UPES
UNIVERSITY OF TOMORROW

SCHOOL OF
HEALTH SCIENCES
AND TECHNOLOGY

B. Tech. Biotechnology

Four-Year Program

Program Structure | 2023-2027

UPES Bidholi Campus, P.O. Bidholi via Prem Nagar, Dehradun, Uttarakhand-248007
Tel: +91 0135 2770137 | Website: www.upes.ac.in

School of Health Sciences and Technology

[B. Tech. Biotechnology]

Programme Structure

2023-2027

UPES Campus
Energy Acres
P.O Bidholi via Prem Nagar, Bidholi
Dehradun – 248007
(Uttarakhand)

Tel : + 91-135-2776053/54
Fax: + 91-135-2776090
URL: www.upes.ac.in

Contents

INTELLECTUAL PROPERTY RIGHTS

Abbreviations

Cat	Category
L	Lecture
T	Tutorial
P	Practical
C	Credits
UC	University Core
PC	Program Core
PRJ	Project Work (including Seminars, Dissertation, and Internships)
PE	Program Elective (includes Specialization courses)
UE	University Elective (includes Signatory, Exploratory and Open Electives)
TC	Total Credits

Vision and Mission of UPES and SOHST:

Vision of UPES

- To be an Institution of Global standing for developing professionally competent talent contributing to nation building.

Mission of UPES

- Develop industry-focused professionals with an international outlook.
- Foster effective outcome-based education system to continually improve teaching-learning and research.
- Inculcate integrative thought process among students to instil lifelong learning.
- Create global knowledge eco-system through training, research & development and consultancy.
- Practice and promote high standards of professional ethics and develop harmonious relationship with environment and society.

Vision of SOHST

- Leadership in Health Sciences & Technology for improving Planetary, and Public Health

Mission of SOHST

- Create thought leaders and change makers.
- Design appropriate, holistic and sustainable programs.
- Converge multi-disciplinary efforts to make a difference.

Programme Educational Objectives (PEOs)

PEO1: To prepare students for successful careers in industry and research institutes.

PEO2: To develop skills in students as to enable them to solve problems with relevance to biotechnology research, industry and societal issues.

PEO3: To enable students to work in a team with multidisciplinary approach.

PEO4: To promote and inculcate ethics and code of professional practice among students.

Programme Outcomes (POs)

Graduates will be able to:

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex bio-engineering problems.

PO2. Identify, formulate, research literature, and analyze complex bio-engineering problems reaching substantiated conclusions using first principles of mathematics, natural and life sciences, and engineering sciences.

PO3. Design solutions for complex bio-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. 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. Create, select, and apply appropriate techniques, resources, and modern bio-engineering and bioinformatics tools including prediction and modelling to complex bio-engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional bio-engineering practice.

PO7. Comprehend the impact of the professional and global issues in societal and environmental contexts, and come up with ideas for global solutions, demonstrate the knowledge and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the bio-engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex bio-engineering activities with the community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the bio-engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments.

PO12. 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.

Program Specific Outcomes (PSOs)

Graduates will be able to:

PSO1	Understand biotechnology principles
PSO2	Demonstrate proficiency in using advanced laboratory techniques and equipment.
PSO3	Develop and implement innovative biotechnological solutions for various sectors,

PSO4	Apply ethical and regulatory principles, and social awareness to biotechnological practices, exhibit an understanding of regulatory frameworks and intellectual property rights.

Overview of Credit Allocation/ Credit Break up

Category-wise Credit distribution

Category	Number of Credits	Credit Percentage (%)
University Core (UC)	42	26.25
Programme Core (PC)	73	45.625
Programme Elective (PE)	12	7.5
University Elective (UE)	18	11.25
Projects (PRJ)	15	9.375
Mandatory Non-Credit Courses (MNC)	2 Non- credit Qualifier courses (Social Internship- IInd Sem) (Govt/ NGO/ Startup Internship-IVth Sem)	
Total	160	100

Programme Structure

Semester 1						
Cat	**Course Code**	**Subjects**	**L**	**T**	**P**	**C**
UC	CHEM1001	Chemistry	2	1	1	4
UC	PHYS1002	Physics	2	1	1	4
UC	MATH1048	Mathematics (I)	2	1	0	3
PC	HSBT1004	Introduction to Biotechnology	2	1	1	4
UC	HSBT1003	IT systems for Health Sciences	2	0	1	3
UC		Living Conversations	1	1	0	2
	Total credits		**11**	**5**	**4**	**20**

Semester 2						
Cat	**Course Code**	**Subjects**	**L**	**T**	**P**	**C**
UC		Mathematics (II)	2	1	0	3
UC	ECEG 1005	Basic Electrical and Electronics Engineering	2	0	0	2
UC	MEPD 1003	Workshop Practices	1	0	1	2
UC	MECH 1005	Engineering Graphics	1	0	1	2
UC	MECH 1006	Engineering Thermodynamics	2	1	0	3
PC	HSCC 2022	Biostatistics	2	0	0	2
PC		Biochemistry	2	1	1	4
UC		Critical Thinking and Writing (SFL)	1	1	0	2
MNC	HUMN 1019	Social Internship	0	0	0	0
	Total credits		**13**	**4**	**3**	**20**

Semester 3						
Cat	**Course Code**	**Subjects**	**L**	**T**	**P**	**C**
PC	HSMB 2018	Cell Biology	2	1	1	4
PC	HSMB 2019	Microbiology & Microbial Technology	2	0	1	3
PC	HSBT 1002	Molecular Biology and Genetics	2	1	1	4
UE		Exploratory Elective 1	3	0	0	3
UC		Leadership and Teamwork	1	1	0	2
UC		Environmental Science	3	1	0	4
	Total credits		**13**	**4**	**3**	**20**

Semester 4						
Cat	**Course Code**	**Subjects**	**L**	**T**	**P**	**C**
PC	HSMB 3026	Immunology & Immuno-techniques	2	1	1	4
PC	HSFT2009	Bioprocess Engineering	2	0	1	3
PC	New course	Heat and Mass transfer	2	0	1	3
PC	HSBT 3008	Bioinformatics & Computational Biology	2	0	1	3
PC		Biophysics	2	0	0	2
UE		Exploratory Elective 2	3	0	0	3
UC		Working With Data	1	1	0	2
MNC		Government/NGO/Startup Internship-Qualifying	0	0	0	0
	Total credits		**14**	**2**	**4**	**20**

Semester 5						
Cat	**Course Code**	**Subjects**	**L**	**T**	**P**	**C**
PC	HSMB 3027	Genetic Engineering & Genomics	2	1	1	4
PC	HSBT 3005	Systems Biology	2	0	1	3
PC	HSBT 3003	Downstream Processing	2	0	1	3
PC	HSBT 3004	Bioanalytical Techniques	2	1	1	4
PRJ	PROJ 3108	Project I	0	0	1	1
UE		Exploratory Elective 3	3	0	0	3
UC		Design Thinking	1	1	0	2
	Total credits		**12**	**3**	**5**	**20**

Semester 6						
Cat	**Course Code**	**Subjects**	**L**	**T**	**P**	**C**
PC		Molecular & Nano Diagnostics	2	0	1	3
PC		Data analysis and simulations	2	0	1	3
PC		Environmental Biotechnology	2	0	0	2
PC	HSBT 2007	Enzyme Technology	2	1	0	3
PE		Program Elective - I	2	1	0	3
PRJ	PROJ 3109	Project II (Research plan/ synopsis)	0	0	1	1
UE		Exploratory Elective 4	3	0	0	3
UC		Start your Start Up	1	1	0	2
MNC	SIIB 3106	Summer Industrial Internship-Qualifying	0	0	0	0
	Total credits		**14**	**3**	**3**	**20**

Semester 7						
Cat	**Course Code**	**Subjects**	**L**	**T**	**P**	**C**
PC	HSBT 3007	Animal and Plant Biotechnology	2	1	1	4
PC		Proteomics & Protein Engineering	2	0	1	3
PE		Program Elective - II	2	1	0	3
PE		Program Elective - III	2	1	0	3
PRJ	PROJ 4105	Project III (Hands On experience)	0	0	3	3
UE		Exploratory Elective 5	3	0	0	3
PRJ	SIIB 4107	Summer Internship Presentation	0	0	1	1
	Total credits		**11**	**3**	**6**	**20**

Semester 8						
Cat	**Course Code**	**Subjects**	**L**	**T**	**P**	**C**
PC	HSCC 4001	Ethics, Regulations and IPR	2	1	0	3
PC	HSBT 4002	GMP and GLP	1	1	0	2
PE		Program Elective - IV	2	1	0	3
PRJ	PROJ 4125	Project IV (Startup/ Industrial/ Research)	0	0	9	9
UE		Exploratory Elective 6	3	0	0	3

	Total credits		**8**	**3**	**9**	**20**
Total credits for all semesters			**160**			

List of available Courses in Programme (Major) Electives/ Specialization baskets

	Computational and Nano-Biotechnology	**Gene Therapy and Personalized Medicine**	**Biosimilars and Oncology**
PE-1	Big data Analytics	Gene Expression and Transgenic	Biosimilars (Discovery, development and Technology)
PE-2	Machine Learning	Stem-Cell technology	Waste management and Upcycle
PE-3	Rational Drug Discovery	Genome Editing	Cancer Biology
PE-4	Nano-Biotechnology	Precision Medicine & Wellness	Tissue Engineering

SEMESTER I

CHEM1001	Chemistry	L-T-P-C: 2-1-1-4

Course Objectives: The objective of the Chemistry is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during the course of their study in the industry and Engineering field. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will be able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with new technologies.

Course Outcomes: On the completion of the course, the students will be able to:
CO1. Understand microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
CO2. Comprehend bulk properties and processes using thermodynamic considerations.
CO3. Apply the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.
CO4. Rationalize periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.

Syllabus

Unit 1: Atomic and Molecular Structure (5hrs)
Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Unit 2: Spectroscopic techniques and applications (5hrs)
Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.

Unit 3: Intermolecular forces and potential energy surfaces (4hrs)
Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Unit 4: Use of free energy in chemical equilibria (6hrs)

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

Unit 5: Periodic properties (5hrs)

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard and soft acids and bases, molecular geometries.

Unit 6: Stereochemistry (5hrs)

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, di-stereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transition metal compounds.

Unit 7: Organic reactions and synthesis of a drug molecule (5hrs)

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Text and Reference books:

1. Ramesh, S. and Vairam S. Engineering Chemistry, Wiley India (2012).
2. Jain, P.C. and Jain, M. Engineering Chemistry, Dhanpat Rai Publishing Co. (2005).
3. Puri, B.R., Sharma and L.R., Pathania, M.S. Principles of Physical Chemistry, Vishal Publishing Co. (2008).

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	2	-	2	2	1	-								
CO 2	3	3	1	2	3	2	1	2	1	1	2					
CO 3	2	3	3	-	-	1	3	1		2				1		
CO 4	2	3	2	-	-	2	3	1	2	2			1	1		
Average	3	3	2	2	1	2	2	1	1	1	1		1	1		

Practical:

Choice of 10-12 experiments from the following:

1. Determination of surface tension and viscosity.

2. Thin layer chromatography.
3. Ion exchange column for removal of hardness of water.
4. Determination of chloride content of water.
5. Colligative properties using freezing point depression.
6. Determination of the rate constant of a reaction.
7. Determination of cell constant and conductance of solutions.
8. Potentiometry - determination of redox potentials and emfs.
9. Synthesis of a polymer/drug.
10. Saponification/acid value of an oil.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

PHYS1002	**Physics**	**L-T-P-C: 2-1-1-4**

Course Objectives: The objective of the course is to demonstrate the various phenomenon of light, principles of LASER and electron optics and their applications in health sciences. To make students understand the basic radiation, characteristics, interaction and detection used in nuclear medicine and health sciences. To develop understanding of the state of matter and their characteristics along

with the fundamentals of x-rays and applications in health sciences, and to utilize the fundamentals of quantum mechanics in various areas of health sciences.

