: Develop a positive attitude towards dignity of labour, self-help and the need for combining physical work with intellectual pursuits.
CO4: Improve inter-personal skills and contribute to nation building by serving the local community, thereby promoting a healthy and positive attitude towards life.

NSS activities have been divided in two major groups. These are Regular NSS Activities and Special Camping programme.

(a) Regular NSS Activity: NSS volunteers undertake various activities in adopted villages and slums for community service. The NSS units organise the regular activities as detailed below:
i) Orientation of NSS volunteers: To get the NSS volunteers acquainted with the basics of NSS programmes, for their orientation through lectures, discussions, field visits, audio-visuals etc.
ii) Campus Work: The NSS volunteers may be involved in the projects undertaken for the benefit of the institution and students concerned. Such projects cover maintenance of public properties, tree plantation, waste management and Swach Bharat activities, conservation of water and energy sources, social audits, awareness programmes on drug-abuse, AIDS, population education, and other projects
iii) Community service will be in adopted villages/urban slums independently or in collaboration with others in this field.
iv) Institutional work: The students may be placed with selected voluntary organisations working for the welfare of women, children, aged and disabled outside the campus.
v) Rural Project: The rural projects generally include the working of NSS volunteers in adopted villages for e-governance and digital literacy, watershed management and wasteland development, rainwater harvesting, agricultural operations, health, nutrition, hygiene, sanitation, mother and child care, gender equality sensitization programmes, family life education, gender justice, development of rural cooperatives, savings drives, construction of rural roads, campaign against social evils etc.
vi) Urban Projects: In addition to rural projects other include adult education, welfare of slum dwellers, work in hospitals, orphanages, destitute home, environment enrichment, population education, drug, AIDS awareness, and income generation,
vii) National Days and Celebrations: The National Service Scheme programmes also include the celebration of National days. The purpose of such a provision is to celebrate such occasions in a befitting manner,
viii) Blood Donation Activities,
ix) Campus farming activities,
x) Activities for social inclusion such as organizing programmes for differently – abled children.
Students shall volunteer and contribute to the activities of the National Service Scheme for a minimum duration of 39 hours for the award of credit.

b) Special Camping Programme: Under this, camps of 7 days’ duration are organised during vacations with some specific projects by involving local communities.

MA2001D MATHEMATICS III

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Handle application problems involving random variables and functions of random variables.
CO2: Identify statistical problems and make use of statistical inference while handling stochastic systems.
CO3: Apply regression and correlation analysis for studying relationship between variables.
CO4: Identify situations where analysis of variance is appropriate and apply it.
CO5: Use probabilistic and statistical analysis in various applications of engineering.

Module 1: (15 Hours)

Probability distributions, Random variables, Expectation of a function of a random variable, Mean, Variance and Moment generating function of a probability distribution, Chebyshev's theorem, Binomial distribution, Poisson distribution, Geometric distribution, Hyper- geometric distribution, Normal Distribution, Uniform distribution, Gamma distribution, Beta distribution and Weibull distribution. Transformation of a random variable, Probability distribution of a function of a random variable, Jointly distributed random variables, Marginal and conditional distributions, Bi-variate Normal distribution, Joint probability distribution of functions of random variables.

Module 2: (14 hours)

Population and samples, The sampling distribution of the mean (σ known and σ unknown), Sampling distribution of the variance, Point estimation, Maximum likelihood estimation, Method of moments,Interval estimation, Point estimation and interval estimation of mean and variance. Tests of hypothesis, Hypothesis tests concerning one mean and two means. Hypothesis tests concerning one variance and two variances, Estimation of proportions, Hypothesis tests concerning one proportion and several proportions, Analysis of ⍰ × ⍰ contingency tables, Chi – square test for goodness of fit.

Module 3: (10 hours)

Analysis of variance, General principles, Completely randomized designs, Randomized block design. Curve fitting, Method of least squares, Estimation of simple regression models and hypotheses concerning regression coefficients, Correlation coefficient- Estimation of correlation coefficient, Hypothesis concerning correlation coefficient. Estimation of curvilinear regression models.

References:

1. R. A. Johnson, Miller and Freund's Probability and Statistics for Engineers, 8^{th} edition., PHI, New Delhi, 2011.
2. W. W. Hines, D. C. Montgomery, D. M. Goldsman and C. M. Borror, Probability and Statistics in Engineering, 4^{th} edition, John Wiley & Sons, Inc., 2003
3. S.M. Ross, Introduction to Probability and statistics for Engineers and Scientists, 5^{rd} edition, Academic Press (Elsevier), New Delhi, 2014.

BT2001D BIOCHEMISTRY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain biotechnology from a biochemical perspective after understanding the basic foundation.
CO2: Explain complex biochemical pathways within living cells, catabolic and anabolic metabolism. Students will use biochemistry principles in biotechnology.
CO3: Students will apply their learning about the core principles and topics of Biochemistry with their experimental basis.
CO4: Upon gaining specialized knowledge and understanding of selected aspects by means of a lecture series, students will apply Henderson-Hasselbalch equation to prepare buffers, and evaluate the presence of various amino acids, proteins, and carbohydrates based on the principle of different qualitative tests they learn.

Module 1: (13 hours)

Definition, scope and significance of biochemistry, Chemical constituents of life, Importance of water and physiological buffers, Carbohydrates – mono-, di- and polysaccharides, Amino acids and proteins, Fatty acids, lipids and steroids, Nucleosides, nucleotides and nucleic acids, Vitamins and minerals.

Module 2: (13 hours)

Introduction to metabolism, Metabolism of carbohydrates – glycolysis, TCA cycle, gluconeogenesis etc, Electron transport chain and oxidative phosphorylation, Metabolism of lipids, Metabolism of amino acids, Metabolism of nucleotides, Regulation of metabolism.

Module 3: (13 hours)

Biological membrane and structure, Transport across membranes, Free radicals and antioxidants, Photosynthesis - photosystem I and photosystem II

References:

1. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 4th Edn, WH Freeman and Company, 2005.
2. J.M. Berg, J.L. Tymoczko, and L. Stryer, Biochemistry, 6th Edn., WH Freeman and Company, 2007.
3. R. H. Garret and C. M. Grisham, Biochemistry, 3rd Edn., Brooks Cole, 2004.

BT2002D MICROBIOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain basic knowledge of Microbial kingdom and classify, microbial interactions, and enumeration -microbial load calculation, staining procedures interpret the of tools involved in analysis and imagining of microbes.

CO2: Describe the structure, reproduction of Bacteria, virus and fungi. Sterilization techniques involved. Emphasizes on sessions of effect of microbial and viral community with humans

CO3: Students will assess both aerobic and anaerobic microbial metabolic processes and develop and interest to solve the hurdles created by these types of microbes.

CO4: Formulate an awareness about growth and control of both beneficial and harmful microbes. Assess various modern technology involved in remediation and genetic modification of bacterial utility industrially.

Module 1: (14hours)

History of Microbiology, Prokaryotes and eukaryotes, Types of microbes, General introduction to viruses, bacteria, fungi and protozoa. Staining techniques- simple, negative, Grams, spore, flagella, acid fast, voluting, capsule and Fuelgen staining. Study of microbes using microscopes bright field, dark field, phase contrast, fluorescent and electron microscopy. Nutritional requirements for growth, Growth curve, Culture methods, enumeration methods of microbes, biochemical and molecular characterization of microbes.

Module 2: (13hours)

Structure and reproduction of viruses, bacteria and fungi. Introduction to genetics of viruses and bacteria, Nature of bacterial variation, Fluctuation test, Selection of bacterial mutants Microbial metabolism, Aerobic and anaerobic processes, Heterotrophic CO_2 fixation, Photophosphorylation in bacteria, Secondary metabolism

Module 3: (12hours)

Control of microorganisms by physical and chemical methods, Microbial pathogenesis, brief introduction to microbes causing Malaria, Tuberculosis, Leprosy, AIDS and Polio. Antibiotic resistance, Soil microbiology, Bioremediation, Microbes used in recombinant DNA technology.

References:

1. L.M. Prescott, J.P. Harley, and D.A. Klein, Microbiology, 9th Edn., McGraw-Hill, 2013.
2. M.J. Pelczar, E.C.S. Chan, and N.R. Krieg, Microbiology, 5th Edn., McGraw-Hill, 2007.
3. R.Y. Stanier, J.L. Ingraham, M.L. Wheelis, and P.R. Painter, The Microbial World, 5th Edn., Macmillan, 1987.
4. L.M. Prescott, J.P. Harley, and D.A. Klein, Microbiology, 9th Edn., McGraw-Hill, 2013.
5. D. Freifelder, Microbial Genetics, 2nd Edn., Narosa Publishing House, 1994.
6. J.C.Pommerville Alcamo's Fundamentals of Microbiology, 9th Revised Edn., Jones and Bartlett Publishers, Inc 2010.

BT2003D BIOCHEMICAL THERMODYNAMICS

Pre-requisites: **Nil**

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyse different laws of thermodynamics and properties of a thermodynamic system
CO2: Determine the behaviour of gases and analyze the concept of phase equilibria
CO3: Apply the concepts of solution thermodynamics and various reaction equilibria
CO4: Investigate the applications of thermodynamics to analyze and solve problems encountered in biological systems

Module 1: (14 hours)
Systems, Open system and closed system, State and path function, Zeroth law of thermodynamics, Reversible and irreversible processes, First and second law of thermodynamics, Internal Energy, Enthalpy, Flow processes, Third law of thermodynamics, Concept of Entropy, Behavior of ideal gases, Properties of gases showing non-ideal behaviour, Phase rule, Vapour-liquid equilibrium, Liquid-liquid equilibrium, Fugacity of pure gases, liquids and solids.

Module 2: (13 hours)
Solution thermodynamic, Homogeneous chemical reactions, Effect of pressure and temperature on equilibrium constant, Activity coefficient, Ionic equilibria, Dissociation equilibria of acids and bases, Henry's law, Properties of fluids, Gibbs free energy, Entropy and heat capacity relation, Chemical Potential, Gibbs-Helmholtz equation, Colligative properties.

Module 3: (12 hours)
Thermodynamics and energetics of metabolic pathways, Free energy of transfer of amino acids, Protein stability and protein dynamics, Membrane transport, Protein folding and pathological misfolding, Interaction free energy, Thermodynamics of oxidation-reduction reactions, Energetics of DNA-protein interactions.

References:

1. Peter Atkins and Julio De Paula, Physical Chemistry, 10th Edn, Oxford University Press, 2014.
2. B.R. Puri, L.R. Sharma and M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 2017.
3. D.T. Haynie, Biological Thermodynamics, 2nd Edn.,Cambridge University Press, 2008.
4. D.V.S. Jain and S.P. Jauhar, Physical Chemistry: Principles and Problems, 1st Edn., Tata McGraw-Hill Publishing Company Limited, 1989.

BT2004D UNIT OPERATIONS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe the basic equations in fluid mechanics, heat transfer and the concept of vapor liquid equilibrium
CO2: Solve problems in pressure, density, viscosity, surface tension, fluid flow, heat transfer and mass transfer
CO3: Apply the fundamental principles to design different types of equipments like pressure manometers, heat exchangers, evaporators, distillation units
CO4: Identify the relationships between physical quantities with the help of their dimensions and develop equations to solve complex problems. Illustrate the design of equipments used for mechanical operations and describe their functioning.

Module 1: (14 hours)
FLUID MECHANICS: Fluid definition; Basic equations and problems to understand the physical properties of liquids like specific weight, viscosity, surface tension, capillarity and the relationships between pressure-density-height. Measurement of pressure using different manometers (Problems). Units and dimensions, dimensional analysis, dimensionless numbers, Rayleigh's method, Buckingham's pi theorem. Types of Fluid flow - laminar and turbulent, Basic equations of fluid flow - Continuity equation in 2 dimensions 3 dimensions, Bernoulli's equation, flow through circular conduits – Hagen Poiseuille equation (derivation and problems). Working principle and instrumentation of Venturimeter and Orifice meter, Flow measurement problems.

Module 2: (13 hours)
HEAT TRANSFER: Modes of heat transfer. Conduction - Fourier's law of heat conduction, Steady-state conduction through walls, Heat flow through a cylinder and sphere. Convection - Concepts of heat transfer by convection, Counter-current and parallel flows, Overall heat transfer coefficient, Log-mean temperature difference. Heat transfer equipments - parallel and counter flow heat exchangers, Single pass and multi-pass heat exchangers, Design of various types of heat exchangers. Theory of evaporation, Single effect and multiple effect evaporation, Design calculation for single and multiple effect evaporation (Solving problems using steam tables).

Module 3: (12 hours)
MASS TRANSFER and MECHANICAL OPERATIONS: Distillation - Vapour liquid equilibrium data, methods of distillation - batch, continuous, flash distillation, differential distillation, steam distillation, continuous rectification; Continuous fractionation. Significance of size reduction, equipments used for size reduction and sieve analysis, sedimentation equipments, types of different mixers.

References:

1. W. L. McCabe, J. Smith, and P. Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw-Hill Education, New York, 2004.
2. R. K. Rajput, A Textbook of Fluid Mechanics, S. Chand & Company Limited, New Delhi, 2008.
3. J.M. Coulson and J.F. Richardson, Chemical Engineering, Vol. I & Vol. II, 4th Edn., Butterworth - Heinemann, 1991.
4. W. L. Badger and J. T. Banchero, Introduction to Chemical Engineering, 1st Edn., McGraw- Hill Education, NewYork, 1955
5. J.P. Holman, Heat Transfer, 8th Edn., McGraw Hill, 1997.

BT2005D PROCESS CALCULATIONS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Perform unit conversion involved in bioprocesses and to know the expression of the concentration of dilute solutions
CO2: Solve the material balance problems in unit operations
CO3: Analyze the stoichiometry of cell growth and product formation
CO4: Solve the energy balance problems in fermentation processes

Module1: (9 hours)
Introduction - conversion of units, dimensional consistency, number of significant figures, precision and accuracy, mole concept and mole fraction, weight fraction and volume fraction, concentration of liquid solutions, stoichiometric principles, graphical differentiation and graphical integration, treatment and interpretation of data.

Module 2: (10 hours)
General material balance equation for steady and unsteady state, simplifications for steady-state processes without chemical reaction, element balance, material balance in processes like crystallization, drying, evaporation, extraction, distillation, absorption, recycle, bypass and purge calculations.

Module 3: (10 hours)
Material balance problems with chemical reactions, stoichiometry of cell growth and product formation, elemental balances, electron balance, degrees of reduction of substrate and biomass, yield coefficients of biomass and product formation, maintenance coefficients, oxygen consumption and heat evolution in aerobic cultures, case studies on heat evolution during fermentation.

Module 4 (10 hours)
Energy balance - heat capacity, estimation of heat capacities, general energy balance, Enthalpy calculation procedures, Special cases *viz* spray dryer, distillation column, enthalpy change due to reaction: heat of combustion, heat of reaction for processes with biomass production, energy-balance equation for cell culture and fermentation processes.

References

1. K.V. Narayanan and B. Lakshmikuttyamma, *Stoichiometry & Process Calculations*, Prentice Hall Publishing, Delhi, 2006.
2. B.I. Bhatt and S. M. Vora, *Stoichiometry*, 4th Edn., Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2001.
3. M. L. Shuler and F. Kargi, *Bioprocess Engineering-Basic Concepts*, 2nd Edn., Prentice Hall, 2004.

BT2091D BIOCHEMISTRY LABORATORY

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcome

CO1: To learn fundamental approaches for experimentally investigating biochemical problems.
CO2: To develop analytical and critical-thinking skills that allow independent exploration of biological phenomena through the scientific method.
CO3: To introduce students to modern methods of biochemical experimentation within the disciplines of biochemistry.