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

CO1. Understand the significance of light, lasers, electron optics and their application in health sciences.

CO2. Illustrate the basic radiation, their characteristics, interaction and detection used in nuclear medicine and health sciences.

CO3. Comprehend the utilization of X-ray characteristics, properties and applications in health sciences.

CO4. Apply the fundamentals of Quantum Mechanics in various areas of health sciences.

Syllabus

Unit 1: Light, LASER, and electron optics: (12hrs)

Interference, waves and Huygen's principle, phase and path difference, diffraction, difference with interference. Introduction to LASER, Absorption, Spontaneous and Stimulated emission of radiation, Population inversion & types of pumping, Main components of a LASER, Construction & working of Ruby and Helium-Neon laser, applications in health sciences.

Electron optics, motion of an electron in uniform electric and magnetic field, scanning electron microscopy (SEM), transmission electron microscopy (TEM), applications of microscopy in health sciences.

Unit 2: Basic Radiation Physics: (10hrs)

Introduction, Classification of radiation – ionizing and non-ionizing, Nuclear structure, Nuclear reactions, Radioactivity, Modes of radioactive decay-alpha decay, beta decay, gamma decay, Radioactive isotopes, G.M. and Scintillation counters, Precautions in radio isotope handling, Nuclear Medicine.

Unit 3: Solid-State Physics and X-ray diffraction: (12hrs)

States of matter, Introduction to Solid State Physics: single crystals, polycrystalline and amorphous materials, Lattice, Basis and crystal structure, Unit Cell (primitive and non-primitive), Bravais lattices, lattice planes, Miller indices, SC, BCC, and sodium chloride structures, closed packed structures (FCC and HCP).

Origin of x-rays, properties of x-rays, Moseley's law, X-ray diffraction, Structure determination by x-ray diffraction, Bragg's law, applications of x-rays in health sciences.

Unit 4: Quantum Mechanics for Biologists: (11hrs)

Introduction to Quantum Mechanics, Wave particle duality, De Broglie waves, Wave function and its interpretation, Normalization, Uncertainty principle and its applications.

Text books:

1. Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001).

2. Beiser, A., Concept of Modern Physics, Tata McGraw Hill (2007).

3. Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999).

Reference Books:

1. Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice HallTM (2008).

2. Wehr, M.R, Richards, J.A., Adair, T.W., Physics of The Atom, Narosa Publishing House (1990).

3. Verma, N.K., Physics for Engineers, Prentice Hall of India (2014).

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	1	-	-	-	2	-	2	-	-	-	1	-	-	-	
CO2	3	1	-	-	-	1	-	-	-	-	-	1	-	-	-	
CO3	2	3	2	2	1	-	2	1	2	1	1	1				
CO4	3	2	1	2	1	-	2	1	2	1	2	1				
Avera ge	3	2	2	2	1	2	2	1	2	1	2	1				

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

Practical:

1. To determine the frequency of AC mains by using a sonometer.
2. To study the Hall effect and hence determine the Hall coefficient (R_h) and carrier density (n) of a given semiconductor material.
3. To study the induced emf as a function of velocity of the magnet passing through the coil (Faraday's Law).
4. To study the charge delivered due to electromagnetic induction.
5. To study the variation of magnetic field with distance along the axis of a current carrying circular coil and hence estimate the radius of the coil.
6. To plot the characteristics of photocurrent vs voltage at different frequency.
7. To determine the Numerical Aperture of an optical fibre and study about the bending losses. 8. To study the laser beam diffraction.
8. Study of both the current - voltage characteristic and the power curve to find the maximum power point (MPP) and efficiency of a solar cell.
9. To find the Planck's constant by using LEDs.
10. Presentation related to any science concept.

Text Books

1. H. Singh, Practical Physics, S. Chand & Company LTD., ISBN: 8121904692.
2. S. L. Kakani, S. Kakani, Applied Physics-Theory & Practicals, Viva Books, ISBN: 9788130924892.
3. C. L. Arora, Practical Physics, S. Chand & Company LTD., ISBN: 9788121909099, 8121909090.

Reference Books

1. Gupta, Kumar, Practical Physics, Pragati Prakashan, ISBN: 9789386633569.
2. I. Prakash, R. Krishna, A. K. Jha, Practical Physics, Kitab Mahal, ISBN: 8122504167, 9788122504163
3. P. R. Sasi Kumar, Practical Physics, Prentice Hall of India Pvt Ltd, ISBN: 9788920344341

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs)

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	3	-	-	-	2	-	-	-	2	-	-	-	-	-	
CO2	-	3	-	-	-	-	-	-	-	2	-	-	-	-	-	
CO3	-	-	-	3	-	2	-	-	1	1	-	-	-	-	-	
CO4	-	-	3	-	2	-	-	-	1	-	-	-	-	-	-	
Avg	-	3	3	3	2	-	-	-	1	2	-	-	-	-	-	

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

HSBT1004	Introduction to Biotechnology	L-T-P-C: 2-1-1-4

Course Objectives: The "Introduction to Biotechnology" course provides an in-depth exploration of the exciting field of biotechnology. This course is designed for students who want to gain a comprehensive understanding of the fundamental principles and applications of biotechnology and how it is changing the world. The course covers the latest advancements in genetic engineering, recombinant DNA technology, bioprocessing, and bio-manufacturing techniques. The course is intended to be suitable for a wide range of learners, including students, professionals from other fields, and anyone with an interest in biotechnology and its potential impact on society. No specific prerequisites are necessary for taking this course, making it an ideal starting point for anyone looking to learn about biotechnology from the ground up.

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

CO1. Understanding key concepts and techniques in biotechnology, including genetic engineering, fermentation, and cell culture.

CO2. Applying the Knowledge of applications of biotechnology in fields such as medicine, agriculture, and environmental science.

CO3. Analyze and evaluate the ethical and social implications of biotechnology.

CO4. Apply skills in critical thinking, problem solving, and scientific communication related to biotechnology.

Syllabus

Unit 1: Introduction Basic Unit of life: (7hrs)

Macromolecules; prokaryotes; eukaryotes; cell components- sub-cellular organelles.

Unit 2. Microbial life and fermentation process: **(7hrs)**

Bacteria, fungi and viruses; basic concept of microbial growth, bioprocess technology and enzymes.

Unit 3. Molecular biology concepts: (8hrs)

Central dogma of molecular biology-replication, transcription and translation; recombinant DNA technology; basic concept of immune system, vaccines, GMOs.

Unit 4. Plant and Animal Biotechnology: (7hrs)

Cell and tissue culture, transgenic plant and animals.

Unit 5. Medical Biotechnology: (8hrs)

Introduction to biopharmaceuticals, herbal medicines, gene therapy, nano-biotechnology, bioinformatics and drug design, biosafety and bioethics.

Unit 6. Molecular techniques in Biotechnology: (8hrs)

Introduction to microscopy, spectroscopy, electrophoresis, chromatography, centrifugation, radioisotope technique, PCR, northern blotting southern blotting, western blotting.

Text books

1. Smith J. E., Biotechnology, 3rd Edition, Cambridge University Press (2006)

2. Dhami, P.S., Srivastava, H.N. and Chopra, G., A Textbook of Biology, Pradeep Publications (2008).

Reference Books

1. Saltzman WM. Biomedical Engineering Bridging Medicine and Technology 2009 (ISBN-13: 9780521840996)

2. Starr, C., Evers C. A., Starr L. Concepts of Biology, First Edition, Cengage Learning India Pvt. Ltd. (2010)

3. Roberts, M. and Ingram, N. Biology, 2nd Edition, Nelson Thomas Ltd., UK (2001)

Practical:

1. Basic handling of instruments: Pipettes, pH-meter, centrifuge, weighing balance, autoclave
2. Preparation of DNA using C-Tab method
3. Introduction to PCR – working of PCR, Programming.
4. Introduction to RT-PCR – working, programming.
5. Primer design using software.
6. Gene DNA amplification by random / specific primers.
7. Southern Hybridization.
8. Protein Isolation
9. Agarose gel electrophoresis.
10. Isolation and Purification of microorganism from the soil

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	1	2	1	-	-	2	1	-	1	1	2	1	1	-

CO 2	2	1	1	2	1	-	-	2	1	-	1	2	2	2	1	-
CO 3	2	1	1	2	1	-	-	2	1	-	1	2	2	3	1	-
CO 4	2	2	2	3	3	1	1	2	2	1	2	3	1	3	3	1
Avg	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

MATH1048	**Mathematics-I**	**L-T-P-C: 2-1-0-3**

Course Objectives: The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus

mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

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

CO1. Understand differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.

CO2. Illustrate the tool of power series and Fourier series for learning advanced Engineering Mathematics.

CO3. Describe functions of several variables that are essential in most branches of engineering.

CO4. Apply the essential tool of matrices and linear algebra in a comprehensive manner.

Syllabus

Unit 1: Calculus: **(12hrs)**

Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Unit 2: Sequences and Series: **(10hrs)**

Convergence of sequences and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithmic functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Unit 3: Multivariable Calculus (Differentiation): **(11hrs)**

Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Unit 4: Matrices: **(12hrs)**

Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Text books

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

2. Reena Garg & Chandrika Prasad, Advanced Engineering Mathematics, Khanna Book Publishing Co., 2018.
3. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	
CO4	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-	
Avg	-	3	3	3	2	-	-	-	-	3	-	-	-	-	-	

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

HSBT1003	IT systems for Health Sciences	L-T-P-C: 2-0-1-3

Course Objectives: The objective of the course is to know the basics of computers, various types of databases,, their applications in the field of life sciences and basics of data visualization.

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

CO1. Understand the basics of computer system.
CO2. Understand the management of the database-information gathering, requirement.
CO3. Analyze the basics of data visualization and reporting.
CO4. Comprehend the role of bioinformatics in drug discovery.
CO5. Apply this knowledge in planning and managing the projects.

Syllabus

Unit 1: Knowing Computer: (9hrs)

What is Computer, Basic Applications of Computer; Components of Computer System, Central Processing Unit (CPU), input/output Devices, Computer Memory, Concepts of Hardware and Software; Concept of Computing, Data and Information; evolution of computing devices.

Unit 2: Basics of data handling: (9hrs)

Types of data; structured, unstucture and semi stuctured data; Introduction to database, ACID properties, SQL & NOSQL databases, BASE Properties, ER Diagram, Introduction Inmemory processing, Basics Excel Operations, Graphs and formulas in Ms Excel.

Unit 3: Protein and Genome Databanks: (9hrs)

GenBank, SwissProt, PDP, RefSeq. Concept of Information Systems and Software: Information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project.

Unit 4: Visualization: (8hrs)

Basics of Tableau for visualization, Reports and graphs, data connection; Tableau Calculations & Filters; Dashboard.

Unit 5: (10hrs)

Data analysis in Preclinical development: Chromatographic data analysis (CDS), Laboratory Information management System (LIMS) and Text Information Management System (TIMS)

Text Books and References:

1. Computer Application in Pharmacy – William E.Fassett –Lea and Febiger, ISBN 13- 978-0812110197

2. Computer Application in Pharmaceutical Research and Development –Sean Ekins, Wiley-Interscience, ISBN:9780471737797
3. Bioinformatics (Concept, Skills and Applications) – S.C.Rastogi-CBS, (2019), ISBN 13- 978-8123914824

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1				2	3	1				1			1	2		
CO 2				2	3	1				1			1	2		
CO 3		3		2	3	1		2	2	1		2	1	2		
CO 4				3	3	1				2			1	2	2	
CO 5		2										0.5				
Average	0	3	0	2	3	1	0	1	1	1	0	1	1	2	1	0

Practical:

1. MS. Excel: Getting to Know Excel, The Ribbon, Identify the terminology and elements of the Ribbon. The Work Surface, Recognize the main terms used to describe Excel's work canvas. Navigation, utilize the keyboard or mouse to select cells and ranges in a spreadsheet. Controlling Your Start Experience
2. Essential Formula Knowledge: Formula Anatomy, Understanding Excel Formula Anatomy, Cell Referencing –Learn about working with absolute and relative cell referencing. Cell referencing – Example: See absolute and relative cell referencing in practice and learn about ways to copy and paste formulas. Function Anatomy: Use to understand the anatomy of Excel functions and what their components mean. Math Functions: Learn basic math functions including SUM, ROUND, and SUBTOTAL.
3. Basic Statistics: Learn basic statistical functions including COUNT, COUNTA, AVERAGE, MAX, MIN, MEDIAN, and MODE. Logic Functions: Learn to build standalone logical IF functions and make them more complex by nesting AND and OR within them. Text Functions: Learn to break apart text with the LEFT, RIGHT, MID, FIND and SEARCH functions, and to combine text with the & character..
4. Tableau: Basics-Start Page-Show Me; Connecting to Excel Files; Connecting to Text Files; Connect to Microsoft SQL Server; Connecting to Microsoft Analysis Services; Creating and Removing Hierarchies; Bins; Joining Tables; Data Blending.
5. Tableau Basic Reports-Parameters; Grouping Example 1; Grouping Example 2; Edit Groups; Set; Combined Sets; Creating a First Report; Data Labels; Create Folders; Sorting Data; Add Totals, Sub Totals and Grand Totals 6. Tableau Calculations & Filters-Calculated Fields; Basic Approach to Calculate Rank; Advanced Approach to Calculate Rank; Calculating Running Total; Filters Introduction; Quick Filters; Filters on Dimensions; Conditional Filters; Top and Bottom Filters; Filters on Measures; Context Filters; Slicing Filters; Data Source Filters; Extract Filters.

Recommended books

1. Excel, All-in-One For Dummies 1st Edition by Greg Harvey, (2019)

2. Tableau 10 for Beginners: Step by Step guide to developing visualizations in Tableau 10 Kindle Edition by Chandraish Sinha (Author)

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

SEMESTER II

Mathematics-II	L-T-P-C: 2-1-0-3

Course Objectives: The objective of this course is to familiarize prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level mathematics and applications that would be essential for their disciplines.

Course outcomes: On completion of the course the students will be able to:

CO1. Understand and apply the mathematical tools needed in evaluating multiple integrals and their usage.

CO2. Analyze the tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing with engineering problems.

CO3. Apply effective mathematical tools for the solutions of differential equations that model physical processes.

Syllabus

Unit 1: Multivariable Calculus (Integration) Multiple Integration:

(9hrs)

Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Unit 2: First order ordinary differential equations:

(9hrs)

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

Unit 3: Ordinary differential equations of higher orders:

(9hrs)

Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Unit 4: Complex Variable:

(9hrs)

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Unit 5: Integration Contour integrals:

(9hrs)

Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Text book

1. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, 2018.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
3. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
4. W. E. Boyce and R. C. Di Prima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
5. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
6. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	3			1		3		2			3	2			
CO 2	2	3			2		1					1	2			1
CO 3	2	3			1		1			3					1	2
Average	2	3			1		2		2	3		2	2		1	2

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

ECEG1005	Basic Electrical and Electronics Engineering	L-T-P-C: 2-0-0-2

Course Objectives:

This course introduces basic signal, spectrum, and amplifier concepts for the analog electronic circuits. The electronic devices including diodes, bipolar junction transistors (BJTs), field effect transistors (FETs) and Operational Amplifiers (Op-Amps) will be discussed. In each device, its analysis is firstly presented after a particular device physics overview, and then the design some circuit applications follow. The focus of this course is not only to develop the student ability to analyze and design basic analog electronic circuits with passive components and/or the active elements like diode, transistors and Op-Amp. Besides, some experiments provided to help students to have a thorough grasp of the basic electronic circuit problem.

Course Outcomes:

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

CO1. Understand the basics of EE abstractions on which analysis and design of electrical and electronic circuits and systems are based, including lumped circuit, digital and operational amplifier abstractions.

CO2. Comprehend the use of abstractions to analyze and design simple electronic circuits.

CO3. Formulate and solve the differential equations describing time behavior of circuits containing energy storage elements.

CO4. Analyze complex devices such as semiconductor diodes and field-effect Transistors modeled and how the models are used in the design and analysis of useful circuits.

CO5. Design and construct circuits, take measurements of circuit behavior and Performance, compare with predicted circuit models and explain discrepancies.

Syllabus

UNIT 1 D.C. & A.C circuits: D.C. circuits: (12hrs)

Ohm's law, Kirchhoff's Laws, Thevenins, Nortons, superposition theorem, Maximum power transfer theorem, Reciprocity, Compensation and Tellegan's Theorem. D.C. circuits, Nodal and Mesh analysis. Series and Parallel A.C. circuits: Series and Parallel A.C. circuit, Series and Parallel resonance. Q factor, cut off frequency and bandwidth. , importance of earthling& power factor.

UNIT 2: Electromagnetism: (10hrs)

Transformers: Principle, construction and working of transformer, Efficiency and regulation. Electrical Machines: Introduction to D.C. Machines, induction motor, Synchronous machines. Measuring Instruments: Voltmeter, Ammeter, Wattmeter, Energy meter.

UNIT 3: Semiconductors: (13hrs)

Crystalline material: Mechanical properties, Energy band theory, Fermi levels; Conductors, Semiconductors and Insulators: electrical properties, band diagrams. Semiconductors: intrinsic and

extrinsic, energy band diagram, electrical conduction phenomenon, P-type and N-type semiconductors, drift and diffusion carriers.
Formation of P-N junction, energy band diagram, built-in-potential forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics, Zener breakdown, Avalanche breakdown and its reverse characteristics; Junction capacitance and Varactor diode. Simple diode circuits, load line, linear piecewise model; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.

UNIT 4: Bipolar Junction Transistors: (10hrs)

Formation of PNP / NPN junctions, energy band diagram; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode, transistor action, injection efficiency, base transport factor and current amplification factors for CB and CE modes. Biasing and Bias stability: calculation of stability factor;

Reference Books

1. Kothari &Nagarath: Basic Electrical Engg. (4th Edition, 2019), TMH. ISBN-978-9353165727
2. B.L. Theraja& A.K. Theraja, S.Chand: Electrical Technology (Vol-1). ISBN-978-8121924405
3. Deltoro: Electrical Engg Fundamentals, PHI (2011). ISBN- 978-8126529513
4. D.C. Kulshreshtha: Basic Electrical Engineering, Revised 1st Edition, Mcgraw Hill Education.(2019), ISBN- 978-9353167219

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1			1	1	3		2			3				
CO 2	1	2	2				1					1				
CO 3	2	3		2	1	2	1			3						
CO 4	1	1	2		2		1		1		1	2				
CO 5		2	1	1	1		1	2		2						
Average	1	2	1	2	1	1	1	2	0.5	1	0.2	1.2				

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10

	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

MEPD1003	**Workshop Practices**	**L-T-P-C: 1-0-1-2**

Course Objectives: The objective of this subject is to make students familiar with basic engineering practices in a workshop. This will help in equipment, handling, repair and save wastage of time.

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

CO1. Know how casting and welding is carried out.
CO2. Understand how metal work is carried out and fitting of different parts in an equipment.
CO3. Outline the applications of carpentry in various domains of food processing and additives.
C04. Analyze the principles of hot working and cold working.
CO5. Apply rolling and forging, drawing and extrusion.

Syllabus

Unit 1. Manufacturing Methods: **(5hrs)**

Casting, forming, machining, joining, advanced manufacturing methods. CNC machining, Additive manufacturing.

Unit 2. Fitting operations: **(3hrs)**

Power tools. Electrical & Electronics.

Unit 3. Carpentry: **(3hrs)**

Plastic moulding, glass cutting.

Unit 4: **Metal casting:** **(4hrs)**

Welding (arc welding & gas welding), brazing.

Practical:

Experiment 1. Casting
Experiment 2. Welding, Non-traditional Machining
Experiment 3. Metal working
Experiment 4. Fitting
Experiment 5. Carpentry
Experiment 6. Additive
Experiment 7. Hot working cold working
Experiment 8. Rolling
Experiment 9. Forging, drawing, extrusion

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1			1	1	3		2			3				
CO 2	1	2	2				1					1				
CO 3	2	3		2	1	2	1			3						
CO 4	1	1	2		2		1		2		1	2				
CO 5		2	1	1	1		2	3		2						
Average	1	2	1	1	1	1	2	2	1	1	1	1				

Text Books/References:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.

3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.

4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

MECH1005	Engineering graphics	L-T-P-C: 1-0-1-2

Course Objectives: To construct any structure or machine correctly and methodically, one must record his idea before starting construction work. These recorded ideas become more vivid and forceful if they are shown on a paper in the form of drawing of the structure or machine. Such a drawing will be very great help to the man who looks after the construction of this structure or machine.

Course Outcome: On the completion of the course the students will be able to:

CO1. Comprehend sheet metal industry

CO2. Interpret engineering data in the form of drawing

CO3. Analyze different lines and their importance

CO4. Project different solids, and customize Computer aided designs and drawings.

Syllabus

UNIT 1- Drawing Techniques and Scales: (3hrs)

Various type of lines, principles of dimensioning, size and location as per IS code of practice (SP-46) for general Engineering. Drawing: Practice of drawing, various types of lines and dimensioning exercises. Drawing exercises pertaining to symbols. Conventions and Exercise of lettering techniques. Free hand printing of letters and numerals in 3, 5, 8 and 12 mm sizes, vertical and inclined at 75 degree. Instrumental lettering in single stroke. Linear scale, Diagonal scale &Vernier scale. Projection of point, line and plane

UNIT-2: Projections of Solids: (3hrs)

Regular solids of revolution and polyhedrons etc. and their auxiliary views. Sectioning of Solids, Principal of sanctioning, Types of sanctioning and their practice on projection of solids, Sectioning by auxiliary planes.

UNIT-3: Development of Surfaces: (3hrs)

Development of surfaces of cylinders, cones, pyramid, prism etc. Exercises involving development of unique surfaces like Y-piece, hopper, tray, truncated pieces etc. Intersection of Surfaces: Intersection of cylinders, cones and prisms with their axes being vertical, horizontal or inclines. Exercise on intersection of solids-cylinder and cylinder, cylinder and cone, prism and prism.

Unit-4: Isometric Projection: (2hrs)

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

Unit-5: Overview of Computer Graphics (2hrs)

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

Unit-6: Customization & CAD Drawing (2 Hrs)

Consisting of set up of the drawing page and the printer, including scale settings, setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles; Practice of Orthographic projections. Simple Trusses: Graphical Method.