Module

1. Units, volume/weight measurements, concentration units, pH measurements, preparation of buffers, sensitivity, specificity.
2. Qualitative tests for carbohydrates, amino acids and lipids.
3. Quantitative determination of Carbohydrates.
4. Quantitative determination proteins.
5. Separation of plasma proteins by SDS-PAGE electrophoresis.
6. Separation of DNA by agarose gel electrophoresis.
7. Paper chromatography of amino acids.

References:

1. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 4thEdn, WH Freeman and Company, 2005.
2. K. Wilson, J. Walker, and J. M. Walker, Practical Biochemistry, 4thEdn., Cambridge University Press, 1994.
3. S. Rao and V. Deshpande, Experimental Biochemistry, 1stEdn., I K International Publishing House, 2005.

BT2092D MICROBIOLOGY LABORATORY

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Understand standard Good Laboratory practices, Microbiological Lab practices, Importance of sterility and tools for enumeration of microbes, staining procedures interpret the tools involved in analysis and imagining of microbes.
CO2: Familiarize sterilization techniques and preparation of different types of culture. Various media preparation. Isolation techniques microbes through samples.
CO3: Identify and differentiate types of culturing and long-term storage and preservation of microbe. The course imparts microbial growth nature and its manipulation.
CO4: Enumerate microbes by CFU method, microscopy, nephelometry.

1. Sterilization techniques.
2. Preparation of culture media (I) broth type of media (II) agar.
3. Culturing of microorganisms.
4. Isolation of pure culture using streak plate and pour plate methods.
5. Isolation of microbes from soil/mouth flora/water samples.
6. Growth curve measurement of bacterial population by turbidometry/Colony Forming Unit methods.
7. Growth curve of yeast
8. Storage/preservation of micro-organisms
9. Identification of microorganisms – (I) staining techniques (II) hanging drop (III) biochemical testing (Indole test, methyl red test, Voges Proskaeur test, citrate utilization, starch hydrolysis, urease test, catalase test, oxidase test, coagulase test) (IV) antibiotic sensitivity.
10. Microbial count – (I) microscopy (II) nephelometry – turbidometry (III) dry weight.
11. Food microbiology: Isolation of microbes from (I) milk (II) fermented food.
12. Isolation of bacteriophages from contaminated water.
13. Microbial production of metabolites.

References:

1. Benson, Microbiological Applications Laboratory Manual in General Microbiology, 8th Edn., McGraw−Hil, 2001.
2. Emanuel Goldman Lorrence H. Green ,Practical Handbook of Microbiology, 2nd Edn., CRC Press 2009.
3. G. I. Barrow, R. K. A. Feltham, Cowan and Steel's Manual for the Identification of Medical Bacteria, 3rd Edn.,Cambridge University Press, 2004.
4. M.J. Pelczar, E.C.S. Chan, and N.R. Krieg, Microbiology, 5th Edn., McGraw-Hill, 2007.
5. John Harley and Lansing, Prescott,Laboratory Exercises in Microbiology 9th Edn., McGraw-Hill,2013.

John Harley and Lansing Prescott,Laboratory Exercises in Microbiology 9th Edn., McGraw-Hill,2013

Semester IV

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	MA2002D	Mathematics IV	3	1	0	3	MA
2.	BT2006D	Biostatistics	3	0	0	3	PC
3.	BT2007D	Cell Biology	3	0	0	3	PC
4.	BT2008D	Molecular Biology	3	0	0	3	PC
5.	BT2009D	Bioenergetics & Metabolism	3	0	0	3	PC
6.	BT2010D	Bioprocess Principles	3	0	0	3	PC
7.	BT2093D	Molecular Biology Laboratory	0	0	3	2	PC
8.	BT2094D	Bioprocess Laboratory	0	0	3	2	PC
	Total Credits					22	

MA2002D: MATHEMATICS IV

Pre-requisites: MA 1001 Mathematics I, MA 1002 Mathematics II

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will
CO1: be able to find solutions of linear differential equations using power series method and Frobenius series method.
CO2: be able to formulate various engineering problems as partial differential equations and hence solve them.
CO3: be able to identify analytic functions and find harmonic conjugates.
CO4: be able to find images of regions under complex transformations.
CO5: be able to evaluate line integrals in the complex plane
CO6: be able to use techniques of complex analysis to evaluate integrals of real valued functions.

Module 1: Series Solutions and Special Functions (11 Hours)
Power series solutions of differential equations, Theory of power series method, Legendre Equation, Legendre Polynomials, Frobenius Method, Bessel's Equation, Bessel functions, Bessel functions of the second kind, Sturm- Liouville's Problems, Orthogonal eigenfunction expansions.

Module 2: Partial differential Equations (10 Hours)
Basic Concepts, Cauchy's problem for first order equations, Linear Equations of the first order, Nonlinear Partial Differential Equations of the first order, Charpit's Method, Special Types of first order equations, Classification of second order partial differential equations, Modeling: Vibrating String, Wave equation, Separation of variables, Use of Fourier Series, D'Alembert's Solution of the wave equation, Heat equation: Solution by Fourier series, Heat equation: solution by Fourier Integrals and transforms, Laplace equation, Solution of a Partial Differential Equations by Laplace transforms.

Module 3: Complex Numbers and Functions (9 Hours)
Complex functions, Derivative , Analytic function, Cauchy- Reimann equations, Laplace's equation, Geometry of Analytic functions: Conformal mapping, Linear fractional Transformations, Schwarz - Christoffel transformation, Transformation by other functions.

Module 4: Complex Integration (9 Hours)
Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula, Derivatives of analytic functions.Power series, Functions given by power series, Taylor series and Maclaurin's series. Laurent's series, Singularities and Zeros, Residue integration method, Evaluation of real Integrals.

References:

1. Kreyszig E, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, New York, 1999.
2. I.N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.
3. 3 . Wylie C. R. & Barret L. C., Advanced Engineering Mathematics, 6th Edition, Mc Graw Hill, NewYork,1995.
4. Donald W. Trim, Applied Partial Differential Equations, PWS – KENT publishing company, 1994.

BT2006D BIOSTATISTICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Summarize the importance of proper sampling techniques and presentation of data in various forms.
CO2: Analyse various aspects of dispersion, probability and conditional probability among samples.
CO3: Summarize the statistical significance in experimental design, sample survey and testing hypotheses.
CO4: Comprehend the application of biostatistics for understanding the biological data.

Module 1: (15 hours)
Introduction to Biostatistics, Collection and presentation of data, Plotting graphs, Bias in sampling and selection, Probability sampling, Random sampling, Measure of central tendency-arithmetic and geometric mean, Variance, Median, Measure of dispersion-range, Mean deviation, Standard deviation, Coefficient of variation,Correlation and regression analysis, Curve fitting-linear, non-linear and exponential; Probability, Conditional probability, Genetic applications of probability, Hardy-Weinberg law.

Module 2: (15 hours)
Discrete probability distributions-Binomial, Poisson, Forensic probability determination, Experimental designs, Sample surveys, Single and double blind experiments, Limitations of experiments, Blocking and extraneous variables, Statistical inference, Estimation theory and testing of hypothesis, Sample size determination, Point estimation, Interval estimation, Simultaneous confidence intervals.

Module 3: (9 hours)
Microbial growth in a chemostat, Growth equations of microbial populations, Basic models for inheritance, mutation and selection models, Genetic inbreeding models, Models of commensalisms, Mutualism and predation.

References:

1. B. Rosner, Fundamentals of Biostatistics, 6th Edn., Duxbury Press, 2005.
2. R. N. Forthofer, E. S. Lee, and M. Hernandaz, Biostatistics: A Guide to Design, Analysis and Discovery, 2nd Edn., Academic Press, 2006.
3. M. Pagano and K. Gauvreau, Principles of Statistics, 2nd Edn., Duxbury Press, 2000.
4. R. C. Elston and W. Johnson, Basic Biostatistics for Geneticists and Epidemiologists: A Practical Approach, 1st Edn., Wiley, 2008.

BT2007D CELL BIOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe the characteristics of a cell, the structural composition of the plasma membrane and the significance of the membrane asymmetry; and the structure of the various intracellular organelles and compartments and the organization of the cytoskeleton

CO2: Illustrate the functioning of the transport proteins and the different modes of cell signaling and second messengers

CO3: Explain the functioning of ribosomes, the transport of molecules into and out of the cell (endocytosis and exocytosis) and the structure of cytoskeletal proteins and their significance and comprehend the events during cell division

CO4: Demonstrate the functioning of various cell organelles, cell cycle regulatory proteins and the second messengers involved in signal transduction and appreciate their significance as drug targets

Module 1: (13 hours)

Definition of cell, cell theory, characteristics of a living cell. structural organization of the Eukaryotic cell. Evolution of modern eukaryotic cells, Different types of cells in the vertebrate body, integrating cells into tissues, Membrane structure and organization, Compositions of cell membranes, significance of the membrane asymmetry, Electrical properties of membranes, and molecular mechanism of transport across the membrane by the transport proteins like channels, pumps and transporters. Compartmentalization in Eukaryotic cells, structural organization of mammalian nuclear envelope and chromosomes.

Module 2: (13 hours)

Structure and functions of Mitochondria and Peroxisomes. The process of endocytosis and exocytosis, synthesis of lipid bilayer by smooth endoplasmic reticulum and the synthesis of secretory proteins by rough endoplasmic reticulum. Golgi apparatus and protein sorting. The architecture and the dynamics of the cytoskeleton, actin based motor proteins and microtubule dependent motor proteins.

Module 3: (13 hours)

Mammalian cell cycle, characteristic features of the different stages of mitosis in an animal cell, regulation of mammalian cell cycle by the various cyclins, cyclin dependent kinases (cdks) and check point proteins. Autocrine, Paracrine and Endocrine models of cell signaling, second messengers and their role in signal transduction. Signaling through the G-protein coupled receptors, intracellular signaling mediated by inositol phospholipid, calcium and CaM-kinases, role of *cAMP* signaling pathway in normal physiology and its significance in drug development, *cAMP*-activated Protein Kinases and their role in glycogen metabolism.

References:

1. B. Alberts, A. Johnson, J. Lewis, and M. Raff, Molecular Biology of the Cell, 5th Edn., Garland Science, 2008.
2. H. Lodish, A.Berk, C.A. Kaiser, and M. Krieger, Molecular Cell Biology, 6th Edn., W. H. Freeman, 2007.
3. G. Karp, Cell and Molecular Biology, 5th Edn., Wiley, 2007
4. G. M. Cooper and R.E. Hausman, The Cell: A Molecular Approach, 4th Edn., Sinauer Associates Inc., 2006.

BT2008D MOLECULAR BIOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
Students will be able to:

CO1: Outline the concepts of DNA as genetic material, genes and its associated phenotypes
CO2: Summarize about the protein sub-units, enzymes and processes involved in central dogma: DNA replication, RNA synthesis, RNA editing, protein synthesis
CO3: Illustrate the idea about gene arrangements, Operon concept and its regulation
CO4: Describe the concepts of genetic variation by gene rearrangements of site-specific, transposon and homologous recombination.

Module 1: (13 hours)
Mendel's laws of heredity, Law of segregation and independent assortment, Chromosomal theory of heredity, the double helix, Gene, Genetic code, Gene linkage and gene mapping, Griffith's experiment, DNA as a genetic material, Epigenetics, Gene interactions, Lethality, Central dogma of molecular biology, Replication of DNA in prokaryotes and eukaryotes, DNA polymerases and other proteins in replication, Models of replication.

Module 2: (13 hours)
Transcription in prokaryotes and eukaryotes, Bacterial RNA polymerase, RNA polymerase I, II and III in eukaryotes, Transcription factors, Post transcriptional processing of RNAs. Translation in prokaryotes and eukaryotes, Translation machinery, Mechanism of translation, Post translational modifications, Regulation of gene expression in prokaryotes, Concept of operon model, *lac, gal* and *trp* operons, Gene regulation in lamda phage.

Module 3: (13 hours)
Regulation of gene expression in eukaryotes, DNA damage and repair mechanism, Chromatin assembly and remodeling, Gene silencing, Genetic recombination, Site-specific recombination in bacteria and viruses, Transposon and transposition, Retroviruses and oncogenes, Homologous recombination in eukaryotes.

References:

1. J. D. Watson, T.A. Baker, S.P. Bell and A. Gann, Molecular Biology of the Gene, 6th Edn., Benjamin Cummings, 2007.
2. B. Lewin, Genes IX, 9th Edn.,Jones & Bartlett Publishers, 2007.
3. D. Freifelder, Molecular Biology, 2nd Edn.,Narosa Publishing House, 2008.
4. R. Weaver, Molecular Biology, 4th Edn., McGraw-Hill, 2007.

BT2009D BIOENERGETICS AND METABOLISM

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain the concept of free energy and high energy phosphate compounds; their synthesis and utilization in metabolic pathways
CO2: Assess the importance of oxidation reduction reactions in biological systems. It also aims to implement knowledge about the design of this pathway affecting the biological system.
CO3: Analyze and infer role and mechanisms of action of Coenzymes and Cofactors in metabolic pathways.
CO4: Compile different aspects of metabolic pathways like carbohydrate, amino acids, lipids and nucleic acids, photosynthesis and biochemistry of biological nitrogen fixation.

Module 1 (13 hours)
Molecular basis of entropy, Concept of free energy and significance in metabolism, Biological oxidation-reduction reactions, redox potentials, High energy phosphate compounds, free energy of hydrolysis of ATP and sugar phosphates. Coenzymes and Cofactors: Role and mechanism of action of NAD^+/$NADP^+$, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, and metal ions with specific examples.

Module 2 (14 hours)
Metabolism; Basic concept and design, Glycolysis and Gluconeogenesis, Citric acid cycle, Hexose monophosphate shunt, Mitochondrial electron transport chain, Oxidative phosphorylation process, ATP generation in bacterial system. Urea cycle, Metabolism of amino acids, lipids and nucleic acids.

Module 3 (12 hours)
Photosynthesis: Structure and function of chloroplasts, Absorption of solar energy, Photosystems (I and II), Light and dark reactions, C3 and C4 plants, Calvin cycle. Biochemistry of biological nitrogen fixation.

References:

1. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 7th Edn, WH Freeman and Company, 2017.
2. J.M. Berg, J.L. Tymoczko, and L. Stryer, Biochemistry, 7th Edn., WH Freeman and Company, 2011.
3. J.E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, McGraw-Hill Higher Education, 2nd Edn., 1986.
4. D. Voet and J.G. Voet, Biochemistry, 4th Edn., John Wiley & Sons Inc., 2010.
5. G.L. Zubey, Biochemistry, 4th Edn, Wm. C. Brown Publications, 1998.

BT2010D BIOPROCESS PRINCIPLES

Pre-requisites: Biochemistry, Microbiology

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Design a fermentation process in a bioreactor
CO2: Analyze the cell growth and product formation in different cultivation systems
CO3: Design batch and continuous sterilization
CO4: Perform scale up of bioprocesses

Module 1: (10 hours)
Introduction to fermentation process, Overview of fermentation industry, Requirements of a fermentation process, Types of fermentation media, Design and optimization of media by response surface methodology, Configuration of bioreactor and ancillaries, Control of pH, temperature, dissolved oxygen and other environmental parameters, containment in bioprocesses.

Module 2: (10 hours)
Kinetics of cell growth, Unstructured kinetic models for microbial growth, Monod model, Product formation kinetics, Different modes of cultivation systems, Batch, Continuous and fed batch, Oxygen requirements of microbial growth, mass transfer and determination of K_la, Factors affecting K_la.

Module 3: (9 hours)
Sterilization, Thermal death kinetics of microorganisms, Batch and continuous heat, Sterilization of liquid media, Filter sterilization of liquid media, Air sterilization, Design of sterilization equipment, Effluent treatment in bioprocesses, types of treatment methods, containment and effluent disposal.

Module 4: (10 hours)
Scale up in bioreactors, Scale up criteria for bioreactors based on impeller tip speed, power consumption, oxygen transfer and other parameters, bioreactor system for immobilized enzymes, effectiveness factors, design of immobilized enzyme reactors, Introduction to structured and non-structured models, Compartment model.

References:

1. J. E. Bailey and D.F. Ollis, *Biochemical Engineering Fundamentals*, 2nd Edn., McGraw Hill Publishers, 1986.
2. M. L. Shuler and F. Kargi, *Bioprocess Engineering-Basic Concepts*, 2nd Edn., Prentice Hall, 2004.
3. P. M. Doran, Bioprocess Engineering Principles, 2nd Edition, Academic Press, 2005.
4. P. F. Stanbury, S. J. Hall and A. Whitaker, Principles of Fermentation Technology, 2nd Edn., Elsevier, Science & Technology Books, , 2005.

BT2093D MOLECULAR BIOLOGY LABORATORY

Pre-requisites: **Nil**

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Prepare DNA and RNA from any source
CO2: Evaluate, design and analyse DNA, RNA preparation
CO3: Design experiments and analyse data for transformation and restriction mapping.
CO4: Create a recombinant DNA and evaluate its structure and function.

1. Isolation of plasmid from *Escherichia coli (E.coli)*.
2. Isolation of plasmid from yeast *Saccharomyces cerevisiae*
3. Transformation of *E.coli*.
4. Selection of recombinants (blue-white screening).
5. Transformation of yeast.
6. Restriction mapping of *E.coli*/ Yeast vectors
7. Isolation of genomic DNA from *E.coli.*
8. Isolation of genomic DNA from yeast/ plants
9. Isolation of RNA from *E.coli*/ Yeast
10. Cloning a DNA fragment in *E.coli* / Yeast vector
11. Restriction mapping of a DNA fragment cloned in a vector.
12. Amplification of a cloned DNA fragment by Polymerase Chain Reaction.
13. PCR out of a gene/ DNA fragment from genomic DNA of yeast/ *E.coli*/plant.
14. Site directed mutagenesis of a cloned gene.
15. Southern hybridization.
16. Separation of chromosomes using Contour clamped homogenous electric field.

References:

1. J. Sambrook and D. W. Russell, Molecular Cloning: A Laboratory Manual, 3 volume set, 3rd Edn., Cold Spring Harbor Laboratory Press, 2001.
2. D. C. Amberg, D. J. Burke, and J. N. Strathern, Methods in Yeast Genetics, Cold Spring Harbor Laboratory Press, 2005.
3. J. D. Watson, T. A. Baker, S. P. Bell, and A. Gann, Molecular Biology of the Gene, 6th Edn., Benjamin Cummings, 2007.
4. C. Guthrie and G. R. Fink, Methods in Enzymology: Guide to Yeast Genetics and Molecular Cell Biology, Volume 350 (Part B), 1st Edn., Academic Press, 2002.
5. I. H. Segel, Biochemical Calculations, 2nd Edn., Wiley, 1976.

BT2094D BIOPROCESS LABORATORY

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:
CO1: Perform the kinetics of fermentation processes
CO2: Design and optimization of medium components for biomass production
CO3: Analyze the oxygen transfer rate in fermentation processes
CO4: Execution of small scale and pilot scale study for fermentation of biological products

1. Construction of growth curve of bacteria – estimation of biomass, calculation of specific growth rate, yield coefficient, utilization and product formation kinetics in shake flask culture.
2. Control of pH and temperature in a bioprocess.
3. Control of flow rates and pressure in a bioprocess.
4. Enzyme kinetics – Determination of Michaelis Menton parameters.
5. Enzyme immobilization and whole cell immobilization.
6. Kinetics of immobilized enzyme reactions.
7. Determination of volumetric oxygen transfer co-efficient (K_la) in a fermentor by static gassing out and sulphite oxidation methods.
8. Determination of Residence Time Distribution (RTD) of CSTR.
9. Determination of mixing time in stirred tank reactor with Newtonian and Non-Newtonian fluids.
10. Determination of thermal death kinetics.
11. Fermentation process of some biomolecules.
12. Measurement of ethanol production in a fermentor.

References
1. J. E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, 2nd Edn., McGraw Hill Publishers, 1986.
2. M. L. Shuler, F. Kargi, Bioprocess Engineering-Basic Concepts, 2nd Edn., Prentice Hall, 2004.

Semester V

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	ME3104D	Principles of Management	3	0	0	3	HL
2.	BT3001D	Genetic Engineering	3	0	0	3	PC
3.	BT3002D	Bioinformatics	3	0	0	3	PC
4.	BT3003D	Downstream Processing	3	0	0	3	PC
5.	BT3*** D	Elective-I	3	0	0	3	DE
6.	BT3004D	Environmental Studies*	3	0	0	3	OT
7.	BT3091D	Bioinformatics Laboratory	0	0	3	2	PC
8.	BT3092D	Downstream Process Laboratory	0	0	3	2	PC
	Total Credits					22	

ME3104D PRINCIPLES OF MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: To explain the characteristics and functions of management in the contemporary context
CO2: To demonstrate ability in decision making process and develop a project schedule
CO3: To summarize the functional areas of management
CO4: To comprehend the concept of entrepreneurship and create business plans

Module 1: (14 hours)

Introduction to management functions, Characteristics of management, Systems approach to management, Task and responsibilities of a professional manager, Levels of managers and skill required. Management process – planning – mission – objectives – goals – strategy – policies – programmes – procedures. Organizing – principles of organizing – organization structures, Directing – delegation – span of control – leadership – motivation, Controlling, Sustainability issues.

Module 2: (10 hours)

Decision making process – decision making under certainty, risk and uncertainty, Project management – critical path method – crashing - programme evaluation and review technique.

Module 3: (15 hours)

Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management – principles of double entry book keeping, financial statements, Sources of finance.
Entrepreneurial processes – analysis of new ventures/startups, creating new products/services and business plans, Intellectual property issues.

References

1. Koontz, H., and Weihrich, H., *Essentials of Management: An International Perspective*, 8th ed.,
2. McGraw Hill, 2009.
3. Griffin, R.W., *Management: Principles and Applications,* Cengage Learning, 2008.
4. Kotler, P., Keller K.L., Koshy, A., and Jha, M., *Marketing Management*, 13th ed., 2009.
5. Khan, M.Y., and Jain, P.K., *Financial Management*, Tata-McGraw Hill, 2008.
6. Hisrich R.D., and Peters M.P., Entrepreneurship: Strategy, Developing, and Managing a New Enterprise, Irwin, Chicago, 1995.
7. Roberts E.B., Entrepreneurs in High Tech- Lessons from MIT and beyond, Oxford University Press, New York, 1991

BT3001D GENETIC ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Learn about plasmid construction and restriction enzymes.
CO2: Evaluate and analyse cloning of DNA fragments and its modifications.
CO3: Design and perform DNA analysis and modification, construction of DNA libraries.
CO4: Generate synthetic DNA molecules, construct and evaluate synthetic organism.

Module 1: (13 hours)
asic concepts of recombinant DNA technology, Isolation, identification and characterization of DNA fragments; Plasmids, Phagemids, Cosmids, Restriction Enzymes, Type I, II and III, Nomenclature and sequence recognition, Restriction mapping, Construction of *E. coli* vectors, Ligation of DNA fragments, Blunt end and cohesive end ligation, T4 DNA ligase, Use of Klenow fragment, T4 DNA polymerase, Alkaline phosphatase, Polynucleotide kinase, Screening of recombinant DNA fragments.

Module 2: (13 hours)
Cloning in M13 vectors, Yeast vectors, Mammalian vector, Expression vectors. Hybridization techniques-Southern hybridization, northern hybridization; Labeling of probes, Nick translation, Construction of genomic DNA and cDNA libraries, Linkers, Adapters, DNA sequencing methods, Sanger Dideoxy sequencing method, Maxam-Gilbert sequencing method.

Module 3: (13 hours)
Polymerase chain reaction, Primer design, Variants of polymerase chain reaction, DNA fingerprinting, DNA footprinting, Site-directed mutagenesis, Restriction fragment length polymorphism, Application of genetic engineering in agriculture, medicine, Cloning of Dolly the sheep, Creation of synthetic bacteria.

References:

1. S. B. Primrose and R. Twyman, Principles of Gene Manipulation and Genomics, 7th Edn.,Wiley-Blackwell, 2006.
2. D. S. T. Nicholl, An Introduction to Genetic Engineering, 3rd Edn.,Cambridge University Press, 2008.
3. J. D. Watson, T. A. Baker, S. P. Bell, and A. Gann, Molecular Biology of the Gene, 6th Edn.,Benjamin Cummings, 2007.
4. J. Dale and M. von Schantz, From Genes to Genomes: Concepts and Applications of DNA Technology, 2nd Edn.,Wiley-Interscience, 2007.

BT3002D BIOINFORMATICS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Discover the online available databases for nucleic acids and proteins
CO2: Summarize about the basic algorithms for sequence analysis of proteins and nucleic acids.
CO3: Develop an idea about the predictive methods for structure and/ function, and phylogenetic relatedness of any given nucleic acid and protein sequences based.
CO4: Students will be able to value the importance of 3D structures of proteins and small molecules functional prediction and their homology

Module 1: (13 hours)
Introduction to Bioinformatics, Nucleotide and Protein sequence databases, Genbank, NCBI, DDBJ, Pubmed, UniProt, PROSITE, SCOP; Protein structural data bases – RCSB-PDB, EMBL-EBI,Nucleotide and Protein Sequence analysis,Substitution matrices, PAM, BLOSUM, Gap penalties, Sequence homology searching using FASTA and BLAST, Dynamic programming algorithms for sequence alignment.

Module 2: (13 hours)
Multiple alignments, Common multiple alignment methods, Practical aspects of multiple alignments for identification of motifs and patterns, CLUSTALW, PROSITE, Hidden Markov model, Phylogenetic analysis, Elements of phylogenetic models, Determining the substitution model tree, Evaluating phylogenetic trees.

Module 3: (13 hours)
Predictive methods, Codon bias detection, Detection of functional sites in the DNA sequences, Plasmid construction, Restriction mapping of DNA, Primer design, Modular nature of proteins - Protein identity based on primary, secondary and tertiary structure of proteins, Sequencing of DNA-Human Genome Project, Detection of SNPs and their relevance, Gene predictions, protein homology modeling, Bioinformatics approaches for Molecular modeling in drug discovery.

References:

1. Arthur K. Lesk , Introduction to Bioinformatics, 3rdEdn., Oxford University Press, 2008.
2. J. Pevsner, Bioinformatics and Functional Genomics, 2ndEdn.,Wiley-Blackwell, 2009.
3. R. Drubin, S.R. Eddy, A. Krogh, and G. Mitchison, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 1stEdn, Cambridge University Press, 1999.
4. W.H. Majoros, Methods for Computational Gene Prediction, 1st Edn.,Cambridge University Press, 2007.

BT3003D DOWNSTREAM PROCESSING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Recognize the basis for various steps in downstream processing and their economics, to design a strategy for the purification of a product.
CO2: Apply the basic laws governing filtration, centrifugation, flocculation, sedimentation, cell disruption, extraction, leaching, and adsorption, to solve practical problems in industry and research.
CO3: Assess techniques such as precipitation, membrane separation and chromatographic technique for the purification of a targeted protein(s) or any other biological material.
CO4: Propose a technique to give final polishing to the isolated product.

Module 1: (13 hours)
Introduction to the various downstream processing steps and their significance in biotechnology, Economics of downstream processing, cost-cutting strategies, process design criteria for various classes of bioproducts (high volume, low value products and low volume, high value products) with suitable problems. Physico-chemical basis of different bioseparation processes.

Module 2: (13 hours)
Working principle and design of various industrial filters and centrifuges, Flocculation and sedimentation, problems based on the laws governing filtration and centrifugation. Cell disruption by chemical, mechanical and enzymatic methods. Basic equations of extraction, batch extraction, staged extraction and differential extraction, leaching, adsorption and problems related to extraction, leaching and adsorption.

Module 3: (13 hours)
Precipitation methods for proteins and other biological materials (with salts, organic solvents and polymers), theory, design and configuration of membrane separation equipment and applications, general chromatography theory and the different chromatographic techniques like adsorption, partition, ion exchange, affinity, gel filtration, HPLC and others used for the downstream processing of biological materials. Crystallization and drying.

References:

1. P. A. Belter, E. L. Cussler, and W.S. Hu, Bioseparation: Downstream Processing for Biotechnology, 1st Edn., Wiley-Interscience, 1988.
2. N. K. Prasad, Downstream Process Technology - A New Horizon in Biotechnolo", Prentice Hall of India, New Delhi, 2012
3. M. R. Ladisch, Bioseparations Engineering: Principles, Practice and Economics, 1st Edn., Wiley-Interscience, 2001.
4. J. D. Seader and E.J. Henley, Separation Process Principles, 2nd Edn., Wiley, 2005.

BT3004D ENVIRONMENTAL STUDIES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Comprehend the natural resource availability, importance and their geographical distribution.
CO2: Concise the interdependence of the population in a given environment into ecosystems.
CO3: Be aware about the importance of various aspects of biodiversity and conservation of environment, ecosystems and biodiversity.
CO4: Summarize the preventive measures of various pollution, policy making and legislation for addressing the environmental and social issues.

Module 1: (16 hours)
Multidisciplinary nature of environmental studies - definition, scope and importance, need for public awareness. Natural resources and associated problems. Forest resources, multipurpose tree species, Nitrogen fixing tree species, Water resources, Mineral resources, Food resources, Energy resources, Land resources, Conservation of natural resources, Concept, structure and function of an ecosystem. Food chains, food webs and ecological pyramids. Biodiversity and its conservation. hot-spots of biodiversity, threats to biodiversity, conservation of biodiversity.

Module 2: (10 hours)
Environmental pollution – definition, cause, effects and control measures of - air pollution, water pollution, soil pollution, marine pollution, noise pollution, light pollution, thermal pollution, electronic waste, nuclear hazards. Bio-Indicators. Role of an individual in prevention of pollution, disaster management.

Module 3: (13 hours)
Social issues and the environment. Environmental ethics - issues and possible solutions. Issues involved in enforcement of environmental legislation, public awareness. Human population and the environment. Family Welfare Programme, environment and human health, human rights, value education, HIV/AIDS, women and child welfare, role of information technology in environment and human health.

References:

1. K.C. Agarwal, Environmental Biology, Nidi Publ. Ltd. Bikaner, 2001.
2. Jadhav, H & Bhosale, V.M. Environmental Protection and Laws. Himalaya Pub. House, Delhi, 1995.
3. Raina, M., I. Pepper and Gerba C. Environmental Microbiology, Academic Press, New York, 2006.
4. E.P. Odum, Fundamentals of Ecology. W.B. Saunders Co. USA, 1971.
5. Wanger K.D., Environmental Management. W.B. Saunders Co. Philadelphia, USA, 1998.

BT3091D BIOINFORMATICS LABORATORY

Prerequisite: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Identify the available online databases for nucleic acids and proteins sequences.
CO2: Summarize about the basic algorithms for sequence analysis of proteins and nucleic acids
CO3: Gain knowledge of the predictive methods for structure and/ function, and phylogenetic relatedness.
CO4: Describe about Restriction mapping of DNA sequences, Primer design and Comparison of Genomes.
CO5: Explain about protein secondary structure and 3D structures.