Text book:

1. A Text book of Engineering Drawing by P. S. Gill. S. K. Kataria and sons publications. 2013, ISBN: 978-9350143155
2. A Text book of Engineering Drawing by R.K Dhawan, S. Chand & company Pvt. Ltd. 2019, ISBN: 9352837371
3. A Text book of Engineering Drawing by K. Venkata Reddy, B.S Publications. 2008

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3				1	2			1		1					
CO 2	3				1				1		1					
CO 3	3				1				1		1					
CO 4	3				1				1		1					
Average	3	0	0	0	1	2	0	0	1	0	1					

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

MECH1006	Engineering Thermodynamics	L-T-P-C: 2-1-0-3

Course Objective:

1. To understand the concepts of engineering thermodynamics.
2. To acquire knowledge about the laws of thermodynamics and its applicability.
3. To be able to solve complex engineering problems using the thermodynamic principles.

Course Outcome:

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

CO1. Understand the basics of thermodynamics, mass and energy conservation principle and work and heat for closed and open system. .

CO2. Comprehend the concepts and applications of energy, entropy and exergy.

CO3. Analyze the thermodynamic cycles and evaluate performance parameters.

CO4. Apply the laws of thermodynamics to solve engineering problems.

CO5. Estimate heat of reaction and heat capacities for various processes using tools like spreadsheets.

Syllabus

Unit 1: Introduction to thermodynamics- **(8hrs)**

Scope of thermodynamics, Dimensions and units, temperature, pressure, work, energy and heat, thermodynamic system and control volume, thermodynamic properties, processes and cycles, Thermodynamic equilibrium.

Unit 2: First law of thermodynamics- **(8hrs)**
State functions; equilibrium; phase rule; reversible process; constant P, V, T processes, mass, and energy balance for open systems, first law of thermodynamics for steady flow process.

Unit 3: Phases and, phase transitions- **(8hrs)**
PVT behavior; description of materials – Ideal gas law, van der Waals, virial, and cubic equations of state; Reduced conditions & corresponding states theories; correlations in description of material properties and behavior; Calculations done using tools like spreadsheets/MS Excel; Defining Thermodynamic packages in simulators (ASPEN/DWSim).

Unit 4: Heat effects- **(7hrs)**
latent heat, sensible heat, standard heats of formation, reaction, and combustion. Calculations done using tools like spreadsheets/MS Excel.

Unit 5: Second law of thermodynamic- **(7hrs)**
Concepts of second law, Heat engines, Carnot's theorem; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work.

Unit 6: **Applications of thermodynamics**- **(7hrs)**
Flow processes, pumps, compressors, and turbines; The Carnot refrigerator; Vapor-compression cycle; Absorption refrigeration; Heat pump, Liquefaction processes.

Text books:
1. Engineering Thermodynamics by P.K. Nag, McGraw-Hill Education, 6th Edition, ISBN: 978-9352606429
2. Fundamentals of Thermodynamics by Borgnakke & Sonntag, 7th Ed. Wiley India (P) Ltd. 2016
3. Thermodynamics – An Engineering Approach by Yunus Cengel & Boles, McGraw-Hill Education. 2019

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	1	1		2	2		2	2	1	3	2	1		
CO 2	3	3	2	1		3	2	2	2	2	1	3	2	1		
CO 3	3	3	2	2		3	1	1	2	2		2	1	1		
CO 4	2	1	1	1	1	2			2	1		3	1	1		
CO 5	2	2	2	1		1			2	2		3	1	1		
Average	3	2	2	1	1	2	1	2	2	2	1	3	1	1		

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10

	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Biochemistry	L-T-P-C: 2-1-1-4

Course objectives: The course is aimed to give students an exposure of basic role of biomolecules and their chemical interactions inside the cell. It provides deeper insight into structures, properties and functions of major bio-molecules and metabolic pathways in the living systems.

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

CO1. Understand the structure and functions of different chemical building blocks of life.

CO2. Identify and draw structures of various types of biomolecules.

CO3. Explain about basic concepts of enzymes and central role of enzymes in catalyzing the reactions in living system.

CO4. Comprehensive knowledge of primary biochemical pathways leading to synthesis and catabolism of major bio-molecules.

Syllabus

Unit-I: Monosaccharides- **(12hrs)**

structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers. Disaccharides- Maltose, Lactose and Sucrose. Polysaccharides- homo and heteropolysaccharides, structural and storage polysaccharides. Anabolism and catabolism, Glycolysis, Production of acetyl CoA, Citric acid cycle, Gluconeogenesis.

Unit-II: Amino acids and Enzymes- **(12hrs)**

Classification, chemical and physical properties of different amino acids. Natural modification of amino acid, titration curve of amino acid and its significance. Introduction to protein structure and function, alpha helix, beta pleated sheets, tertiary and quaternary structure of proteins, different non-covalent and covalent interactions. Amino acid metabolism-Amino acid deamination and transamination, urea cycle. Introduction to enzymes, classification of enzymes, mechanism of action, factors affecting enzyme activity, Michaelis-Menten equation, significance of Km, Vmax and turnover number.

Unit-III: Building blocks of lipids - **(12hrs)**

Fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes. Introduction to lipid micelles, monolayer and bilayer. Fatty acid synthesis and transport.

Unit IV: Nucleotides - **(9hrs)**

Structure and properties. Nucleic acid structure-Watson - Crick Model of DNA. Structure of major species of RNA. De novo synthesis of purine and pyrimidine nucleotides. Disorders of purine and pyrimidine metabolism.

Practical

[1].Numerical calculations for preparation of solution, e.g. Normality, Molality, Molarity, dilutions and dilution factors.

[2].Preparation of buffer and pH measurement

[3].Qualitative test for carbohydrates

[4].Qualitative test for amino acids.

[5].Quantitative estimation of protein by Bradford/Bicinchoninic acid method

[6].Assay of salivary amylase.

[7].Qualitative test for lipids.

[8].Tests for lipids- Salkowski/Lieberman-Burchard test.

Reference Books

1. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN 13: 978-1464126116.
2. Textbook of Biochemistry with Clinical Correlations an Indian Adaptation (2022) 7th ed., Devlin, T.M., John Wiley & Sons, Inc., ISBN: 978-9354641558.
3. Biochemistry (2019) 9th ed., Berg, J.M., Tymoczko, J.L. and Stryer, L., W.H Freeman and Company (New York), ISBN 13: 978-1319114671.
4. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed., Wilson, K. and Walker, J. Cambridge University Press, ISBN 13: 978-1316614761.
5. Introduction to Practical Biochemistry, Sawhney, S.K. and Singh R. so Narosa Publishing House (New Delhi), ISBN-13: 978-8173193026.

CO-PO Mapping

CO/ PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	1	-	-	2	1	-	1	1	2	1	1	-
CO2	2	1	1	2	1	-	-	2	1	-	1	2	2	2	1	-
CO3	2	1	1	2	1	-	-	2	1	-	1	2	2	3	1	-
CO4	2	2	2	3	3	1	1	2	2	1	2	3	2	3	3	1
Avg	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**1**

1 – Weakly Mapped (Low) 2 – Moderately Mapped (Medium) 3 – Strongly Mapped (High)

4 - "_" means there is no correlation.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10

	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Biostatistics	**L-T-P-C: 2-0-0-2**

Course Objective(s):

This course Define the principal concepts about biostatistics. Recognize the definition of statistics, its subject and its relations with the other sciences. Restate the principal concepts about biostatistics methods. Collect data relating to variable/variables which will be examined and calculate descriptive statistics from these data.

Course Outcomes:

CO1. Identify the roles of biostatistics in the prevention of disease and the improvement of health.
CO2. Compute basic descriptive statistics and explore data analytic methods.
CO3. Analyze the concept of appropriate statistical methods.
CO4. Apply different design tools used for data analysis including screening designs and response surface designs

Syllabus

Unit-1: Sources of data: (8hrs)

Types of data collection methods; Measurement of disease frequency, Person-time exposure.
Types of measures – reliability, validity, accuracy, questionnaire construction, index construction and scaling, observe variation, diagnostic tests, measurement issues, evaluating sources of data.
STUDY DESIGNS: - epidemiological study designs, overview of study designs, descriptive studies, ecological studies, Case control, Cohort, Randomized control trials, Systematic review and meta-analysis – Hybrid designs in epidemiology – Community based epidemiologic studies, Causation and association, Hills Criterion.

Unit-2: Data ethics- (7hrs)

IRBs, Informed consent, Confidentiality, Clinical trials, Behavioral & social experiments. Natural history and spectrum of disease: Concepts of Disease Occurrence Chain of Infections Epidemic Disease Occurrence Epidemic Patterns. Public Health Surveillance: Purpose and characteristics of public health surveillance. Identifying health problems for surveillance. Working with data for surveillance Evaluating and improving surveillance.

Unit-3: Introduction to Biostatistics: (7hrs)

Frequency distribution Measures of central tendency: Mean, Median, Mode- Pharmaceutical examples Measures of dispersion: Dispersion, Range, standard deviation. Descriptive Statistics – Variables, Pie charts, bar graphs, histograms, Scatterplots Distribution, Measuring Center, Measuring Spread, Density curves, Types of variables, Error-I type, Error-II type, Standard error of mean (SEM), Confidence Intervals.

Unit 4: Design and Statistical analysis: (8hrs)

Probability: Overview of probability. Types of Distribution: Binomial distribution, Normal distribution, Poisson's distribution, Null hypothesis, alternative hypothesis, Sampling: Types of sampling, Power Statistics for sample size analysis. Design and Analysis of experiments using parametric and non-parametric methods. Correlation and Simple Linear Regression. Statistical Analysis Using Excel, SPSS, MINITAB®, DESIGN OF EXPERIMENTS, R Online Statistical Software's. Factorial Design: Definition. Advantage of factorial design Response Surface methodology: Central composite design, Historical design, Optimization Techniques.

Text books:

1. Gordis, L. (2004). Epidemiology. Third edition. Philadelphia: Elsevier Saunders. (The second edition is also acceptable.)
2. Pagano, M. and Gauvreau, K. (2000). Principles of Biostatistics. Belmont, CA: Wadsworth.
3. Textbook: CDC – downloadable e-book: Principles of Epidemiology in Public Health Practice, Third Edition: An introduction to Applied Epidemiology and Biostatistics U.S. and "The Basic Practice of Statistics, Fourth Edition." David S. Moore (This book can be ordered for a few cents off of Amazon.)

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	3		2	-	-		1	-	-	3	3	3	2	2
CO 2	2	3	3		3	3	-		2	2	1	2	3	3	3	2
CO 3	2	2	2		2	-	2		2	3	1	3	2	3	3	2
CO4	3	1	1		1	2	-		1	1	1	1	3	1	1	2
Average	2.5	2	2.25		2	2.5	2		1.5	1.5	1	2.25	2.75	2.5	2.25	2

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

SEMESTER III

HSMB2018	Cell Biology	L-T-P-C: 2-1-1-4

Course objective(s):

The purpose of this course is to provide an overview of cell structure and function at the molecular level, including the regulation of cellular processes, cell division, proliferation, cell signaling and transport of biomolecules in eukaryotic cells.

Course Outcomes:

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

CO1. Understand different types of cell structure, function and implications of important cell organelles and other cellular components.

CO2. Describe the fundamental concepts of Cell division and regulation of Cell cycle.

CO3. Analyze the pathways of Cell signaling mechanisms, transduction pathways.

CO4. Apply various techniques to identify and study the sub-cellular organelles, and cell cycle.

Syllabus

Unit 1. Cell structure and function: (9hrs)

Introduction to cell biology, cell theory, cell size and their components, eukaryotic and prokaryotic cell, difference between bacterial, plant, animal and fungal cells, structure and function of cellular organelles. Cytoskeleton- Intermediate filaments, microtubules, cilia and centrioles, actin filaments, actin-binding proteins.