1. Basics of sequence analysis, Retrieving a sequence-nucleic acid/Protein
2. Use of FASTA searching-effect of different substitution matrices.
3. Pairwise comparison of sequences using BLAST
4. Alignment of multiple sequences
5. Phylogenetic analysis-Parameters affecting evolutionary trees.
6. Secondary structure prediction of proteins.
7. Superimposition of structures
8. Identification of functional sites in Genes and Genomes
9. Restriction mapping of DNA sequences
10. Protein-ligand interactions
11. Comparison of two genomes
12. Primer design.

References:

1. J. Pevsner, Bioinformatics and Functional Genomics, 2nd Edn.,Wiley-Blackwell, 2009.
2. R. Drubin, S.R. Eddy, A. Krogh, and G. Mitchison, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 1st Edn, Cambridge University Press, 1999.
3. W.H. Majoros, Methods for Computational Gene Prediction, 1st Edn. Cambridge University Press, 2007.
4. D.W.Mount, Bioinformatics: Sequence and Genome analysis, 2nd Edn., Cold Spring Harbor Laboratory Press, 2004.
5. A.D. Baxevanis and B.F.F. Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edn.,Wiley-Interscience, 2004

BT3092D DOWNSTREAM PROCESS LABORATORY

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Apply the principles of cell disruption, filtration, concentration, extraction and drying using different techniques and analyze the efficiency of the method.

CO2: Plan and evaluate the downstream processing steps for the expression and purification of a recombinant protein in a systematic manner using various techniques.

CO3: Design experimental setup to isolate proteins/enzymes and other small molecules of commercial significance using various precipitation and chromatographic techniques.

1. Solid-liquid separation by filtration.
2. Estimation of Protein Concentration.
3. Separation of proteins and estimation of molecular weight by Sodium dodecyl sulfate-polyacrylamide gel electrophoresis.
4. Bacterial cell disruption using different methods.
5. Aqueous two phase extraction of biological products.
6. Separation of Carbohydrates/amino acids by TLC.
7. Downstream processing of a recombinant protein over expressed in bacterial system.
8. Separation of a recombinant protein in bacterial cell lysate using Ammonium sulphate precipitation
9. High resolution purification by the recombinant protein by affinity chromatography.
10. Downstream processing of lysozyme from egg white using ion exchange chromatography.
11. Gel filtration chromatography to remove the salts and other ions present in the final product.
12. Downstream processing of citric acid produced using *Aspergillus spp.*
13. Experiments involving crystallization of the downstream processed material
14. Product polishing by Lyophilisation and drying

References

1. P. A. Belter, E. L. Cussler, and W.S. Hu, Bioseparation: Downstream Processing for Biotechnology, 1st Edn., Wiley-Interscience, 1988.
2. R. K. Scopes, Protein Purification: Principles and Practice, 3rd Edn., Springer, 1993.
3. J. N. Abelson, M. I. Simon, and M. P. Deutscher, Methods in Enzymology: Guide to Protein Purification, Volume 182, Academic Press, 1990.

Semester VI

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	MS3001D	Engineering Economics	3	0	0	3	HL
2.	BT3007D	Immunology	3	0	0	3	PC
3.	BT3005D	Enzyme kinetics & technology	3	0	0	3	PC
4.	BT3006D	Instrumental Methods of Analysis	3	0	0	3	PC
5.	BT3*** D	Elective-II	3	0	0	3	PC
6.	BT3*** D	Elective-III	3	0	0	3	PC
7.	BT3093D	Immunology Laboratory	2	0	3	2	PC
8.	BT3094D	Mini Project	0	0	3	2	PC
	Total Credits					22	

MS3001D ENGINEERING ECONOMICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total Hours: 39

Course Outcomes:

CO1: To evaluate the economics of the management, operation, and growth and profitability of engineering firms and analyze operations of markets under varying competitive conditions
CO2: The course equips a student to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives
CO3: To analyze cost/revenue data and carry out make economic analyses in the decision making process to justify or reject alternatives/projects on an economic basis.
CO4: Produce a constructive assessment of a social problem by drawing the importance of environmental responsibility and demonstrate knowledge of global factors influencing business and ethical issues.
CO5: Helps to use models to describe economic phenomena; analyze and make predictions about the impact of government intervention and changing market conditions on consumer and producer behavior and well-being.

Module 1: (9 hours)
General Foundations of Economics; Forms of organizations-Objectives of firms-Opportunity principle-Discounting, Marginalism versus Incrementalism-Production Possibility frontier-Central problems of an economy- Two sector, Three sector and Four sector circular flow of income. Demand analysis-Individual, Market and Firm demand, Determinants of demand and supply, Shifts and changes in demand and supply, Market equilibrium, Shortages versus surpluses, Price ceiling ,Price floor-Elasticity of demand and business decision making.

Module 2: (17 hours)
Production functions in the short and long run-Cost concepts- Short run and long run costs- economies and diseconomies of scale-economies and diseconomies of scope-Break even analysis-Vertical & horizontal integration-Product markets- Market structure-Competitive market-Imperfect competition (Monopoly, Monopolistic competition and Oligopoly) and barriers to entry; Pricing in different markets; Price discrimination-Dead weight loss-consumer's surplus ; Game Theory-Prisoner's Dilemma-Maximin, Minimax, Saddle point, Nash Equilibrium.

Module 3: (13 hours)
Macroeconomic Aggregates-Gross Domestic Product; Gross national product, net domestic product, Transfer payments, Depreciation, Economic Indicators; Models of measuring national income; Fiscal deficit, primary deficit, Inflation and deflation ; Fiscal and Monetary Policies ; Monetary system; Indian stock market; Development Banks; NBFIs, role of Reserve Bank of India, Money Market, Capital market; NIFTY, SENSEX, Financial ratios.

References:

1. R. S. Pindyck, D. L. Rubinfield and P. L. Mehta, *Microeconomics*, Pearson Education, 9th Edition, 2018.
2. P. A. Samuelson and W. D. Nordhaus, *Economics*, Tata McGraw Hill, 19th ed., 2015.
3. N. G. Mankiw, *Principles of Microeconomics*, Cengage Publications, 7th ed., 2014.
4. S. B. Gupta, *Monetary Economics: Institutions, Theory & Policy*, New Delhi: S. Chand & Company Ltd., 2013.
5. K. E. Case, R. C. Fair and S. Oster, *Principles of Economics*, Prentice Hall, 10th ed., 2011.

Note: Supplementary materials would be suggested / supplied for select topics on financial markets and Indian economy.

BT3007D IMMUNOLOGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1:Identify the types of immune cells and functional cooperation between the innate and adaptive immunity, role of complement and their biological functions
CO2:Summarize the cellular and molecular pathways in humoral (B cell) and cell (Tcell) mediated immunity
CO3:Explain the role of MHC molecules
CO4:Apply the knowledge in basic and state-of-the-art experimental methods and technologies (ELISA, RIA etc.,)

Module 1 (13 hours)
Introduction to immunity and immune system, Type of cells of immune system, Primary and secondary lymphoid organs, Types of immune responses; Innate, humoral and acquired immunity, Complement system and their biological functions, Antigens and their properties, B lymphocytes and their maturation, Antibodies-their structures and functions.

Module 2 (13 hours)
Hybridoma technology, Cell-mediated immunity, T lymphocytes-their maturation and functions, Antigen presenting cells, Mechanism of phagocytosis, Antigen processing and presentation, Major histocompatibility complex-types and their functions, T cell activation, Mixed lymphocyte reactions, Hypersensitivity reactions.

Module 3 (13 hours)
Autoimmune disorders, Primary and secondary immunodeficiency disorders, Immunological mechanisms in AIDS, cancer and allergies; Transplantation and graft rejection, Basic concepts of vaccine design and development, Antigen antibody interactions, Blood typing, Immunological techniques-double diffusion, ELISA and Radioimmunoassay.

References:

1. D. Male, J. Brostoff, D. Roth, and I. Roitt, Immunology, 7thEdn., Mosby, 2006.
2. T. J. Kindt, B.A. Osborne, and R.A. Goldsby, Kuby Immunology, 6thEdn.,W.H.Freeman, 2006.
A. K. Abbas and A.H.Lichtman, Basic Immunology, 3rdEdn.,Saunders, 2008.
3. S. K. Mohanty, Text Book of Immunology, Jaypee Brothers Medical Publishers, 2008.
4. R. Coico and G. Sunshine, Immunology: A Short Course, 6thEdn.,Wiley-Blackwell, 2009.

BT3005D ENZYME KINETICS AND TECHNOLOGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Students will explain principles of enzyme catalyzed reactions; factors that affect catalytic rates of enzymes, students will identify enzyme classes.
CO2: The student will be able to describe the mechanisms and kinetics of enzyme action, generate kinetic data, analyse kinetic data, and give appropriate interpretations
CO3: The students will be able to apply the kinetics of free and immobilized enzymes in industries, enzyme inhibition analysis, as well as explain probable future trends in enzyme technology
CO4: Upon completion of the course the student will recognize different ways to quantify enzymes, modification of enzymes, improve catalytic efficiency and describe different industrial applications of enzymes

Module 1 (13 hours)
Classification and nomenclature of enzymes, Hydrolases, Oxidoreductases, Peptidases, Esterases, Lyases, Kinases, ATPases, Ligases, Conformation and stereochemistry, Nomenclature: d/l, D/L, R/S, Importance of shapes in biological reactions, Chirality- diastereomers and prochiral molecules.

Module 2 (13 hours)
Basic catalytic principles, Factors contributing to enzymatic catalytic rates, Single and multi-substrate systems, Quantification of enzyme activity, Michaelis-Menten theory and kinetics, Initial velocity, Steady state kinetics, Enzyme assays and inhibition, Enzyme inhibition kinetics, Allosteric enzyme. Effect of pH and temperature on enzyme activity, Role of metal ions in enzyme activity, the catalytic triad of serine proteases (chymotrypsin), Carbonic anhydrase, Protein kinases.

Module 3 (13 hours)
Roles and mechanisms of co-enzymes like pyridoxal phosphate, thiamine -pyrophosphate, folate, biotin, flavin, nicotinamide nucleotides and lipoate in enzyme catalytic activity. Structural enzymology, Chemical modifications and site directed mutagenesis, Active sites as targets for drug action, Enzyme immobilization, Effect of immobilization on enzyme activity, Immobilized enzyme kinetics, Enzyme engineering and its role in industry.

References:

1. A. Fersht, Enzyme Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding, 1st Edn., W. H. Freeman, 1998.
2. I. H. Segel, Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems, Wiley Classics Library Edn., Wiley-Interscience, 1993.
3. M. D. Trevan, Immobilized Enzymes: An Introduction and Applications in Biotechnology, John Wiley & Sons Inc, 1980.
3. P. A. Frey and A. D. Hegeman, Enzymatic Reaction Mechanisms, 1st Edn., Oxford University Press, USA, 2007.
4. N. P. Colowich, N. P. Kaplan, and K. Mosbach, Immobilized Enzymes and Cells, Methods in Enzymology, Part C, Vol.136, Academic Press, 1987.

BT3006D INSTRUMENTAL METHODS OF ANALYSIS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe the principle of the various spectroscopic techniques and use them to analyze biochemicals and other products in industry and research.
CO2: Summarize the techniques like UV-Vis spectroscopy, atomic absorption spectroscopy, LC/GC Mass and NMR spectroscopy and apply this knowledge in structure elucidation of proteins and other biological compounds.
CO3: Explain the various microscopic techniques to analyze biological samples.
CO4: Outline the principle behind the basic biochemical and molecular biological techniques.

Module 1: (14 hours)
Introduction to absorption and emission spectroscopy, Theory (Lambert-Beer's law) and instrumentation of single beam and double beam UV-visible spectrophotometers, calibration and standardization. Theory and instrumentation of fluorescence and phosphorescence spectrometry, Flame emission and atomic absorption spectroscopy. Infrared spectrometry and the correlation of infrared spectra with molecular structure with some basic problems in structure elucidation.

Module 2: (13 hours)
Raman spectroscopy, X-ray diffraction crystallography, Mass spectrometry, Ionization and fragmentation, Basics of LC/MS, Tandem mass spectrometry, Nuclear magnetic resonance spectrometry. Thermal analysis techniques

Module 3: (12 hours)
Basic principles of microscopic methods, Phase contrast and confocal microscopy, Principles of SEM & TEM, Fluorescence microscopy, Principles and instrumentation of Gel electrophoresis (for DNA and Proteins), Isoelectric focusing, Two dimensional gel electrophoresis, Pulse field gel electrophoresis. Western blot, Southern blot, Immunofluorescence, immunohistology.

References:

1. H. Willard, L. Merritt, J. Dean and F. Settle, Instrumental Methods of Analysis, 7thEdn., Wadsworth Pub. Co., 1988.
2. D. L. Pavia, G. M. Lampman, G. S. Kriz, and J. A. Vyvyan, Introduction to Spectroscopy, 4thEdn., Brooks Cole, 2008.
3. A. Messerschmidt, X-Ray Crystallography of Biomolecules: A Practical Guide, 1stEdn., Wiley-VCH, 2007.
4. R. Westermeier, Electrophoresis in Practice: A Guide to Methods and Applications of DNA and Protein Separations, 4thEdn.,Wiley-VCH, 2005.
5. J. A. Glasel and M. P. Deutscher, Introduction to Biophysical Methods for Protein and Nucleic Acid Research, Academic Press, 1995.

BT3093D IMMUNOLOGY LABORATORY

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Experimenting antigen-antibody interactions and apply the knowledge to diagnostic immunology

CO2: Understand the methods of studying immune reactions

1. Handling the animals and raising antibodies.
2. Generation of antibodies against bovine serum albumin
3. Purification of antibodies
4. Purification of lymphocytes from peripheral blood.
5. Enzyme-linked immunosorbent assay (ELISA)
6. Western blot
7. Identification of blood group
8. Isolation of monocytes from blood.
9. Immunoelectrophoresis
10. Identification of T cells by T cell rossetting
11. Haemagglutination reaction test.
12. Countercurrent Immunoelectrophoresis

References:

1. G. P. Talwar and S. K. Gupta,A Handbook of Practical and Clinical Immunology, Volumes 1 & 2, CBS Publications, 1992.
2. K. Chakaravarty, Immunology and Immunotechnology, 1stEdn.,Oxford University Press, 2006.
3. D. P. Sites, J. D. Stobo, and J. U. Wells, Basic and Clinical Immunology, 8thEdn.,Mcgraw-Hill/Appleton & Lange, 1994.
4. K. Abbas and A.H.Lichtman, Basic Immunology, 3rdEdn.,Saunders, 2008.
5. S. K. Mohanty, Text Book of Immunology, Jaypee Brothers Medical Publishers, 2008.
6. R. Coico and G. Sunshine, Immunology: A Short Course, 6thEdn.,Wiley-Blackwell, 2009.

BT3094D MINI PROJECT

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Hands-on experimentation of research projects in different labs

CO2: Experimenting the knowledge of theory for designing and setting up the experiments

The mini project work would be carried out in the Institute under the guidance of a faculty member. Students will be given the flexibility to come up with new ideas for their project proposals. A faculty coordinator will coordinate the work. An evaluation committee will be formed and students will present their work before this committee. Students will also prepare a report and submit it to the School of Biotechnology through their respective guides and course coordinator.