Unit 2. Membrane Structure: (9hrs)

The Lipid bilayer, membrane Proteins, membrane transport of small molecules and the ionic basis of membrane excitability, principles of membrane transport, carrier proteins, active and passive membrane transport, ion channels and electrical properties of membranes, intracellular compartments and protein sorting, vesicular trafficking in secretory and endocytic pathways.

Unit 3. Energy Conversion: (9hrs)

Mitochondria and Chloroplasts-The respiratory chain and ATP synthase. Chloroplasts and Photosynthesis. The evolution of electron-transport chains. The genomes of mitochondria and chloroplasts

Unit 4. Cell Signaling: (9hrs)

Signaling via G-Protein-linked cell-surface receptors, signaling via enzyme-linked cell-surface receptors, target-cell adaptation. cell-cell interactions; cell Junctions, cell-cell adhesion. The cell receptors, ligands and trans-membrane signaling.

Unit 5. Cell division: (9hrs)

Mitosis and the phases of cell division, meiosis, cell cycle regulation and its checkpoints. Significance of cell cycle regulation in connection to cell death by apoptosis and their regulation

Practical:

1. To perform staining for identification of cell organelles.
2. To observe distinguishing features of different eukaryotic cells.
3. To perform staining to visualize divisional stages in Mitosis.
4. To perform the cell propagation using sterile techniques.
5. To perform Gram staining for identification of bacterial cells.
6. To perform Giemsa Staining
7. To separate Peripheral Blood Mononuclear Cells from blood
8. To determine Osmosis and Tonicity
9. To determine viability of cells through Trypan Blue Assay

Text Books/References:

1. Albert Bruce, Bray Dennis, Levis Julian ,Raff Martin, Roberts Keith and Watson James (2008).Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.
2. Cooper, G.M. and Hausman, R.E. (2009). The Cell: AMolecularApproach.5thEdition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Hardin, J. Bertoni, G and Klein smith, J. L. (2012). Becker's World of the Cell. 8th Edn, Pearson Benjamin Cummings, San Francisco.
4. Harvey, L. (2004). Molecular Cell Biology. 5th Edn. W.H. Freeman.
5. Karp, G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.
6. Lodish, Berk, Matsudaira, Kaiser, Bretscher, Ploegh, Amon, and Martin (2016) Molecular Cell Biology. 8th Edn. W.H. Freeman.

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	1	2	1	-	-	2	1	-	1	1	3	1	1	-
CO 2	2	1	1	2	1	-	-	2	1	-	1	2	3	2	1	-
CO 3	2	1	1	2	1	-	-	2	1	-	1	2	3	3	1	-
CO 4	2	2	2	3	3	1	1	2	2	1	2	3	3	3	3	1
Avg	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**

Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

HSMB2019 3	**Microbiology & Microbial Technology**	**L-T-P-C: 2-0-1-**

Course Objective(s):

The course provides the students with a conceptual and experimental background in the broad discipline of microbiology. The students will be introduced to the major groups of microorganisms and their diversity in structure and functions and microbial interactions. Emphasis has been laid on bacterial growth, nutrition, control, metabolism, and genetics. To make the student aware of microbial culture selection for fermentation processes. Media formulation, inoculum development and process optimization. The course also introduces the students to the scope and relevance of microbes in the field of medicine, agriculture, and industry.

Course Outcomes:

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

CO1. Comprehend the conspicuous presence of microbes in the environment and their influence in our daily lives as part of the food, soil, air environment, and disease development.

CO2. Describe the immense diversity in the microbial world, their varied inter or intra-community interactions and contribution to the biotech industry.

CO3. Perform microbial culture selection for fermentation processes, media formulation, inoculum development and process optimization.

CO4. Operate fermenters and apply basic concepts for selection of a reactor.

Syllabus

Unit 1: Introduction to Microbiology: **(6hrs)**

History and Scope- Role of Microbes in agriculture, public health, medicine and industry. Organization of prokaryotic and eukaryotic cell structure and function. Diversity of the microbial world, Viruses and their acellularity, and Archaea.

Unit 2: Microbial Nutrition and Growth: **(6hrs)**

Types of growth media, growth phases, culture methods. Fundamentals of microbial physiology and metabolism (Aerobic & anaerobic respiration, fermentation, Entner Duodruffs pathway, photosynthesis, nitrogen fixation).

Unit 3: Fundamentals of microbial ecology: **(6hrs)**

Microbes from Marine, Freshwater and Terrestrial Environments, Microbial Interactions (Symbiotic, non-symbiotic). Negative interactions: Pathogenic Microbes. Control of microbial growth – (Effect of heat, Sterilization, disinfectants, therapeutic agents, antimicrobial resistance). Application of sterilization methods in Food and Industrial Microbiology.

Unit 4: Industrial microbiology: q **(6hrs)**

Brief history and developments in industrial microbiology, Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates. Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations; Measurement and control of fermentation parameters- pH, temperature, dissolved oxygen, foaming and aeration.

Unit 5: Microbial products: **(6hrs)**

Industrial production of citric acid, ethanol, penicillin, glutamic acid, vitamin B12, enzymes (amylase, protease, lipase), Wine, beer.

Laboratory

1. Isolation of fungi from soil: Dilution plate method, Warcup method, stamping method.
2. Isolation of fungi from plant material: Epiphytic fungi, washing method, implant method, impression method; endophytic fungi.
3. Growth measurement of fungi- linear and biomass.
4. Effect of environmental (pH, temperature) and nutritional factors (carbon, nitrogen sources) on growth of fungi.
5. Isolation and identification of microscopic algae from soil and water.
6. Isolation and identification of protozoa from environmental samples.
7. Screening for antibiotic producing microbes (antibacterial, antifungal).

Text books

1. Prescott's Microbiology by Willey, Sherwood and Woolverton. 12th Edition (2022).
2. Brock Biology of Microorganisms by Madigan, Martinko, Stahl and Clark. 14th Edition (2017)
3. General Microbiology by Stanier, Ingraham, Wheelis and Painter. 5th Edition (1999)
4. Microbiology, M. Pelczar, E. Chan, N. Kreig, 5th ed, MGH. 5th Edition (2001)
5. Biotechnology and Safety Assessment Thomas J.A., Fuch R.L Academic Press. 3rd Edition (2002)

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	1	2	1	-	-	2	1	-	1	1	3	1	1	-
CO 2	2	1	1	2	1	-	-	2	1	-	1	2	3	2	1	-
CO 3	2	1	1	2	1	-	-	2	1	-	1	2	3	3	1	-
CO4	2	2	2	3	3	1	1	2	2	1	2	3	3	3	3	1
Average	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10

	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Molecular Biology and Genetics	**L-T-P-C: 2-1-1-4**

Course Objectives: The objective of the course is to acquaint the student with the basic and advanced concepts of Molecular biology, and Genetics.

Course Outcomes: On the completion of course, student would be able to

CO1. Understand and explain the fundamental concepts and principles of molecular biology and genetics.

CO2. Describe the mechanisms of gene expression, including transcription and translation.

CO3. Interpret experimental data related to molecular biology and genetics.

CO4: Analyze the concepts of genetic inheritance, and apply molecular biology techniques, such as PCR, gel electrophoresis, and DNA sequencing, to manipulate and analyze DNA samples.

Syllabus

Unit 1: DNA stores genetic Information: (6hrs)

Classical experiments from Meischer to Watson, RNA as a genetic material, DNA Supercoiling. Structure of Chromosomes: Histones, Nucleosomes and their packaging into successively higher order structures.

Unit 2: DNA Replication and its fundamentals: (7hrs)

Semi-conservative nature of DNA Replication, Origin and Directionality of the replication fork, Semi-discontinuous mode of replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication. Initiation of Replication: Origin recognizing complex in prokaryotes. Elongation: Synthesis of Leading and Lagging Strands (Okazaki fragments). Termination: Tus-Ter complex and formation of catenanes.

Unit 3: Transcription and Post- Transcriptional processing: (7hrs)

Transcription: Abortive Transcription, DNA dependent RNA Polymerase, Promoter sequences, Events of Transcription (Initiation, Elongation and Termination- rho dependent and independent), Transcription in Eukaryotes. Splicing and alternative splicing.

Unit-4: Translation: (6hrs)

Translational machinery, Charging of tRNA, aminoacyl-tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes. Post translation modifications.

Unit-5: Introduction to Genetics: (10hrs

Mendelian Genetics, Extensions of Mendelian Genetics, Sex Determination and Sex Chromosomes, Nature of heritable changes: Chromosome Mutations: Variation in Number and Arrangement, Extra-nuclear Inheritance. DNA Repair and Transposable elements.

Unit 6: Epigenetics: (9hrs)

Epigenetic alterations to genome: DNA methylation, Histone modification, MicroRNAs and Long Noncoding RNAs, Epigenetics in Imprinting and cancer, Dosage compensation. Emerging roles of RNA: siRNAs and RNA Interference, miRNAs and posttranscriptional Gene Expression, piRNAs and Transposons, RNA-Induced Transcriptional silencing, lnc RNAs and Transcriptional repression.

Practical:

1. PCI method of genomic DNA isolation and Quantification
2. Isolation of the plasmid from bacterial culture (alkali lysis methods)
3. Isolation of RNA and their Quantification
4. Synthesis of c-DNA using RNA template.
5. Primer design and preparation of working stocks for primers
6. PCR using gene specific primers
7. Agarose Gel electrophoresis of the PCR products
8. SDS-PAGE electrophoresis
9. Hands on experience on Drosophila genetics
10. Complementation Analysis

Text Books/References:

1. Agranoff BW, Albers RW, et al., editors. Philadelphia: Lippincott-Raven; 1999.
2. Genetics Analysis and Principles., Robert J. Brooker. 7th Edition (2020)
3. Concepts of Genetics., Klug and Cummings. 12th Edition (2019)
4. Molecular Biology of the Cell. Alberts B, Johnson A, Lewis J, et al. New York: Garland Science; 4th edition. (2002).
5. Molecular Cell Biology. 4th edition. Lodish H, Berk A, Zipursky SL, et al. New York: W. H. Freeman; 2000
6. Neuroscience. 2nd edition.Purves D, Augustine GJ, Fitzpatrick D, et al., editors. Sunderland (MA): Sinauer Associates; 2001.

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	2	1	-	-	2	3	-	3	1	3	1	3	-
CO 2	3	2	3	2	2	-	-	2	3	-	3	2	3	2	3	-
CO 3	2	2	2	2	2	-	-	2	2	-	2	2	3	3	2	-
CO 4	3	2	1	3	3	1	1	2	3	1	3	3	3	3	3	1
Avg	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30

	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical)	20
	Viva voce	10
	Total	**100**

SEMESTER IV

Immunology & Immunotechniques	L-T-P-C: 2-1-1-4

Course Objective(s)

The objective of this course is to provide Students with detail understanding of different cells of the immune system and their role in immune protection as well as application of immunological techniques. The course will provide knowledge about the role of immune system in pathogenesis of cancer, autoimmune disease, AIDS and different infectious diseases.

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

CO1. Understand the structure and function of immune system, cell types and its pathways.
CO2. Analyze the role of the immune system in disease conditions.
CO3. Apply knowledge about the generation of antibodies and the applications of antibodies in diagnostics, and therapy.

Syllabus

Unit-1: Introduction and overview of immune system- (9hrs)
Types of immunity - innate and adaptive, Cells and organs of the immune system, Inflammation, Antigens - epitopes, antigenicity, factors influencing antigenicity.

Unit 2: Immunoglobulins: (9hrs)

Structure and types of Immunoglobulins, Biological activities. Polyclonal and monoclonal antibodies - productions and applications, Complement System, Antibody-dependent protection mechanisms. Antigen receptors, BCR and TCR genes, Genetic mechanisms and molecular basis for generation of antibody diversity and Hypersensitivity.