Semester VII

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1.	BT4001D	Ethics & IPR	3	0	0	3	PC
2.	BT4002D	Plant Biotechnology	3	0	0	3	PC
3.	BT4*** D	Elective-IV	3	0	0	3	DE
4.	BT4*** D	Elective-V	3	0	0	3	DE
5.	Global Elective	Global Elective- I	3	0	0	3	GE
6.	BT4091D	Plant Biotechnology Laboratory	0	0	3	2	PC
7.	BT4092D	Seminar	0	0	2	1	PC
8.	BT4093D	Project: PART I	0	0	8	4	PC
	Total Credits					22	

BT4001D ETHICS & IPR

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Define ethical values in scientific research and ethical violations
CO2: Summarize the rights and laws governing the protection of intellectual property
CO3: Outline the scope of biotechnology research and innovation in maintaining human health, food supply, and safe environment
CO4: Summarize the role of patent laws and traditional knowledge

Module 1: (15 hours)
Values in science, Misconduct in science, Negligence and error, Conflict of interest, Techniques used and treatment of data, Authorships, Plagiarism, Response to ethical violations. Basic concepts of Intellectual Property Rights (IPR), IPR in the global economy-in international trade, Constitutional aspects of intellectual property, Principles of Patent laws, Historical background of patent laws, Non-governmental initiated community intellectual rights.

Module 2: (15 hours)
Patent laws and biotechnology, Evolution of biotechnology, Application of biotechnology, Concept of novelty and inventive steps in biotechnology, Microorganism and its application, Research and development investments, Patent laws related to microbial, pharmaceutical, environmental and agricultural inventions.

Module 3: (9 hours)
Conventions and agreements, TRIPS agreement, UPOV convention,Traditional knowledge, Rights of traditional knowledge holders, Peoples biodiversity register, Traditional knowledge in the international scenario.

References:

1. On Being a Scientist, 3rdEdn., National Academy Press, USA, 2009.
2. K.D. Sibley, The Law & Strategy of Biotechnology Patents, Butterworth-Heinemann, 1994.
3. L. Bently and B. Sherman, Intellectual Property Law, 3rd Edn., Oxford University Press, 2008.
4. S. M. McJohn, Intellectual Property: Examples and Explanations, 2nd Edn., Aspen Publishers, 2006.

BT4002D PLANT BIOTECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe the basic concepts of plant tissue culture, including types of cultures and media components.
CO2: Apply scientific and engineering principles to explain various strategies to enhance the productivity of value-added products in plant tissue cultures.
CO3: Discuss the basic concepts of plant genome organization and, explain the tools and applications of plant transformation technology along with safety regulations for transgenic plants.
CO4: Recall secondary metabolism in plants and explain the concepts of metabolic engineering.

Module 1: (13 hours)
Plant cell and tissue culture techniques and applications: Physico-chemical conditions for propagation of plant cells and tissues, Media composition, Growth regulators, Culture types, Plant regeneration, Organogenesis, Somatic embryogenesis, Protoplast Culture and Somatic Hybridization, Organ culture and hairy root culture. Bioreactors for plant cell and tissue culture. Approaches to increase productivity: Optimization of conditions, Precursors, Elicitors, Immobilization of plant cells. Germplasm conservation and cryopreservation.

Module 2: (13 hours)
Plant genome: Structure, organization and regulation of plant genome ex-pression; Transposons, Organelle genomes: Chloroplast and mitochondrial genome, Plant transformation technology and transgenics: Direct transformation and Agrobacterium mediated transformation, T-DNA transfer, Ti and Ri plasmids; Vectors for plant transformation, Helper plasmids, Promoters, Reporters, terminators and selectable genes; Characterization of transgenics, Marker free methodologies.

Module 3: (13 hours)
Major secondary metabolite pathways like Shikimate pathway, Phenylpropanoid pathway, terpenoid indole alkaloid, terpenoid synthesis pathways, Metabolite profiling, Metabolic engineering, genetic engineering of enzymes diverting amino acids into secondary Metabolism. Transgenics conferring resistance to biotic and abiotic stress, Molecular pharming and industrial products. Guidelines and safety regulations for transgenic plants.

References:

1. H. S. Chawla, Introduction to Plant Biotechnology, 2nd Edn., Science Publishers, 2002.
2. A. Slater, N. Scott, and M. R. Fowler, Plant Biotechnnology: The Genetic Manipulation of Plants, 2nd Edn., Oxford University Press, 2008.
3. K. Oksman-Caldentey and W.H. Barz, Plant Biotechnology and Transgenic Plants, 1st Edn., CRC press, 2002.
4. H. Daniell and C. Chase, Molecular Biology and Biotechnology of Plant Organelles: Chloroplasts and Mitochondria, 1st Edn., Springer, 2007.
5. R. Verpoorte and A. W. Alfermann, Metabolic Engineering of Plant Secondary Metabolism, 1st Edn., Springer, 2002.
6. M. K. Razdan, Introduction to Plant Tissue Culture, 2nd Edn., Science Publishers, 2003.
7. S. D. Gupta and Y. Ibaraki, Plant Tissue Culture Engineering, 1st Edn., Springer, 2005.

BT4091D PLANT BIOTECHNOLOGY LABORATORY

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Develop skills for application of basic tissue culture techniques
CO2: Perform and evaluate experiments in plant genetic engineering
CO3: Apply the knowledge and design experiments to increase the yield of secondary metabolites

1. Media preparation and plant growth regulators
2. Sterilization techniques for instruments and explants
3. Aseptic culture establishment by regeneration from seed
4. Protocol for organogenesis from axillary buds
5. *In vitro* culturing technique
6. *Agrobacterium* mediated transformation
7. Plasmid DNA isolation from *Agrobacterium*
8. Genomic DNA isolation from plant samples
9. Screening of transgenic plants using PCR
10. Increasing the yield of secondary metabolite by genetic engineering techniques
11. RAPD analysis for genetic homogeneity testing

References

1. R. A. Dixon and R. A. Gonzales, Plant Cell Culture: A Practical Approach, 2nd Edn., Oxford University Press,1995.
2. K.-H. Neuman, A. Kuma, and J. Imani, Plant Cell and Tissue Culture: A Tool in Biotechnology: Basics and Application, 1st Edn., Springer, 2009.
3. J. Sambrook and D. W. Russell, Molecular Cloning: A Laboratory Manual, 3 volume set, 3rd Edn., Cold Spring Harbor Laboratory Press, 2001.
4. R. Eisenthal and M. Danson, Enzyme Assays: A Practical Approach, 2nd Edn., Oxford University Press,2002.
5. G. Marangoni, Enzyme Kinetics: A Modern Approach, 1st Edn., Wiley-Interscience, 2002.
6. H. Segel, Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Stead-State Enzyme Systems, Wiley Classics Library Edn., Wiley-Interscience, 1993.

BT4092D SEMINAR

Prerequisite: Nil

L	T	P	C
		2	1

Total hours: 39

Course Outcomes:

CO1: Identify complex scientific, engineering and societal problems and prepare a comprehensive scientific report based on research literature and reaching substantiated conclusions.
CO2: Appraise the strength of the report in an effective presentation cogently with or without notes and develop their topic with appropriate signposting, visual, audio and audio-visual
CO3: Summarize the methodology, structure and conclusion around the designated research topic.

Each student will identify a current topic of interest in biotechnology in consultation with a faculty member. Student will submit report on that topic and will give a presentation before a committee consisting of faculty members. The seminar topic shall be preferentially from published articles in peer reviewed journals.

BT4093D PROJECT: PART I

Pre-requisites: Nil

L	T	P	C
0	0	8	4

Total hours: 104

Course Outcomes:

CO1: Will able to identify, formulate biotechnological solutions by analyzing gap area in Life science research for the betterment of society and environment

CO2: Emphasize to infer and summarize the basic experiment and learn the principle involved in the experiment. It also develops the knowledge and understand ways to address it. Students will be able to communicate scientifically.

CO3: Develop scientific expertise from project. Thus, enabling students to explain the objectives attained by the project and the basic science, technique involved in the project with professional and ethical commitments.

CO4: Impart students writing and compiling skills various software involved in thesis writing and reference management. It will help to learn scientific writing skills

The students will be given the flexibility to come up with project proposals in consultation with the faculty members. Students will form groups having maximum of four members. At the end of the semester, students will submit a brief report and will present their work to a committee consisting of the faculty

Semester VIII

Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Category**
1.	BT4*** D	Elective-VI	3	0	0	3	PC
2.	BT4*** D	Elective- VII	3	0	0	3	PC
3.	Global Elective	Global Elective- II	3	0	0	3	GE
4.	BT4094D	Project: PART II	0	0	8	4	PC
	Total Credits					13	

BT4094D PROJECT: PART II

Pre-requisites: Nil

L	T	P	C
0	0	8	4

Total hours: 104

Course Outcomes:

CO1: Will able to identify, formulate biotechnological solutions by analyzing gap area in Life science research for the betterment of society and environment
CO2: Emphasize to infer and summarize the basic experiment and learn the principle involved in the experiment. It also develops the knowledge and understand ways to address it. Students will be able to communicate scientifically.
CO3: Develop scientific expertise from project. Thus, enabling students to explain the objectives attained by the project and the basic science, technique involved in the project with professional and ethical commitments.
CO4: Impart students writing and compiling skills various software involved in thesis writing and reference management. It will help to learn scientific writing skills

The project work started in the seventh semester shall preferentially continue in this semester. The students will complete the project work in this semester and present it before the assessment committee. The assessment committee as constituted in the seventh semester will assess the various projects for the relative grading and group average. The guides will award the grades for the individual students depending on the group average. Each group will submit the copies of the completed project report signed by the guide to the School of Biotechnology. The Head of School of Biotechnology will certify the copies and return them to the students. One copy will be kept in the departmental library.

BT3021D BIOPHARMACEUTICAL TECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify steps involved in the discovery and development of biopharmaceuticals
CO2: Enumerate the different sources of biopharmaceuticals and apply this knowledge for drug development
CO3: Analyze the clinical applications of cytokines, growth factors and hormones
CO4: Describe the uses, production and purification of clinically important biopharmaceuticals.

Module 1: (13 hours)

Introduction to the history of drugs and pharmaceutical industry, a brief study about drugs from different sources like plants, animals, microbes and minerals and their therapeutic uses. Conventional drug development process- discovery of biopharmaceuticals, pharmacogenetics, and delivery of biopharmaceuticals, pre-clinical trials, pharmacodynamics and pharmacokinetics, toxicity studies, clinical trials, regulatory procedures, approval of FDA.

Module 2: (14 hours)

Introduction to biopharmaceutical products, International pharmacopeia, role of Good manufacturing practices (GMP), manufacturing facilities for biopharmaceuticals, sources of biopharmaceuticals: *E. coli,* yeasts, animal cells, transgenic animals, transgenic plants, Insect-cell based systems (roles, description of drug development) novel bioreactors for animal cells in pharmaceutical industry, production of final product and analysis of biopharmaceuticals. Production, purification and applications of the Interferons, Interleukins I & II, Tumor Necrosis Factor (TNF). Growth factors. Production and therapeutic application of hormones like insulin, glucagon, human growth hormone, gonadotrophins.

Module 3: (12 hours)

Recombinant blood products and therapeutic enzymes. Production and purification of monoclonal antibodies, Application of monoclonal antibodies in therapies, diagnosis and research, Nucleic acid and cell based therapeutics, gene silencing, gene editing, radioimmune conjugates: radioimmune therapy (RIT), choice of isotopes, conventional RIT, pre-targeted RIT.

References:

1. G. Walsh, Biopharmaceuticals Biochemistry and Biotechnology, 2nd Edn., John Wiley 2002.
2. G. Walsh, Pharmaceutical Biotechnology: Concepts and Applications, John Wiley & Sons, 2007.
3. Leon Lachman, Herbert A Lieberman, Joseph L. Kanig, Theory & Practice of Industrial Pharmacy, 4^{th} Edn., CBS Publishers, 2013
4. J. P. Remington and A. Osol, Remington's Pharmaceutical sciences, 16^{th} Edn., Mack Publications & Company, Easton, 1980.

BT3022D FOOD BIOTECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Understand the role of biotechnology in food processing and fermented food production.
CO2: Know principal types of microorganisms involved in the fermentation process.
CO3: Delineate food-borne diseases in human of bacterial and non-bacterial agents.
CO4: Comprehend food preservation by physical, chemical and biological agents.

Module 1: (13 hours)

Introduction to food biotechnology, Food processing, Types of microorganisms used for food processing and their resources, Nutritional values of food, Use of enzymes in food industry, Factors affecting growth and survival of microorganisms in food, Single cell protein, Genetically modified food, Fermented food products,Diary products-Fermented milk, Cheese, Butter, Fermented Meat, Fermented fish.

Module 2: (13 hours)

Beverages and related products of baking, Beer, Vinegar, Mould fermentation, Non beverage plant products, Food spoilage, Bacterial agents of food borne illness- *Clostridium, Salmonella, Vibrio,* Non-bacterial agents of food borne illness - Helminthes, protozoa, Algae, Fungi, Viruses, Genomics.

Module 3: (13 hours)

Food preservation, Role of chemicals and enzymes in food preservation, Biochemical engineering for flavour and food production, Microbiology of food preservation-physical, chemical and biological based preservation system, Food standards.

References:

1. R. Angold, G. A. Beech, and J. Taggart, Food Biotechnology, 1st Edn., Cambridge University Press, 1989.
2. J. M. Jay, M. J. Loessner, and D. A. Golden, Modern Food Microbiology, 7th Edn, Springer, 2006.
3. K. Shetty, G. Paliyath, A. Pometto, and R. E. Levin, Food Biotechnology, 2nd Edn., CRC, 2005.
4. P. J. Green, Introduction to Food Biotechnology, 1st Edn., CRC, 2002.
5. M. Ruse and D. Castle, Genetically Modified Foods: Debating Biotechnology, Prometheus Books, 2002.

BT3023D BIOREACTOR DESIGN AND ANALYSIS

Pre-requisite: Bioprocess Principles

L	T	P	C
3	0	0	3

Total Hours: 39

Course Outcomes:

CO1: Describe the reaction engineering principles and the kinetics of biochemical reactions
CO2: Analyze the types of bioreactors and their configurations for several industrial applications
CO3: Apply bioreaction engineering principles to design bioreactors and evaluate their performance
CO4: Determine the flow characteristics in bioreactors to identify non-ideal behaviour in bioreactors.

Module 1 (10 hours)

Principles and kinetics of chemical and biochemical reactions - Fundamentals of homogeneous reactions for batch, plug flow, semi-batch, stirred tank/ mixed reactors, Energy and mass balances in biological reaction modeling, Types of bioreactors and their configurations, Classification based schuegerl, kafarov components of bioreactors and their operation.

Module 2 (11hours)

Reactors based on flow characteristics, ideal and non-ideal bioreactors, Design of ideal reactors, Material and energy balance, Batch bioreactor design, Performance equations for ideal reactors and non-isothermal reactors, Batch reactor analysis for kinetics (synchronous growth and its application in product production), Design and analysis of fed batch systems.

Module 3 (10 hours)

Definition of chemostat and turbidostat, Single flow single stage chemostat, Single flow multistage chemostat, Chemostat with recycle, Concepts of dilution rate and productivity analysis in CSTR, Plug flow analysis, Design of plug flow reactor, comparison of productivity in plug flow and chemostat.

Module 4 (11 hours)

Non-ideal flow in bioreactors, Reasons for non-ideality, Mixing time and Residence time distributions, Models for non-ideal reactors, plug flow with axial dispersion, tanks-n-series model, Multiphase bio reactors, Packed bed reactors, Air-lift reactors, Bubble column reactors, Fluidized bed reactors, Trickle bed reactors, Stability analysis of bioreactors.

References

1. A. Moser, Bioprocess Technology - Kinetics and Reactors, 2nd Edn., Springer Verlag, 1988
2. O. Levenspiel., Chemical Reaction Engineering, 3rd Edn., John Wiley Eastern Ltd, 1998
3. J.E. Bailey, D.F. Ollis, Biochemical Engineering Fundamentals, 3rd Edn., McGraw-Hill, 1990
4. B. Atkinson, Biological Reactors, 2nd Edn., Pion Ltd., 1974.
5. H. W. Blanch and D. S. Clark, Biochemical Engineering, 1st Edn., CRC Press, 1997.

BT3024D MINERAL BIOTECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain the concepts of biomineralisation and biohydrometallurgy
CO2: Describe the microbes and the microbial processes involved in mineralisation
CO3: Apply the microbiological methods to control the process of mineralization
CO4: Outline the processes and techniques used in bioremediation

Module 1 (13 hours)

Biogenesis, Ecology and Genetics, Ecological problems of biotechnology, Biobenefication, Biological conversion of coal to organic chemicals, Down-downstream processing, Bioflotation, Bioflocculation, Decrepitation, Oxidation metallurgy, Swelling and softening, Melting, Environmental control and mine site remediation, Biocorrosion and biofouling. Biomineralization, Types of biomineral forming processes, Biomineral species, Biologically-controlled mineralization, biologically induced mineralization.

Module 2 (13 hours)

Biohydrometallurgy, Bioleaching, Methods are used to recover copper, zinc, gold and cobalt; Biodegradation, Biodegradation of xenobiotics, Removal of toxic metals and radionuclides from the environment, Microbial treatment of metal contaminated liquid effluents, Wastewater treatment,Bioaccumulation.Geomicrobiology-Microbes and geochemical cycles, Biocrystallization, Biometrics and its application, Magnetotactic bacteria.

Module 3 (13 hours)

Bioremediation-Microbial physiology, bio-reactors, growth characteristics of microorganisms; Biochemistry of leaching microbes, Leaching characteristics, Biodiversity of sulfate-reducing bacteria, Remediation of metal pollutants by sulfate-reducing bacteria, Tank operations, Heap operations, Designing Operations.

References:

1. S. K. Kawatra and K. A. Natarajan, Mineral Biotechnology: Microbial Aspects of Mineral Benefication, Metal Extraction, and Environmental Control, Society for Mining, Metallurgy, and Exploration, 2001.
2. S.C. Bhatia, Handbook of Environmental Biotechnology, Vols. I to III, Atlantic Pub., 2008.
3. H. L. Ehrlich and C. L. Brierley, Microbial Mineral Recovery, McGraw-Hill, 1990.
4. E. R. Donati and W. Sand, Microbial Processing of Metal Sulfides, 1st Edn., Springer, 2007.
5. G. M. Evans and J.C. Furlong, Environmental Biotechnology: Theory and Applications, 1st Edn., Wiley, 2002.

BT3025D CYTOGENETICS

Pre-requisites: **Nil**

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: learn about the concept of cytogenetics.

CO2: know about the genetic variation in microbial organisms.

CO3: delineate the mechanism of chromosomal abnormalities.

CO4: decipher relation between chromosome copy number and diseases.

CO5: learn about phenotypic plasticity.

Module 1: (14 hours)

Introduction to cytogenetics, Chromosome replication and its segregation, Structure of chromatins, Nucleosomes, Centrosome, Karyotypic analysis and nomenclature, Numerical abnormalities, Sex chromosome X and Y, Structural chromosome abnormalities, Chromosome inactivation, Mechanism of structural abnormalities.

Module 2: (13 hours)
Molecular methods for cytogenetics, Microdeletion syndromes, Cytogenetics of cancer, Epigenetics, Modification of chromatin structures, Chromosome breakage and instability syndrome, Genomic imprinting and its effect, Model organisms: yeast, fruitfly, Abrabidopsis thaliana.

Module 3: (12 hours)

Mitochondrial genome, Killer plasmids, Prions, Mating system, Pheromones, Phenotypic plasticity, Transposable elements, Ty elements and their genomes, Structure of telomeres, Telomere shortening and its phenotypes.

References:

1. H. Feldmann, Yeast Molecular and Cell Biology, 2nd Edn, Wiley-Blackwell, 2012.
2. B. Lewin, Genes XI, 11th Edn., Jones & Bartlett Publishers, 2013.
3. R. Tamarin, Principles of Genetics, 7th Edn, McGraw Hill Education, 2017.
4. S. Heim and F. Mitelman, Cancer cytogenetics: Chromosomal and molecular genetic aberrations of tumor cells, 4th Edn, Wiley-Blackwell.
5. B. Hamkalo, Molecular Cytogenetics, Springer, 2012.

BT3026D MARINE BIOTECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe the theory behind the production of marine pharmaceuticals.
CO2: Recognize the causes of marine pollution and evaluate the steps to prevent pollution
CO3: Identify the significance of marine resources and their conservation.
CO4: Analyze the theory and rationale behind the production of genetically modified fish, including ethical issues and environmental impacts

Module 1: (13 hours)

Types of marine environment - Physical, Chemical and Biological aspects, Marine organisms, Types of marine microbes and their biology, Structures of bacteria, fungi, algae, protozoa and viruses; Introduction to marine pharmacology, Microbial metabolites, Microbial interaction Microbes of Biotechnological importance, Primary and secondary metabolite. Bioaugmentation, Biofouling, Corrosion Process and control of marine structures, Bioremediation, Nutrient cycling, Bio-fertilization,

Module 2: (13 hours)

Probiotics, Regulation of bacterial growth, Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial), Biological indicators and accumulators. Marine resources assessment, Methods of surveying the living resources (Acoustic, Aerial and Remote sensing), Population study and Marine environment protection Population dynamics, Abundance and density, Growth and mortality(fishing & natural),

Module 3: (13 hours)

Conservation and management- in situ and ex situ, IUCN categorization, Marine biosphere reserves, Marine parks - heritage sites. Chromosome manipulation in aquaculture – hybridization, Ploidy induction, Gynogenesis, Androgenesis and sex reversal in commercially important fishes, Transgenic fish, Tools for disease diagnosis in cultivable organisms,

References:

1. M. Fingerman, R. Nagabhushanam and M.-F. Thompson. Recent Advances in Marine Biotechnology , Science Publishers I999.
2. P. Proksch, Frontiers in Marine Biotechnology, 1st Edn., Taylor & Francis, 2006.
3. G. Sanchez and E. Hernandez, Environmental Biotechnology and Cleaner Bioprocesses, 1st Edn., CRC press, I999.
4. P. Proksch, Frontiers in Marine Biotechnology, 1st Edn., Taylor & Francis, 2006.
5. M. Fingerman and R. Nagabhushanam, Molecular Genetics of Marine Organisms, Illustrated Edn., Science Pub., 2004.

BT3027D BIOCONJUGATE TECHNOLOGY AND APPLICATIONS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Classify biological molecules based on their functional group and describe their chemical characteristics
CO2: Identify conjugating reagents and cross-linkers used for conjugating small molecules, and biological macro molecules and illustrate their chemical characteristics
CO3: Outline the methods used to modify the small molecules, proteins, polysaccharides and DNA through chemical reactions and conjugation using cross-linkers
CO4: Appreciate the significance of bioconjugation techniques in clinical therapy, diagnosis and industry.

Module 1: (14 hours)

Modification of Amino Acids, Peptides and Proteins – Modification of sugars, polysaccharides and glycoconjugates, modification of nucleic acids and oligonucleotides. Amine reactive chemical reactions, Thiol reactive chemical reactions, carboxylate reactive chemical reactions, hydroxyl reactive chemical reactions, aldehyde and ketone reactive chemical reactions, Photoreactive chemical reactions.

Module 2: (13 hours)

Bioconjugate Reagents-Zero length cross linkers, Homobifunctional cross linkers, Heterobifunctional cross linkers, Trifunctional cross linkers, Cleavable reagent systems, tags and probes. Modification of Enzyme and Nucleic Acids-Properties of common enzymes, Activated enzymes for conjugation, biotinylated enzymes, chemical modification of nucleic acids, biotin labeling of DNA- enzyme conjugation to DNA, Fluorescent of DNA.

Module 3: (12 hours)

Bioconjugate Aplications- Preparation of Hapten-carrier Immunogen conjugates, antibody modification and conjugation, immunotoxin conjugation techniques, liposome conjugated and derivatives, Colloidal –
gold-labeled proteins , modification with synthetic polymers.

References:

1. G.T. Hermanson, Bioconjugate Techniques, 3rd Edn., Academic Press, 2013.
2. R. Narain, Chemistry of Bioconjugates: Synthesis, Characterization, and Biomedical Applications, John Wiley & Sons 2013.

BT3028D BIOFUEL TECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explains the concept of bio-energy sources, biorefinery, biofuel production and applications, alternative energies sources
CO2: Review the importance of biochemical pathways for various metabolic process involved in biofuel production. It also aims
CO3: Analyse and infer the mechanisms of ethanol production from sugar and starch and lignocellulosic feedstocks and familiarize various fermentation process and different types of fermenters
CO4: Relate the different aspects of different bioreactor designs for biofuel production and concepts of microbial fuel cell

Module 1: (13 hours)

Fossil versus renewable energy resources, Types of biofuels, economic impact of biofuels, Comparison of Bio-energy Sources, Biorefinery, biofuel production and applications, alternative energies, environmental impact of biofuel, Various types of feedstocks: starch feedstocks, sugar feedstock, lignocellulosic feedstock, plant oils and animal fats, miscellaneous feedstocks. Brief description on harvesting Energy from Biochemical Reactions- Organoheterotrophic Metabolism, Phototrophic Metabolism.

Module 2: (13hours)

Ethanol production from sugar and starch feedstock ethanol production from lignocellulosic feedstocks, fermentation process and types of fermenters, Wet milling of grain for alcohol production, grain dry milling cooking for alcohol production, use of cellulosic feed stocks for alcohol production. Biodiesel Production Chemistry: Transesterification, Esterification, Lipase-Catalyzed Interesterification and Transesterification, Supercritical Esterification and Transesterification. Oil Sources For biodiesel production: Plant Oils, Microbial and Algal Oils, Used Cooking Oils, straight Vegetable Oil. Novel type of biodiesel: biofuels that incorporate glycerol into their composition. Production of biohydrogen .

Module 3: (13 hours)

Bioreactor Design for Biofuel Production: Fermentation process, various types of fermentors, bioreactor operation and design. Utilisation of vegetable pure plant oil and crude oil in diesel engines, Biodiesel based palm oil, jatropha oil, coconut oil and kapok nut oil in diesel engines, Biodiesel B5 based cat-fish fat in diesel engines. Microbial Fuel Cells and its role in energy production: Microbiology of methane production, biomass sources for methane production, biogas composition and use, biochemical basis of fuel cell design. Introduction to global warming, global warming factors, geo-chemical cycles.

References:

1. Wim Soetaert, Erick J. Vandamme, Biofuels, Wiley,2011
2. Caye M. Drapcho, Nghiem Phu Nhuan,Terry H. Walker, Biofuels Engineering Process Technology McGrow Hills, 2007
3. Biotol Series, Vch Ellis Horwood, Butterworth-Heinemann, Product Recovery in Bioprocess Technology 1st Edn ,1992

BT3029D STRUCTURAL BIOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Students will be able to describe the roles of different biomolecules.
CO2: Students will be able to analyse the structural constraints that limit the occurrence of probable random structures.
CO3: Students will be able to summarize the interactions that holds up the sub units from different classes of biomolecules.
CO4: Students will be able to apply various techniques for studying biomolecules.

Module 1: (13 hours)

Levels of molecular organizations, Brief discussions- Amino acids, Nucleotides, Carbohydrates, Lipid, Cofactors, Vitamins, Hormones, Chirality of biological molecules, Structure of proteins, Composition and primary structures of proteins, Secondary structure of proteins-alpha helix, beta sheet, coiled-coiled.

Module 2: (13 hours)

Three dimensional conformations, Motifs, Fold, Properties of structures, Ramachandran plot, Membrane proteins, Globular and Fibrous proteins, Quaternary structures-dimers, homodimers and heterodimers, tetramers; Protein folding, Protein-protein interactions, Antigens and antibodies, Transcription factors, Protein-lipid interactions, Protein-DNA interactions, Ribosomes, Protein-carbohydrate interactions, Enzyme catalysis.

Module 3: (13 hours)

Protein-ligand interactions, Scatchard plot, Co-operative interactions, Allosteric effect, Hill constants, Principles of nucleic acid structures, Base pairing, Base stacking, Stabilized forms of DNA-A, B and Z forms, Melting of DNA double helix, RNA folding and catalysis, X-ray spectroscopy, Optical spectroscopy, Mass spectrometry, Structure analysis using NMR and cryo-electron microscopy.

References:

1. C. Branden and J. Tooze, Introduction to Protein Structure, 2ndEdn., Garland Science, 1999.
2. A. M. Lesk, Introduction to Protein Architecture: The Structural Biology of Proteins, 1stEdn., Oxford University Press, USA, 2004.
3. T. E. Creighton, Protein Function: A Practical Approach, 1st Edn., Oxford University Press, 2004.
4. G.G. Hammes, Thermodynamics and Kinetics for the Biological Sciences, 1stEdn., Wiley-Interscience, 2000.
5. V. A. Bloomfield, D. M. Crothers, I. Tinoco, and J. E. Hearst, Nucleic Acids: Structures, Properties, and Functions, 1stEdn., University Science Books, 2000.

BT3030D METABOLIC ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Comprehend and explain basic cellular uptake and metabolism of amino acids, nucleotides.
CO2: Identify the metabolic flux by using quantification tools and models associated with metabolic flux.
CO3: Explain the role of enzymes at the level of production and their kinetic regulation.
CO4: Apply 'Omics' technologies in the metabolic engineering area and describe it's role

Module 1: (13 hours)

Overview of metabolism, Basic concepts of metabolic engineering, Cellular metabolism, Transport processes-Active and passive transports, Biosynthetic and degradation pathways of amino acids, nucleotides, fats. Metabolic flux, Methods for metabolic flux analysis, Application of metabolic flux analysis, Amino acid production by bacteria.

Module 2: (14 hours)

Metabolic flux analysis for glutamic acid and lysine biosynthetic networks, Fluxes in mammalian cell cultures, Flux analysis and design of culture media. Regulation of metabolic pathways, Regulation of enzymatic activities, Enzyme kinetics, Reversible and irreversible inhibitions, Regulatory enzymes, Allosteric enzymes, Cooperativity, Control of enzyme production at transcription, and translation levels, Regulation of metabolic networks.

Module 3: (12 hours)

Metabolic control analysis, Control coefficient and elasticity, Functional genomics, proteomics, metabolomics, systems biology, Application of metabolic engineering, Enhancement of product yield, Alteration of nitrogen metabolism, Production of antibiotics, vitamins, polyketides etc., Bioconversions.

References:

1. G. N. Stephanopoulos, A. A. Aristidou, and J. Nielson, Metabolic Engineering: Principles and Methodologies, 1st Edn., Academic Press, 1998.
2. N. V. Torres and E. O. Voit, Pathway Analysis and Optimization in Metabolic Engineering, 1st Edn., Cambridge University Press, 2002.
3. B. Kholodenko, Metabolic Engineering in the Post Genomic Era, New edition Edn., Taylor & Francis, 2004.
4. S. Cortassa, M.A. Aon, A.A. Iglesias, and D. Lloyd, An Introduction to Metabolic and Cellular Engineering, 1st Edn., World Scientific Pub. Co., 2002.