Unit 3: Major Histocompatibility Complex (MHC): **(9hrs)**
Antigen processing and Presentation. Cellular responses. B lymphocyte and T lymphocyte development, T-cell activation and Cytokines. Immune response to various classes of pathogens.

Unit 4: Transplantation immunology: **(9hrs)**
Allograft rejection, Tumor immunology, categories of tumor antigen. Autoimmunity criteria and causes of autoimmune diseases, immunotherapeutics, vaccines, engineering of immune cells.

Unit 5: Applied immunology generation and purification of antibodies: **(9hrs)**
Antigen and antibody interactions, affinity and avidity agglutination and immunoprecipitation, immunoassays, Immuodiagnostics: principles and applications. RID Assays, ELISA, Western blotting, Immunofluorescence, Fluorescence activated cell sorting.

Practical:

1. To Perform Western blotting.
2. Isolation and microscopic visualization of T-cells and B-cells.
3. Use of commercially available immune diagnostic strip tests.
4. To perform immuno-precipitation of a protein from cell lysate using antibody.
5. To determine binding affinity of antigen-antibody complex.
6. To demonstrate ELISA.

Text books

1. Kuby Immunology by Thomas J. Kindt, Barbara A. Osborne, Richard Goldsby. 4th Edition (2020).
2. Principles of Microbiology and Immunology by Bernard D. Davis. ISBN 978-0063561311
3. Introduction to Medical Immunology by Gabriel Virella. 1st Edition (1998)

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	3	2	1	-	-	2	1	-	1	1	3	1	1	-
CO 2	2	2	3	2	2	-	-	2	1	-	1	2	3	2	1	-
CO 3	2	3	3	2	2	2	3	2	1	-	1	2	3	3	1	1
Avg	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**1**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	Type of Assessment	Total Marks
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Biophysics	**L-T-P-C: 2-0-0-2**

Course objective(s):

The main objective of this course is to understand selected biological phenomena using physical principles. Students will understand how biology, chemistry and physics are interconnected in biophysical system.

Course Outcomes:

After studying this course, students will be able to:

CO1. Understand different intermolecular interactions, molecular excitation, energy transformation phenomena and thermodynamics basis of life.

CO2. Know the role of different weak interactions in structural organization within proteins and DNA molecules.

CO3. Gain knowledge about cell membrane and its topology, membrane transport, passive vs active transport, generation and propagation of action potential and biophysics of synapse.

CO4. Apply biophysical principles and techniques to understand denaturation and renaturation kinetics and interactions among macromolecules.

Syllabus:

Unit 1: Introduction and history of biophysics: (7hrs)

Main features of quantum theory, elementary particles and their interactions, Van der waals interactions, electrostatic interactions, hydrogen bonds, ionic bond, covalent bonds, molecular excitation and energy transfer. Water as a solvent: unusual physical properties. Introduction to thermodynamics, thermodynamics probability, entropy, enthalpy, energy of activation, rate of reaction, enzyme substrate interactions and enzyme mechanism.

Unit 2: Introduction to membrane biophysics: (8hrs)

Interfacial phenomena and membranes, surface and interfacial tensions, self-assembly of membranes, molecular structure of membranes, structure and properties of biological membranes, model membranes: liposomes, supported bilayers, lipid monolayers, transport of molecules across membranes, action potential and resting membrane potential, Electrophysiology, Patch clamp, biophysics of synapse.

Unit 3: Forces and stereochemical factors responsible for molecular confirmation, (8hrs)

Defining confirmation of a macromolecules, complex array of biomolecular structures found in DNA and protein due to interactions, protein folding, Anfinsen's experiment, protein folding pathways, Levinthal's paradox, intermediates and folding pathways, energy landscape theory and folding funnel, molten globule, denaturation and renaturation kinetics, folding in-vivo by molecular chaperones.

Unit 4: Method for investigating folding of proteins: (7hrs)

Fluorescence spectroscopy, methods for investing denaturation and renaturation kinetics: UV/Vis absorption spectroscopy, methods for macromolecular interactions: isothermal calorimetry

Text Books:

1. Biophysics - An Introduction by Rodney Cotterill 1st edition, 2012, ISBN:978-0471485384
2. Biophysics - An Introduction by Roland Glazer, 2nd edition, ISBN: 978-3642252112.
3. Biophysics by Vasantha Pattabhi and N. Gautham, 2nd edition, ISBN:1402002181
4. Biochemistry –by Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto 8th edition, ISBN: 978-1464126109
5. The physical Basis of Biochemistry- The foundation of Molecular Biophysics by Peter R. Bergethon, 2nd edition, ISBN 978-1-4419-6323-9.

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	1	2	1	-	-	2	1	-	1	1	2	1	1	-
CO 2	2	1	1	2	1	-	-	2	1	-	1	2	2	2	1	-
CO 3	2	1	1	2	1	-	-	2	1	-	1	2	2	3	1	-

CO4	2	2	2	3	3	1	1	2	2	1	2	3	2	3	3	1
Average	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	2	**2**	**1**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Bioprocess Engineering **L-T-P-C: 2-0-1-3**

Course Objective:

1. To prepare students with basic concepts and aid them to meet the challenges of the new and emerging biotechnology industry.
2. To provide fundamentals in understanding bioprocess technologies, bioprocesses principles involving bioreactor design, construction, operation, and controls.
3. To impart knowledge and skills for design and analysis of batch, fed batch and continuous bioreactors.
4. To understand and apply the knowledge in enzymes and catalysis for target bioprocesses targeting valued biochemicals.
5. To apply the fundamentals in developing industrial bioprocesses with an emphasis on scale-up and commercialization.

Course Outcomes- After the completion of the course, students will be able to:
CO1. Acquire knowledge about biomolecules and target bioprocesses, reactor systems, and reaction kinetics models for Biochemical systems, microbial growth kinetics.
CO2. Learn about bioreactors and their types, operational mechanisms, design considerations and applications in the field of Biochemical Reaction Engineering.
CO3. Comprehend bioreactor design, scale up, instrumentation and control, fermentation utilities applied to bioprocess and bioreactor considerations in plant and animal cell culture.
CO4. Evaluate microbial kinetics, mechanism of microbial growth and production of industrially important biomolecules.
CO5. Design and propose novel bioprocesses for environment and industry applications.

Syllabus

Unit 1: Understanding cellular systems- **(5hrs)**

Prokaryotic and Eukaryotic growth systems, Microbial growth kinetics, substrate utilization, and product formation kinetics, stoichiometry, principles of enzyme catalysis, enzyme kinetics, immobilized enzymes, bioreactors- batch, fed-batch or continuous bioreactors, Immobilized cell systems, solid-state fermentations,

Unit 2: Principles of kinetics for chemical and Bio-chemical Reactions **(5hrs)**

Fundamentals of homogeneous reactions for batch / semi-batch, plug low reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor bubble column, air lift fermenter etc, stirred tank/mixed reactors, adiabatic and programmed reactors. Unconventional bioreactors: Hollow fiber reactor, membrane reactor, perfusion reactor for animal and plant cell culture.

Unit 3: Analysis of ideal bioreactors: **(5hrs)**

Fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with Recycle and wall growth, Ideal Plug-Flow Tubular reactor. Analysis of Non-ideal Reactor Analysis: Concept of ideal and non-ideal reactor; residence time distribution; models of non-ideal reactors – plug flow reactor for microbial processes; Mass transfer in biochemical processes; Multiphase bioreactors – packed bed with immobilized enzymes or microbial cells; three – phase fluidized bed trickling bed reactor; Design and analysis of the above reactor systems; Gas liquid reactors, Reactor stability.

Unit 4: Design considerations of fermentation: **(5hrs)**

Oxygen transfer, heat transfer, rheology, mixing. Scale up and scale down concepts. Bioprocess control and computer coupled bioreactors, Growth, and product formation by recombinant cells. Biomechanics and biomaterials, Reactor fittings, Mechanical fittings in a bioreactor: vessel, agitation system materials, welds, finish, valves, piping and valves for biotechnology, Bioreactor design calculation.

Unit 5: Bioreactor Design: **(5hrs)**

Energy balances, Transport processes, Scale-up Operations, Operation and Control of bioreactors (aeration, agitation, heat transfer, scale-up and scale-down). Instrumentation and monitoring, sterilization, process modeling, downstream processing, plant/mammalian cell culture reactors, examples of industrial bioprocesses. Case studies on production of antibiotics, enzymes, insulin, bio-ethanol. Bioprocesses to produce antibiotics, proteins, polysaccharides, aroma etc.

Unit 6: Basics of Instrumentation:

(5hrs) Understanding electronics and electrical components, Instrumentation, and control of bioprocesses: Control types and applications; Bioreactor sensing apparatus, online sensors for cell properties, off-line analytical methods.

Laboratory

Experiments

1. Estimation of microbial growth kinetics and cell mass.
2. To measure growth inhibition kinetics.
3. Operation of pH control and dissolved oxygen measurement.
4. To demonstrate enzyme immobilization techniques.

5. To perform bioconversion using immobilized enzyme preparation
6. To measure the mass transfer in immobilized cell
7. Aerobic and anaerobic bioconversion process
8. Product formation kinetics in a fermentation process
9. Online analyses of process parameters
10. Effect of mixing and agitation in bioreactors
11. Estimation of volumetric oxygen transfer coefficient
12. Demonstration of operations control in Bioreactors

Text books:

1. Alba S., Humphrey E and Milli N.R., "Biochemical Engineering" Academic Press, 1973.
2. Atkinson, B.,Biological Reactors, pion Ltd., London,1974.
3. Bailey. J.E and D. F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill, Inc., 1986.
4. Cruger.W and A.Cruger, A Textbook of Industrial Microbiology, Sinauer Associates, Sunderland,US, 2004.
5. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, Prentice Hall, Englewood Cliffs, NJ, 2002.
6. A.L. Lehninger, D.L.Nelson and M.M Cox, Principles of Biochemistry. Worth publishers, New York. 2006.
7. Scragg.A.H "Bioreactors in Biotechnology"- A Practical approach, 2003.
8. Stryer. L, Biochemistry, Freeman, 2002.
9. Thomas Devlin, Textbook of Biochemistry. John publishers. 2002.

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1																
CO 2																
CO 3																
CO4																
CO5																
Average																

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10

	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Bioinformatics & Computational Biology	L-T-P-C: 2-0-1-3

Course objective(s): The basic objective is to give students an introduction to the basic practical techniques of Computational Biology and Bioinformatics. Emphasis will be given to the application of Computational Biology and Bioinformatics and biological databases to problem solving in real research problems. The students will become familiar with the use of a wide variety of internet applications, biological database, sequence alignment, biological database management, molecular docking and drug designing and will be able to apply these methods to research problems.

Course Outcomes:

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

CO1: Understand the basics of computational biology and bioinformatics.

CO2: Analyze and define the basic concepts of bioinformatics and its significance in biological data analysis.

CO3: Apply methods to symbolise and manage the different types of biological database, sequence alignment and phylogenetic tree analysis. Develop competency in bioinformatics for solving different biological data analysis.

Syllabus

Unit 1: Introduction to Computational Biology and Bioinformatics: (6hrs)

Definition and History and Applications of Computational Biology and Bioinformatics, Internet resources, various databases and bioinformatics tools, organization of databases.

Unit 2: Biological Databases: (6hrs)

Nucleic acid sequence databases, Protein sequence databases, Repositories for high throughput genomic sequences, Genome Databases, 3D Structure Database, Chemical Structure database, Gene Expression database, Derived Databases, Structure classification database, Protein-Protein interaction database and Pathway database.