BT3031D BIOMECHANICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Understand and quantify linear and angular characteristics of motion.
CO2: Understand the quantitative relationships between angular and linear motion characteristics of a rotating body
CO3: Understand the mechanics of connective tissue and injury
CO4: Understand the Biomechanics of Musculoskeletal Injury

Module 1: (13 hours)

Mechanical behavior of bodies in contact, relationship between work, power and energy – Angular kinematics of human movement-measuring angles, angular kinematic relationships –relationships between linear and angular motion – Angular kinetics of human movement-resistance to angular acceleration, angular momentum – Equilibrium and human movement-equilibrium, center of gravity, stability and balance – Kinematic concepts for human motion-forms of motion and joint movement terminology – Kinetic concepts for human motion-basic concepts related to kinetics .- mechanical loads on the human body .

Module 2: (13 hours)

Bone structure & composition, blood circulation in bone – mechanical properties of bone, viscoelastic properties of bone – Maxwell & Voight models – viscoelastic properties of articular cartilage – Anisotropy and composite models for bone – Bone growth and development – Bone response to stress – Osteoporosis – causes, diagnosis, treatment – Elasticity and strength of bone. Biofluid Mechanics, Newtonian viscous fluid, non viscous fluid – Rheological properties of blood – Structure and composition of blood vessel – Remodeling of blood vessels – Nature of fluids, Propulsion in fluid medium – Mechanical properties of arterioles, capillary vessels and veins – Bio-viscoelastic solids.

Module 3: (13 hours)

Structure of skeletal muscle –muscle fibers, motor units – Structure of skeletal muscle-fiber types, fiber architecture – Sliding element theory of skeletal muscle.- Skeletal muscle function – Contraction of skeletal muscle and hill"s three element model – Factors affecting muscular force generation – Muscular strength, power and endurance – Muscle injuries. Structure of the shoulder – Movements of shoulder complex – Loads on the shoulder – Structure of the spine – Movements of the spine – Muscles and loads on the spine – Structure and movements of the hip – Loads on the hip.

References:

1. Susan J Hall, "basic biomechanics", Tata Mcgraw hill, 4th edition, 2004.
2. Schneck D J, and Bronzino J D, "Biomechanics- Principles and Applications", CRC Press, 2nd Edition, 2000.
3. Duane Knudson, "Fundamentals of Biomechanics", Springer, 2nd edition, 2007.
4. Fung Y C, Biomechanics: "Mechanical Properties of Living Tissues", Springer, 2nd edition, 1993.

BT4021D ANIMAL BIOTECHNOLOGY

Prerequisite: Nil

L	T	P	C
3			3

Total hours: 39

Course Outcomes:

CO1: To provide students with a scientific and technical understanding of animal biotechnology.
CO2: To introduce students to the commercial and ethical aspects of the generation and use of transgenic animals.
CO3: To present the concepts of animal cloning with its potential benefits and danger.
CO4: To be able to apply a thorough understanding of the basic animal biotechnology concepts to actual experiments.

Module 1 (13 hours)

Animal biotechnology-Scope, organ transplant, Moral Standing, State of the art, Development of animal tissue culture, Equipment and materials, Principles of sterile techniques, Types of tissues, Sources of tissues, Animal metabolism-Regulation, Reactant and product transport through mammalian cells.

Module 2 (13 hours)

Fertilization and Cloning, Conventional methods for animal improvement, Embryo biotechniques, Micro manipulation and cloning, Artificial insemination, Concept of nuclear transfer in cloning, Creation of Dolly, Stem cells, Reprogramming of adult cells, Transgenic animals and their utility in research and related areas.

Module 3 (13 hours)

Cell lines, Preservation of cell lines, Primary culture, Establishment of primary cell culture, Definite and continuous cell lines, Scale up of animal cell culture, Scale up of suspension culture, Nutritional requirement, Growth characteristics, Kinetics, Microcarrier attached growth. Ethical issues in biotechnology.

References:

1. M. Moo-Young, Animal Biotechnology, 1st Edn., Pergamon, 1989.
2. R. Portner, Animal Cell Biotechnology: Applications to Biochemistry and Molecular Biology, 2nd Edn., Humana Press, 2007.
3. R. I. Freshney, Culture of Animal Cells: A Manual of Basic Technique, 5th Edn., Wiley-Liss, 2005.

BT4022D BIOSENSORS AND DIAGNOSTICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain the importance and concept of biosensors, and process of commercial development. Classify different types of biosensors
CO2: Describe the biochemical reactions and mechanism of biosensors in diagnostics level and applications of biosensors for environment
CO3: Familiarize the mechanisms of different Biochips and their application to genomics
CO4: Relate the theories behind molecular and immunodiagnostic biosensors for detection of diseases

Module 1: (13 hours)

Introduction to biosensors, Concept and applications, Different types of biosensors-Electrochemical, optical and thermometric; Static biosensor probes vs flow systems, Enzyme membranes vs enzyme reactors, Commercial development of biosensors.

Module 2: (13 hours)

Application of biosensors, Biosensors for personal diabetes management, Non-invasive blood-gas monitoring, Blood-glucose sensors, Application of biosensors to environmental samples, Biocore-an optical biosensors, Biochips and their application to genomics. Immunodiagnostic procedures, Monoclonal antibodies and their applications in diagnostics, Human leukocyte antigen (HLA), HLA typing.

Module 3: (13 hours)

Molecular beacons, Oligoriboprobes, Ribozymes, Role of bioinformatics in molecular diagnostics. DNA diagnostic systems, Hybridization probes, Non-isotopic hybridization procedures, In situ hybridization, Diagnostic of genetic diseases, detection of mutation in DNA, DNA amplification and quantification, molecular markers and DNA polymorphism, Use of PCR, DNA finger printing.

References:

1. D. L. Wise, Bioinstrumentation and Biosensors, 1st Edn., CRC, 1991.
2. J. Cooper and T. Cass, Biosensors, 2nd Edn., Oxford University Press, 2004.
3. V. C. Yang and T. T. Ngo, Biosensors and Their Applications, 1st Edn., Springer,2000.
4. B. R. Eggins, Chemical Sensors and Biosensors, Illustrated Edn, Wiley, 2008.
5. J. R. Birch and E. S. Lennox, Monoclonal Antibodies: Principles and Applications, 1st Edn., Wiley-Liss, 1995.
6. S. Maulik and S. D. Patel, Molecular Biotechnology: Therapeutic Applications and Strategies, 1st Edn., Wiley-Liss, 1997.

BT4023D NANOBIOTECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Identify and evaluate the techniques for fabrication and characterization of the nanomaterials.
CO2: Outline the fabrication of biocomposite and the microfluidics devices
CO3: Design a nanostructure from isolated protein and DNA for therapeutic applications
CO4: Comprehends the applications of the bio-based nanoparticles coated chips for diagnostics.

Module 1: (15 hours)

Definition of nanotechnology, Nanofabrication, Nanolithography, Bottom-up versus top-down models, Biocomposite inorganic devices, Stents and seeds, implant coating, Microfluids: Basic fluid ideas, Microfluidic devices and their fabrication, potential of microfluidic devices in nanobiotechnology. Strategies of printing proteins on surfaces, Microcontact printing of proteins, Protein based nanostructures: S-layers, lipid chips, engineered nanopores.

Module 2: (14 hours)

Microbial nanoparticles, Magnetosomes: nanoscale magnetic iron minerals in bacteria, Bacteriorhodopsin and its applications, Surface biology and nanoanalytics. Function and application of DNA based nanostructures, DNA templated electronics, DNA-gold bioconjugates, Use of nanoparticles for identification of pathogenic microbes, Nanodiganostics, Rapid ex-vivo diagnostics, Biomaterials and gene therapy, Drug discovery: Drug discovery using nanoparticles, Nanosensors in drug discovery, Use of nanoimaging agents.

Module 3: (10 hours)

Introduction to bioMEMS, Biosignal transduction mechanisms, Chemical transducers, Electromagnetic transducers, Optical transducers, Application of bioMEMS, Recent developments in bioMEMS, Production of nanoparticles using microbes, Nano-labels.

References:

1. C. P. Poole and F. J. Owens, Introduction to Nanotechnology, 1stEdn., Wiley-Interscience, 2003.
2. C. M. Niemeyer and C. A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, 1stEdn., Wiley-VCH, 2004.
3. F. Pinaud, Peptide-coated Quantum Dots: Applications to Biological Imaging of Single Molecules in Live Cells and Organisms, VDM Verlag Dr. Muller, 2009.
4. T. Vo-Dinh, Nanotechnology in Biology and Medicine: Methods, Devices and Applications, 1stEdn., CRC, 2007.

BT4024D GOOD MANUFACTURING PRACTICE

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Outline the different legal procedures to be followed in the manufacture of food and other pharmaceutical products
CO2: Identify the criteria for the operation of aseptic operations with proper maintenance of equipment, sanitation and quality
CO3: Apply different types of quality control testing like the textural quality of the product, instrumental, chemical and microbial quality for the purpose of food safety
CO4: Students should be able to list and recognize the organizations that are involved in the maintenance of trade and company standards.

Module 1: (13 hours)

Implications of cGMP and the regulation for cGMPs. Planning of chemical plant sanitation program and construction factors. Hygienic design of food plants and equipments. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of pests and microbes. Cleaning and Disinfection: Physical, chemical and microbiological approach.

Module 2: (13 hours)

Introduction to Quality control and total Quality control in the chemical industry. Various Quality attributes of food such as size, shape, texture, color, viscosity and flavor. Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Food regulation and compliance. Food inspection and Food Law. Critical quality control point in different stages of production including raw materials and processing materials.

Module 3: (13 hours)

Food Quality and Quality control including the HACCP system. Federal Food and Drug law, BSTI laws, activities. Other Food Laws (legalization). Trade and company standards. Control by (National, International, Social organizations, e.g., FAO, WHO, UNICEF, CAB, NSB, etc).

References:

1. M.A. Potdar, Pharmaceutical Quality Assurance, 2nd Edn., Nirali Prakashan, 2007.
2. M.J. Allport-Settle, Current Good Manufacturing Practices, 1st Edn., Create Space, 2009.
3. B. Graham and J.D. Nally, Good Manufacturing Practices for Pharmaceuticals, 6th Edn., Informa Healthcare, 2006.
4. S.H. Willig and J.R. Stoker, Good Manufacturing Practices for Pharmaceuticals, 4th Rev Edn., Marcel Dekker, 1996.
5. P. Carson, P. Carson and N. Dent, Good Clinical Laboratory and Manufacturing Practices, 1st Edn., Royal Society of Chemistry, 2007.

BT4025D PROTEIN ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain protein structural organization, functions and applications of biologically and industrially important proteins, recombinant proteins, and DNA binding proteins.

CO2: Perform protein sequence alignment, and explain techniques to determine the three dimensional structure of unknown proteins using X-ray crystallography, NMR, etc.

CO3: Produce recombinant proteins, purify isolated proteins and recombinant proteins, perform peptide sequencing (by Edmans degradation, etc) in order to locate the amino acid positions, map the proteins for amino acid change.

CO4: Chemically synthesize peptides by SPPS, design peptides and carry out peptide modification chemically and by directed evolution for enhanced thermal stability and catalytic efficiency.

Module 1: (15 hours)

Introduction to proteins and peptides, Methods for protein isolation and purification, Industrial applications of protein engineering, Multiple sequence alignment, data bank scanning, pattern matching; sequence structure comparison, Mass spectroscopy and analysis of protein expression, Techniques of protein structure determination and prediction, Primary structure, Peptide mapping, Peptide sequencing-Edman degradation method, Secondary structures-Alpha turn, beta sheets, coil-coiled, hair pin, Tertiary structures- Domains, folding, denaturation and renaturation

Module 2: (14 hours)

Methods to determine 3D structures, Quaternary structure: Modular nature, formation of complexes. Post translational modifications, Structure functional relationship of DNA binding proteins, prokaryotic and eukaryotic transcription factors: Zn fingers, Helix-turn-helix motifs, leucine Zippers, DNA polymenrases, Membrane proteins and receptors, bacteriorhodopsin, epidermal growth factor and insulin receptors, and their interaction with effectors, protein phosphorylation, immunoglobulins, enzymes: serine proteases, ribonuclesase, lysozyme.

Module 3: (10 hours)

Design and synthesis of peptides, methods to alter primary structure of proteins- specific modification, change of amino acid by DNA mutation, multiple substitution, chimeric proteins, Thermostability of proteins, Enhancement of catalytic activity of enzymes by protein engineering, Recombinant insulin, *de novo* protein design.

References:

1. D. Voet and J.G. Voet, Biochemistry, 3rd Edn., John Wiley & Sons Inc., 2004.
2. T. E. Creighton, Protein Function: A Practical Approach, 1st Edn., Oxford University Press, 2004.
3. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd Edn., Garland Science, 1999.
4. S. J. Park and J. R. Cochran, Protein Engineering and Design, 1st Edn., CRC press, 2009.

BT4026D SYNTHETIC BIOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: learn how to design synthetic primers
CO2: know about genome editing
CO3: learn design of a cell from its constituents
CO4: know about synthesis and modification of genetic materials
CO5: learn about application of engineered cells

Module 1: (14 hours)

Introduction to synthetic biology, Structure of promoters, Gene expression, Terminators, Design of primers, Synthesis of primers, Synthesis of short double stranded DNA, DNA amplification, Ligation of PCR products with another PCR products and vectors, Digestion of amplified product.

Module 2: (12 hours)

Artificial gene circuits, Noise in gene expression, Biosensors-construction and application, Genome editing, Transposons, Recombinases, Zinc fingers, CRISPR/Cas9.

Module 3: (13 hours)

Molecular assembly of DNA, artificial synthesis of gene and its regulators, synthesis of whole chromosome, Development of synthetic cells, Recoded Escherichia coli and Mycoplasma genitellium, Application of synthetic DNA in medicine.

References:

1. H. D. Kumar, Molecular and Synthetic Biology: Nucleic acids, Metabolomics, Bioinformatics, Vitasta Publishing Pvt.Ltd, 2010.
2. D. N. Nesbeth, Synthetic Biology Handbook, 1st Edn, CRC Press, 2016.
3. A. Glieder, C.P. Kubicek, D. Mattanovich, B. Wiltschi, M. Sauer, Synthetic Biology, 1st Edn, Springer Nature, 2015.
4. T. Cathomen, M. Hirsch, M. Porteus, Genome Editing: The next step in gene therapy, 1st Edn, Springer, 2016.

BT4027D BIOPOLYMERS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain different types and sources of biopolymers, enzymatic or whole cell-based synthesis of degradable and non-biodegradable.

CO2: Comprehend the methods for preparation, extraction and characterization of natural biopolymers, biocomposites.

CO3: Summarize the importance of biodegradable polymers with ecological, medical and material applications.

CO4: Describe the importance of polymers from renewable resources, bioplastics, thermomechanical properties of biopolymers, LCA of biodegradable polymers and legislative.

Module 1: (13 hours)

Introduction to Biopolymers, Biodegradable biopolymers, Non-biodegradable Biopolymers, biopolymers from renewable resources, Plant renewable polymers, starch and its derivatives, cellulose and its derivatives, lignin and its derivatives, hemicellulose and xylan derivatives, Natural rubber, Alginates, Lipids, Proteins from wheat, corn, pea, potato and soy, Gums, carrageenan, Animal renewable polymers, glycogen, chitin, chitosan, hyluronan, casein, whey proteins, albumin, keratin, leather, collagen, gelatin, silk, chondroitin sulphate, Microbial polymers, Xantham, curdlan, pullulan, inulin, dextran, Biobased polyurethanes, polyamides, poly(ε-caprolactone), poly(glycolic acid), Polyhydroxyalkanoates, poly(lactic acid), polyesters, polycarbonates, polypropylene, polyethylene, epoxy and phenolic resins, Biopolymers from fossil carbon, poly(butylene succinate).

Module 2: (13 hours)

Recovery of these polymers (biotechnologically, extraction from natural materials). Biobased thermoplastics, thermosets, and elastomers, composites and blends, types and chemistry of biopolymers, Tools used for making blends, composites and thermosets: 3D printing, Electro spinning; Characterization of polymers for intermolecular interactions, thermal properties, thermo mechanical properties by FT-IR, AFM, SEM, TGA, DSC, Tensile strength tester. Size and linkage analysis of polymers by HPLC, NMR techniques.

Module 3: (13 hours)

Biodegradable polymers from renewable sources and their importance in ecological, medical and material applications: agriculture and packaging, Food colloids, Conductive polymers, tissue grafting, drug delivery, nonotechnologies, active packaging; certification of products and progressive technologies. The ecological importance of biodegradable polymers and polymers from renewable resources, carbon footprint. LCA of biodegradable polymers and legislative, methods of biodegradability and ecotoxicity testing.

References:

1. S. Ebnesajjad, ed., Handbook of biopolymers and biodegradable plastics – properties, processing and applications, Elsevier, 2013.
2. S. Kalia and L. Averous Biopolymers: Biomedical and environmental applications, Wiley-Scrivener, 2011.
3. D. Plackett, ed., Biopolymers - new materials for sustainable films and coatings, John Wiley and Sons Ltd., 2011.
4. H-J. Endres, A. Siebert-Raths, Engineering Biopolymers – Markets, Manufacturing, Properties and Applications, Hanser Publishers, 2011
5. R. J. Young and P. A. Lovell, Introduction to polymers, 2^{nd} Edn., Springer-Sicence + Business media, 1991.
6. S. H. Imam, R. V. Greene and B. R. Zaidi, eds., Biopolymers: Utilizing nature's advanced materials, ACS Symposium series: 723, 1997.

BT4028D RECEPTORS AND CELL SIGNALING

Pre-requisites: Cell Biology

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify various cell signaling pathways and signal molecules and recognize their characteristics
CO2: Describe the various signal transduction pathways and their regulation.
CO3: Illustrate the role of signaling pathways in growth, development and immune response
CO4: Appraise the significance of the signaling pathways in diseases and drug development and critically analyze the cross-talk among different signaling pathways.

Module 1: (13 hours)

Introduction receptors and overview of cell signaling, Ser/Thr protein kinases and phosphatases-structure and regulation, Ser/Thr protein kinases and phosphatases- AKAP anchoring proteins/scaffolds, Tyr phosphorylation signaling receptor and non-receptor TKs, Protein Kinase C (PKC) Signaling, cytokine receptors and the JAK-STAT Pathway

Module 2: (13 hours)

Hedgehog Signaling pathway, wnt signaling pathway, PI3Kinase, AKT, mTOR signaling, Regulation of Cell Function by Small GTPases. Programed Cell death signaling, Autophagy signaling pathways, Cell Signaling in the Immune System

Module 3: (13 hours)

Regulation of signaling in the nucleus by methylation and acetylation, Regulation of Signaling by Ubiquitination, TGF-beta Signaling, Steroid Hormone Signaling, The Role of NO as an Intercellular Messenger, Convergence, Divergence, and Cross-Talk Among Different Signaling Pathways.

References:

1. G. Karp, Cell and Molecular Biology, 5th Edn., Wiley, 2007
2. D. L. Wheeler, Y. Yarden, Receptor Tyrosine Kinases: Structure, Functions and Role in Human Disease, Springer, 2014
3. Q. A. Acton, Receptor Protein-Tyrosine Kinases: Advances in Research and Application, ScholarlyEditions, 2012
4. B. Alberts, A. Johnson, J. Lewis, and M. Raff, Molecular Biology of the Cell, 5th Edn., Garland Science, 2008.
5. H. Lodish, A.Berk, C.A. Kaiser, and M. Krieger, Molecular Cell Biology, 6th Edn., W. H. Freeman, 2007.

BT4029D PHARMACEUTICAL AND MEDICINAL CHEMISTRY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe the chemical concepts of drugs, drug design, QSAR, steroids and prostaglandins
CO2: Classify the drugs acting on CNS, ANS, CVS, and the anticancer, antiviral and antibiotic drugs
CO3: Appraise the mechanism of action of the different classes of drugs, QSAR and their physicochemical properties.
CO4: Appreciate the pharmacological application of the different classes of drugs, prostaglandins, steroids, and hormones

Module1: (9 hours)

Introduction to medicinal chemistry, physico chemical properties in relation to biological action, drug metabolism, concept and application of prodrugs, basics of drug design, traditional analogues and QSAR studies.

Module 2: (10 hours)

Study of classification, Mechanism of action, QSAR, physicochemical properties of drugs acting on central nervous system (CNS) and autonomous nervous system (ANS).

Module 3: (10 hours)

Classification, mechanism of action, QSAR and uses of antibiotics, anti-neoplastic agents and drugs acting on cardio vascular system (CVS).

Module 4: (10 hours)

A brief study on prostaglandins, steroids and hormones, antiviral drugs, antiinfective agents and antimalarial drugs.

References

1. J.N.Delgado, William A. Remers, Wilson and Gisvold`s Text Book of Organic Medicinal and Pharmaceutical Chemistry, J.B. Lippincott Company, 2012..
2. Harkishan Singh, V. K. Kapoor, Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan 2006.
3. H.E. Wolf, Burger's Medicinal Chemistry, Vol I to IV, 5th edition, Oxford University Press, 2012
4. W.C. Foye, Principles of Medicinal Chemistry, Lea and Febiger, 2010.

BT4030D FUNDAMENTAL NEUROBIOLOGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Students learn to recognize and to apply the basic concepts that govern the central nervous system.
CO2: To understand the biochemical and physiological make-up of the central nervous system at a molecular level and relate it to the body as a whole.
CO3: To be able to apply a thorough understanding of the basic neuroscience concepts to actual experiments.

Module 1 (13 hours)

Basic Plan of the Nervous System, Neuroscience history and terminology, Organization of the brain, central nervous system, peripheral nervous system, autonomic system, cerebral hemisphere, Cellular Components of Nervous Tissue, neurons, glia, microvasculature, astrocyte, oligodendrocyte, microglia, pyramidal cell, interneuron.

Module 2 (13 hours)

Membrane Potential and Action Potential, sodium current, potassium current, resting membrane potential, Neurotransmitters, acetylcholine, catecholamine, endocannabinoid, glia, GABA and glutamate, neuron, neurotransmitter, nitric oxide.

Module 3 (13 hours)

Fundamentals of Sensory Systems, Chemical Senses: Taste and Olfaction, Audition and vision, Fundamentals of Motor Systems, Regulatory Systems, Behavioral and Cognitive Neuroscience, Learning and Memory, Neuroscience of Consciousness.

References:

1. A. Waugh, A. Grant, and J.S. Ross, Ross and Wilson Anatomy and Physiology in health and illness, 9th Edition, Churchill Livingstone, 2001.
2. A.C. Guyton and J.E. Hall, Text book of Medical Physiology, 11th Edn., Elsevier Saunders, Philadelphia, 2006.
3. E. Widmaier, H. Raff, and K. Strang, Vander’s Human Physiology, 11th Edn., McGraw-Hill, 2008.

BT4031D BIOMATERIALS & ARTIFICIAL ORGANS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Outline the characteristics and classification of Biomaterials
CO2: Examine the role of biocompatibility in evaluating various materials
CO3: Describe the use of polymeric materials and combinations as a tissue replacement implant.
CO4: Apply the knowledge of biocompatible materials to develop artificial organs

Module 1: (13 hours)

Definition and classification of bio-materials, mechanical properties, visco elasticity, wound-healing process, body response to implants, blood compatibility. Metallic implant materials, stainless steels,co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons, medical applications..

Module 2: (13 hours)

Polymerization, polyolefin, polyamicles, Acryrilic, polymers, rubbers, high strength thermoplastics, medical applications. Soft-tissue replacements, sutures, surgical tapes, adhesive, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.

Module 3: (13 hours)

Artificial Heart, Prosthetic Cardiac Valves, Limb prosthesis, Externally Powered limb Prosthesis, Dental Implants. Extracorporeal artificial organs. Ethical, economical, environmental and legal aspects in artificial organs domain.

References:

1. S. V. Bhatt, Biomaterials, 2nd Edn., Narosa Publishing House,2005.
2. B. D. Ratner and A. S. Hoffman, Biomaterials science : an introduction to materials in medicine / edited by Buddy D. Ratner and others, 2nd Edn., London, Elsevier, 2004
3. J. B. Park, and J. D. Bronzino, Biomaterials - Principles and Applications, CRC Press, 2003.
4. J. B. Park, Biomaterials Science and Engineering, Springer Science & Business Media, 2012.
5. J. Enderle, J. D. Bronzino, and S. M. Blanchard, Introduction to Biomedical Engineering, Elsevier, 2005.

BT4032D CANCER BIOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe the hallmark of cancer and characters of cancer cells
CO2: Summarize protooncogene-oncogene conversion and its role in cancer development
CO3: Illustrate cell cycle, its regulation and how cell cycle dysfunction can lead to cancer
CO4: Explain chemical, radiation-induced carcinogenesis and hormone-dependent cancers

Module 1: (14 hours)

Characteristics of cancer cells and the onset of cancer, steps involved in tumor progression, introduction to protooncogenes, oncogenes and tumor suppressor genes, Genetic basis of cancer, Regulation of normal cell cycle, Mutations that cause changes in signal molecules, Signal switches, Modulation of cell cycle in cancer, Types of cancers. Chemical carcinogenesis, Metabolism of chemical carcinogens, Targets of chemical carcinogens, Principles of physical carcinogenesis, Radiation carcinogenesis, Free radical aspects of carcinogenesis.

Module 2: (13 hours)

Mechanism of virus-induced cancer, Hormone-sensitive and hormone-producing tumors. Oncogenes, Identification of viral and cellular oncogene products, Retroviruses and oncogenes, Detection of oncogenes, Growth factor signaling pathways in cancer, Genomic instability and DNA repair, Telomerase and senescence. Clinical significances of invasion, Heterogeneity of metastatic phenotype, Theory of invasion and metastasis.

Module 3: (12 hours)

Detection of different types of cancers, Advances in cancer detection, Prediction of aggressiveness of cancer, different pathways of apoptosis. Basic principle with examples, advantages and limitations for the different forms of cancer therapy like Chemotherapy, radiation therapy, immuno therapy, radio-immuno therapy; Hyperthermia and magnetic hyperthermia: Chemoprevention of cancer.

References:

1. R. J. B. King, M. W. Robins, Cancer Biology, 3rd Edn., Pearson/Prentice Hall, 2006
2. M. Knowles, P. Selby, Introduction to the Cellular and Molecular Biology of Cancer, 4th Edn., Oxford University Press, Oxford, 2005
3. R. W. Ruddon, Cancer Biology, 4th Edn., Oxford University Press, USA, 2007
4. M. R. Alison, The Cancer Handbook, Nature Publishing Group, 2002.
5. B. Alberts, A. Johnson, J. Lewis, and M. Raff, Molecular Biology of the Cell, 5th Edn., Garland Science, 2008.
6. H. Lodish, A. Berk, C. A. Kaiser, and M. Krieger, Molecular Cell Biology, 6th Edn., W. H. Freeman, 2007.

BT4033D STEM CELL TECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Understand the basics about stem cells and their classification
CO2: Evaluate the properties and application of Embryonic stem cells and their clinical significance.
CO3: Learn the vitro manipulation for generating distinct cell lineages.
CO4: Design experiments to induce differentiation of human embryonic stems cells into various cell types like cardiomyocytes and neurons.

Module 1: (13 hours)

Introduction to Stem Cell Biology, classification of stem cells and their sources, similarities and differences between embryonic and adult stem cells, Early embryogenesis, Blastocyst culture, Properties and application of Embryonic stem cells, embryonic stem cell self-renewal pathways, Maintenance and Characterization of human embryonic stem cells, Cord blood hematopoietic stem cells. Subcloning, spontaneous and controlled differentiation of human embryonic stem cells, Differentiation of embryonic stem cells *in vivo* and *in vitro*, Feeder free culture of human embryonic stem cells,

Module 2: (14 hours)

Therapeutic cloning and its challenges, viral and non-viral vectors, Differentiation of human embryonic stems cells into various cell types like cardiomyocytes, islet cells of the pancreas, neurons. Reprogramming of somatic cells to a pluripotent state, Yamanaka factors and iPS cells, Molecular bases of pluripotency, Role of the embryonic stem cell microenvironment and various signal transduction cascades in maintaining pluripotency, Stem Cell Niches within mammalian tissues, Mechanisms of Stem Cell Self-renewal.

Module 3: (12 hours)

Ethical considerations in stem cell research, Pre-clinical regulatory considerations, Manufacturing and Characterization Issues Pertaining to Stem Cell Products, Stem cell based therapies, genetically engineered stem cells, Therapeutic applications of stem cells for Leukemias, Neurological diseases and injuries, heart disease and diabetes.

References:

1. A. Bongso, and E.H. Lee, Stem Cells: From Bench to Bedside, World Scientific Publishing Co., Singapore, 2005
2. R. Lanza, J. Gearhart et. al., Essential of Stem Cell Biology, 3rd Edn., Elsevier Academic press, 2013
3. P. J. Quesenberry, G. S. Stein, B. Forget, and S. Weissman, Stem Cell Biology and Gene Therapy, Wiley-IEEE, 1998
4. S. Sell, Stem cells handbook, Humana Press, 2004
5. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Volume 1- Embryonic Stem Cells, Academic Press, 2004.
6. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Volume-2 Adult & Fetal Stem Cells, Academic Press, 2004.

BT4034D HUMAN PHYSIOLOGY

Prerequisite: Nil

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Total hours: 39

Course Outcomes:

CO1: Students learn to recognize and to apply the basic concepts that govern integrated body function.
CO2: To understand the chemical make-up of the human body at a molecular level and relate it to the body as a whole.
CO3: To be able to apply a thorough understanding of the basic physiologic concepts to actual experiments.

Module 1 (13 hours)

Physiology Introduction, Level of organization, Overview of nervous system, Structure and function of neurons, Generation & propagation of an action potential, Major diseases of nervous system, Overview and composition of Blood, Hemostasis, ABO Group System, Diseases of the Blood, Introduction to cardiovascular system, Passage of Blood Through the Heart, Circulatory System, Cardiovascular Diseases.

Module 2 (13 hours)

Introduction to Urinary System, Organs of the Urinary System, Formation of Urine, Diseases of the Kidney, Introduction to respiratory system, Breathing and Lung Mechanics, Homeostasis and Gas Exchange, Problems Associated With the Respiratory Tract and Breathing, Introduction to gastrointestinal system, Accessory Organs and the Digestive System, Mechanism of food digestion, Gastrointestinal Dysfunctions.

Module 3 (13 hours)

Introduction to the Endocrine System, Hormones and Types, Physiological functions of major hormones, Disorders of endocrine system, Introduction to reproductive system, Male and female reproductive system, Female Reproductive Cycle, Sexual Reproduction, Types of Birth Control, Dysfunctions of male and female reproductive systems.

References:

1. A. Waugh, A. Grant, and J.S. Ross, Ross and Wilson Anatomy and Physiology in health and illness, 9th Edition, Churchill Livingstone, 2001.
2. A.C. Guyton and J.E. Hall, Text book of Medical Physiology, 11th Edn., Elsevier Saunders, Philadelphia, 2006.
3. E. Widmaier, H. Raff, and K. Strang, Vander's Human Physiology, 11th Edn., McGraw-Hill, 2008