Unit 3: Sequence Alignment and Phylogenetic Tree: (6hrs)

File formats, Basic concepts of sequence analysis, Scoring matrices, Pair wise sequence alignments, Multiple sequence alignment, Database Searches: Keyword-based searches and Sequence-based searches. Phylogenetic Trees: phylogenetic tree representation, building phylogenetic trees,

Unit 4: Structure Prediction: (6hrs)

Overview and Introduction to Protein Structure, Sequence-Sequence Alignment Methods, Sequence Based Secondary Structure Prediction. Visualization of structures using Rasmol or ADT. Fundamentals of the methods for 3D structure prediction, Homology/comparative Modeling. AI based protein structure prediction.

Unit 5: Molecular Docking and Drug Designing: (6hrs)

General approach to discovery of new drugs, lead discovery, lead modification physiochemical, principles of drug action, 3D database search, computer aided drug design, AI based drug screening, docking, molecular modelling in drug design, structure-based drug design.

Text books:

1. Bioinformatics and Computational Biology-A Primer for Biologists by Basant K. Tiwary. 2022, ISBN : 978-981-16-4240-1
2. Lopes H, editor. Computational Biology and Applied Bioinformatics. InTech; 2011. Available from: http://dx.doi.org/10.5772/772
3. Encyclopedia of Bioinformatics and Computational Biology-ABC of Bioinformatics. Shoba Ranganathan, Kenta Nakai, Christian Schonbach. August 21, 2018, ISBN: 9780128114148
4. Introduction to Bioinformatics, Teresa Attwood, David Parry-Smith, Pearson Education. ISBN: 978-8178085074
5. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition, Andreas D. Baxevanis, B. F. Francis Ouellette. A John Wiley & Sons, Inc., Publication. ISBN: 978-0471478782
6. Jianyuan Deng and others, Artificial intelligence in drug discovery: applications and techniques, Briefings in Bioinformatics, Volume 23, Issue 1, January 2022, bbab430, https://doi.org/10.1093/bib/bbab430

Practical:

1. Sequence retrieval from databases.
2. Biological Databases: Study of different Biological databases.
3. Pair wise sequence alignment, Local and Global alignment – Algorithms
4. DOT matrix analysis.
5. Databases search for homologous sequence using (BLAST) and (FASTA)
6. MSA: (Clustal W, Clustal X), Algorithms-MSA, Progressive alignment etc, Problems with MSA method, Statistics behind MSA
7. MUSCLE, T-COFFEE
8. Protein structure prediction tools (2D and 3D structure prediction)
9. Molecular Docking using Autodock
10. Drug Designing using Chemsketch
11. AI application in computational biology and bioinformatics

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	3	1	2	2	1	0	0	2	2	3	2	3	3	2
CO 2	1	2	2	2	2	2	1	0	0	1	2	3	2	2	1	2

CO 3	2	3	3	2	2	3	1	1	0	2	2	2	2	1	2	2
Average	2	2	3	2	2	2	1	1	0	2	2	2	2	2	2	2

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Heat and Mass transfer	L-T-P-C: 2-0-1-3

Course objective: To introduce Students with fundamentals concerning the calculations and principles involved in heat and mass transfer in biotechnology processes.

Course Outcome: On completion of this course, the students will be able to:
CO1. Understand the basic modes of heat transfer and their laws to calculate rate of heat transfer.
CO2. Compute mass transfer coefficients of heterogeneous phases in unit operations
CO3. Evaluate temperature distribution in heat conduction and analyze heat transfer through fins.
CO4. Apply principles and laws of heat and mass transfer in engineering application and design heat exchanger and evaporators.

Syllabus:

Unit 1: Introduction: **(6hrs)**
Units, definitions, Basic modes of Heat transfer, Thermal conductivity for various types of materials, convection heat transfer co-efficient, Stefan Boltzman's law of Thermal radiation**.**

Unit 2: Heat Transfer: **(6hrs)**
Heat conduction, Heat conduction in composite wall structure, thick-walled tube, sphere, insulation, unsteady sate condition, Natural and forced convection, heat transfer in laminar and turbulent flows inside tubes, condensation, design of heat exchangers, basic equation of radiation.

Unit 3: Mass Transfer: **(6hrs)**
Modes of mass transfer, Fick's law of diffusion, diffusion theory, analogy between heat, mass and momentum transfer, interphase mass transfer, overall mass transfer coefficient, mass transfer in equipment, humidification and dehumidification, role of diffusion in mass transfer, oxygen uptake in cell culture, factors affecting cellular oxygen demand, oxygen transfer from gas bubble to cell.

Unit 4: Fluid Characteristics and Dynamics: **(6hrs)**
Definition and classification of fluids, types of fluid, types of flow, Flow through pipes: laminar flow, Turbulent flow, Hagen Poiseuille equation, Power law, Energy losses, Pipe networking, Flow measuring devices, Pumps.

Unit 5: Liquid – liquid extraction **(6hrs)**
Extraction equipment, leaching equipment and equilibrium, absorption/ adsorption: Equilibria, Column Sizing. Simultaneous Heat and Mass Transfer: Humidification, Drying of Solids, Continuous Drying, Driers**.**

Practical:
1. Stefan boltzman’s constant calculations,
2. Natural and forced convection,
3. LMTD calculations for parallel and counter flow,
4. Determination of thermal conductivity through composite wall, lagged pipe, lagged cylinder, sphere,
5. Sedimentation and calculation of terminal velocity,
6. Performance of packed bed apparatus, fluidized bed apparatus: pressure drop vs. flow rate, drying rate.

Text books

1. W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 5th edition, McGraw-Hill (1993).
2. Treybal, R.E., Mass Transfer Operations, McGraw Hill (1980) 3rd Ed.
3. Holman, J.P., Heat Transfer, Tata McGraw-Hill Education (2008).

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1																
CO 2																
CO 3																
CO4																
Average																

SEMESTER V

Genetic Engineering and Genomics	**L-T-P-C: 2-1-1-4**

Course Objective(s): This course is developed to understand the basics of genomics and gene cloning, role of various enzymes and vectors for genetic engineering, Gene transfer methods,

Techniques and safety measures of genetic engineering, genome mapping, genomic and cDNA library, and application of gene therapy.

Course Outcomes: Students would be able to:
CO1. Understand roles of different enzymes and vectors as crucial tools in genetic engineering.
CO2. Design primers and perform applications like PCR/ qPCR.
CO3. Analyze the expression pattern of genes and perform expression of the cloned gene (s) for basic and applied research.
CO4. Apply various applications of recombinant DNA technology and omics, in the area of R&D.

Syllabus:

Unit 1: Introduction and Scope of genetic engineering: **(10hrs)**
Restriction enzymes and other DNA modifying enzymes used in cloning and other DNA manipulations, essential and desired properties of cloning vectors, examples of cloning and expression vectors, recombinant protein expression in bacteria, yeast and higher eukaryotic systems, rDNA technology in purification of over-expressed recombinant proteins.

Unit 2: Genomic and cDNA libraries: **(5hrs)**
Construction and screening of Genomic and cDNA libraries, expression and regulation studies of genes, DNA labelling, nucleic acid hybridization.

Unit 3: Genetic engineering techniques and their applications: **(10hrs)**
Polymerase Chain Reaction and its applications, Site-directed mutagenesis and applications, Molecular markers, CHIP, Genome editing using CRISPR- Cas system, DNA fingerprinting in forensic science. GMOs, transgenics, vaccines, production of recombinant proteins.

Unit 4: Genome & Transcriptomics- **(10hrs)**
Structure of Gene and genomes of Eukaryotes and Prokaryotes. Genome mapping: Physical and Genetic Map. Databases. Genome Sequencing, Sanger sequencing-principle, methodology and applications, Whole genome, Next Generation Sequencing (NGS) workflow. Search for transcription factor binding sites, RNA-Seq, Gene expression analyses and microarrays.

Unit 5: Strategies of gene therapy: **(10hrs)**
Gene augmentation Vectors used in gene therapy. Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer. Gene therapy trials – Familial Hypercholesterolemia, AIDS, Cystic Fibrosis.

Laboratory
1.Preparation of competent cells,
2. Transformation of the selected plasmid (high copy number),
3. Isolation of the plasmid from bacterial culture (alkali lysis methods),
4. Restriction digestion of the plasmids and analysis using DNA gel and extraction of plasmid DNA from the gel.
5. PCR amplification, and ligation
6. Selection of transformed E. coli and validation of cloning - colony PCR
7. RNA isolation from bacterial cells and Reverse Transcriptase PCR for housekeeping genes and their analysis.

8. To perform Real Time PCR for gene expression analyses.

Text books / References

1. Principles of Gene Manipulation and Genomics. Sandy B. Primrose, Richard Twyman – Blackwell Publishing. 7th Edition (2014).
2. Gene Cloning and DNA Analysis: An Introduction- T. A. Brown - John Wiley & Sons. 8th Edition (2020).
3. An Introduction to Genetic Engineering, Desmond S. T. Nicholl - Cambridge University Press. 3rd Edition (2008)
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten - ASM Press. 4th Edition (2008).

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	1	2	1	-	-	2	1	-	1	1	3	1	1	-
CO 2	2	1	1	2	1	-	-	2	1	-	1	2	3	2	1	-
CO 3	2	1	1	2	1	-	-	2	1	-	1	2	3	3	1	-
CO 4	2	2	2	3	3	1	1	2	2	1	2	3	3	3	3	1
Avg	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**1**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)- 20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Systems Biology	L-T-P-C: 2-0-1-3

Course Objectives: Systems Biology is an integrated approach to the study of biology through experiment and the use of computer models with both predictive power.

Course outcomes: After the completion of the course student should be able to :
CO1. Recognize, exemplify and explain typical network motifs for signaling pathways, protein interaction networks, metabolic networks and gene regulatory networks.
CO2. Implement, simulate and analyze biology-related mathematical models using available software packages in a programming language of their choice.
CO3. Work on a biological modelling task and communicate their modelling activities to an interdisciplinary audience.

Syllabus

Unit 1: Introduction to systems biology and metabolism: **(7hrs)**

Components of Biological systems (DNA, RNA, Protein, Metabolites), their properties and function. Overview of cellular metabolism, enzyme kinetics and metabolic pathways. Graph Theory for Network analysis

Unit 2: Biological network: **(8hrs)**

Biological networks and their significance - at the level of genome, transcriptome, proteome, and metabolome. Omics - applications and its role in systems biology. Analytical methods for detecting and quantifying metabolites. General work flow and Statistical methods in omics. Pathway and omics databases.

Unit 3: Modelling and Analysis of networks (MAN): **(7hrs)**

The module focuses on mathematical and statistical methods used to evaluate and analyze large-scale data sets. Cellular systems include genetic switches and oscillators, network motifs, genetic network evolution, and cellular decision-making.

Unit 4. Large biological data analyses: **(8hrs)**

Differential gene expression analysis of transciptome data, 16S rRNA based phylogenetic profiling, phylogenetic tree, introduction to Gene Ontology, KEGG, EcoCyc databases, Automated pathway mapping and annotation of proteins and metabolites, Metabolic network reconstruction, Genome scale model analysis. Functional Enrichment analysis. Genome wide association studies (GWAS).

Text Books:

1. A Practical Approach to Microarray Data Analysis by Daniel P. Berrar, Werner Dubitzky, Martin Granzow (2003)
2. System Biology: Computational Systems Biology by Andres Kriete (2005),
3. Microarray Data Analysis: Gene Expression Data Analysis. A Beginner's Guide By: Helen Causton, J Quackenbush and AlvisBrazma (2009).
4. Stochastic Modelling for Systems Biology. ISBN-I0 1-58488-540-8 and ISBN-13 2018 978-158488-540-5 School of Computational and Integrative Sciences http://ccbb.jnu.ac.in/intranet/images/courses/IT-767_Computational_systems_biology.pdf

Practical:

1. Introduction to various bio-design software.
2. Design and construction of a biosensor.
3. Gene circuit design and engineering.
4. Crispr-Cas9 based genome editing.
5. String and Cytoscape.

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4

CO 1	2	1	2	2	1	1	1	0	1	2	1	2	2	2	3	2
CO 2	2	2	2	2	1	2	1	1	1	2	2	2	1	2	2	3
CO 3	2	2	2	3	2	2	1	0	0	2	2	3	2	2	1	1
Average	2	1	2	2	1	1	1	1	1	1	1	2	2	2	2	2

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Downstream Processing	**L-T-P-C: 2-0-1-3**

Course Objectives:

1. To prepare students with basics of metabolites extraction, separation, and purification.
2. To provide fundamentals in understanding separation technologies, thereby imparting technical, economic, and environmental perspectives and provide requisite skill set for developing product specific downstream processes especially targeting industries.
3. To address challenges in material and energy balance for optimal product separation and purification applicable to bioprocess industries.

Course Outcomes: On completion of the course the student will be able to,

CO1. Understand the basics and differentiate upstream and downstream processes.

CO2. Describe the various stages and components involved in downstream processing operations.

CO3. Explain the principles of major downstream operations used in a bioprocess industry such as filtration, centrifugation, extraction, and chromatography.

CO4. Apply different techniques such as precipitation, coagulation and flocculation during downstream processes targeting industrially important biomolecules.

CO5. Execute and apply product specific separation and downstream methods to industrially relevant biomolecules.

Syllabus:

Unit 1: **Role of Downstream Processing in Biotechnology –** **(6hrs)**

Role and importance of downstream processing in biotechnological processes. Problems and requirements of bio-product purification. Economics and downstream processing in Biotechnology. Cost cutting strategies, characteristics of biological mixtures, process design criteria for various classes of bio-products (high volume-low value products and low volume- high value products), physicochemical basis of bio-separation processes.

Unit 2: **Primary Separation and Recovery Processes -** **(6hrs)**

Cell disruption methods for intracellular products, removal of insolubles, biomass (and particulate debris) separation techniques; flocculation and sedimentation, centrifugation, and filtration methods. Precipitation methods - Precipitation with salts, organic solvents & polymers

Unit 3: Extraction processes- **(6hrs)**

Batch extractions, staged extractions-cross current, co current, counter current extractions. Differential extractions, fractional extractions with a stationary phase, fractional extractions with two moving phases. Aqueous two-phase extraction - reverse micelle extraction, supercritical fluid extraction, in-situ product removal/integrated bioprocessing

Unit 4: **Membrane-based separations (micro- & ultra-filtration)** - **(6hrs)**

Theory; design & configuration of membrane separation equipment; applications; reverse osmosis, dialysis, electro dialysis, Isoelectric focusing. Adsorption - Adsorption isotherms, industrial adsorbents, adsorption equipment's for batch and continuous operations (co current and counter current), adsorption in fixed beds.

Unit 5: **Chromatography and Electrophoretic Techniques**- **(6hrs)**

Principles of chromatographic separation – gel filtration, reversed phase, hydrophobic interaction, ion-exchange, expanded bed adsorption, bio affinity and IMAC, supercritical fluid chromatography, partition coefficient; Electrophoresis: Theory of electrophoresis, Gel electrophoresis, Isoelectric focusing. Case studies: downstream processing of baker's yeast, citric acid.

Practical:

1. Cell separation techniques,
2. Cell disruption techniques,
3. Optimization of flocculating agent concentration,
4. Insoluble separation,
5. Batch process in settling, drying and purification,
6. Filtration efficiency,
7. Protein precipitation by salting-out method,
8. Adsorption process in batch mode,
9. Ball milling,
10. Qualitative and quantitative estimation of product using GC, HPLC.

Text books:

1. Belter P.A, Cussler E and Wei Shan Hu, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience, 1988.
2. Asenjo and Juan A. Asenjo, Separation Processes in Biotechnology, CRC Press, 1990.
3. Wankat P.C, Rate Controlled Separation, Kluwer Publishers, 1990.
4. Wang D.I.C, Cooney C.L, Demain A.L, Dunnil.P, Humphery A.E. and Lilly M.D. Fermentation and Enzyme Technology, John Wiley, and Sons, 1979.
5. Arnold L. demain & Julian E. Davis. Industrial Microbiology & Biotechnology ASM Press, 2004

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	1	2	1	2	2	1	0	1	1	2	2				
CO2	3	1	3	2	2	2	2	0	0	1	2	2				
CO3	2	3	2	2	1	1	1	0	0	2	1	3				
CO4	3	2	3	1	1	2	2	0	1	2	2	3				
CO5	3	2	3	1	1	1	1	0	1	1	1	2				
Average	3	2	2	1	1	2	1	0	1	1	2	2				

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	Type of Assessment	Total Marks
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20

ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Bioanalytical Techniques	**L-T-P-C: 2-1-1-4**

Course Objectives

The objectives of this course are to provide the students with the understanding of various analytical techniques used in biotechnology based research and industry. The course will acquaint the students with the various instruments, their configuration and principle of working, operating procedures, data generation and its analysis. It is intended to impart basic undergraduate level knowledge in the area of separation technologies for the biomolecules. Students would be able to understand workflow for the separation of DNA, RNA, proteins, etc. They would also be able to assimilate recent research findings, advancement and development in the relevant subject.

Course Outcomes : On completion of the course the student will be able to,
CO1. Apply basic principles of different analytical techniques in analytical work.
CO2. Use spectroscopy and bio calorimetry in biotechnological applications.
CO3. Demonstrate principle and working of various instruments. .
CO4: Apply various techniques for solving industrial and research problems.

Syllabus:

Unit 1: Microscopy: (8hrs)
Light spectroscopy and Microscopy-Absorption, IR, Scattering (Raman and Rayleigh), Resonance Raman, Fluorescence (steady-state and time resolved), Confocal microscopy, Multi-photon microscopy, Atomic Force Microscopy.

Unit 2: Chromatography: (6hrs)
Ion-Exchange, Affinity, Hydrophobic, Size exclusion, FPLC, HPLC, GC.

Unit 3: Spectroscopy: (10hrs)
Solution- and solid-state NMR spectroscopy, X-ray crystallography, Mass spectroscopy-MALDI, LC-MS, GC-MS, MS-MS, MALDI-Mass imaging, Proteomics, MS and NMR based Metabolomics, Calorimetry, Surface Plasmon Resonance (SPR), Bio-layer interferometry (BLI), High content screening.

Unit 4: Separation techniques: **(10hrs)**

Ultracentrifugation. Separation of DNA, RNA from cells, plasmids from bacterial cells, DNA and RNA sequencing for genomics, PCR for transcriptomic, Real time PCR, Droplet PCR. Methods for separation of the proteins based on size, charge and chemical nature of the proteins.

Unit 5: Lipid separation and immobilization: **(11hrs)**

Isolation and separation of biolipids, Membrane and Rotating Membrane in Bio-separation, TCL for separation of the lipids, Ultrafiltration methods and separation of biomolecules, Polymer beads for immobilization of biomolecules, Magnetic Beads for Bio-separation, Cell Sorting, Microfluidics based separation.

Practical:

1. Protein purification using affinity/ ion-exchange/ gel filtration chromatography.
2. Separation/concentration of proteins by Ultrafiltration, gel permeation, ion-exchange chromatography.
3. Identification of a specific protein present in the cell-free extract by Western blotting technique.
4. Determination of DNA and RNA concentration by spectroscopy.
5. Demonstration of lyophilization & rotary vacuum evaporation.
6. Determination of Stern-Volmer constant of an Iodine quenching reaction by fluorometric method.
7. Measurement of excitation and emission spectra of a fluorophore and their wavelengths for maximum excitation and emission.
8. Measurement of IR spectra of biomolecules.
9. Kinetic assays using UV-VIS spectroscopy.
10. Measurement of enzyme activity.

Text Books / Reference Books

1. Wilson K. and K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.3rd Edition (1991).
2. Willard and Merrit, Instrumental Methods and Analysis. 7th Edition (2001).
3. Robert M. Silverstein et al., Spectrometric identification of Organic Compounds, 7th Edition, 1981.

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	1	-	-	2	1	-	1	1	3	1	1	-
CO2	2	1	1	2	1	-	-	2	1	-	1	2	3	2	1	-
CO3	2	1	1	2	1	-	-	2	1	-	1	2	3	3	1	-
CO4	2	2	2	3	3	1	1	2	2	1	2	3	3	3	3	1
Avg	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	Type of Assessment	Total Marks
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Project – I (Research Methodology/ Scientific Writing) L-T-P-C: 1-0-0-1

SEMESTER VI

Enzyme Technology	L-T-P-C: 2-1-0-3

Course objectives

This course provides the knowledge relevant to principles, fundamental properties, catalytic mechanisms, and reaction kinetics of enzymes. During the course students will also be introduced to different applications of enzyme technology in food, medical, household, and pharmaceutical industries.

Course outcome: Students will be able to:

CO1. Understand the general characteristics of enzyme and its cofactors.
CO2. Classify enzymes and distinguish between different mechanisms of enzyme action.
CO3. Demonstrate the principles of isolation and purification of enzymes from various sources
CO4. Comprehend various methods involved in enzyme technology and their commercial applications.

Syllabus

Unit 1: Introduction and Mechanism of Enzyme action: (7hrs)

Introduction, general characteristics of enzymes, nature of enzymes - protein and non-protein, cofactor and prosthetic group, properties, nomenclature and IUB classification of enzymes, factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, mechanism of enzyme action.

Unit 2: Enzyme Kinetics: (8hrs)

Derivation of Michaelis-Menten equation for uni-substrate reactions, Briggs and Haldane theory (rapid equilibrium and steady state theory), Significance of Km, Vmax, Kcat, Kcat/Km. Different plots (LineweaverBurk plot, Eadie-Hofstee and Hanes plot) for the determination of Km & Vmax and their physiological significances, measurement of enzyme activity. Reversible and irreversible inhibition and different enzyme inhibitors with examples.

Unit 3: Regulation of Enzymes: (7hrs)

General mechanisms of enzyme regulation, control of activities of single enzymes (end product inhibition), covalent modifications of enzymes. Feedback inhibition, allosteric enzymes, binding of ligands to proteins, co-operativity, Hill equation. Sigmoidal kinetics: MWC and KNF models. Significance of sigmoidal behavior.

Unit 4: Applications of Enzymes: (8hrs)

Enzyme immobilization, methods of enzyme immobilization-adsorption, entrapment, direct covalent linkage, cross-linking Therapeutic and diagnostic applications of enzymes. Applications of enzymes in food, pharmaceutical, detergent industry. Basic principles of biosensors and use of enzymes in biosensors.

Textbook / reference book

1. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, and Jayaraman R, Concepts in Biotechnology, Universities Press (2007).
2. Rastogi SC, Mendiratta N and Rastogi P, Bioinformatics - Methods and Applications, PHI (2006).
3. Satyanarayana, U, Biotechnology, Books and Allied (P) Ltd. (2005).
4. Smith JE, Biotechnology, Cambridge University Press (2006).
5. Biochemical Engineering and Biotechnology Handbook, Atkinson, B and Marituna, F., The Nature Press, Macmillan Publ. Ltd.

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	1	2	1	-	-	2	1	-	1	1	3	1	1	-
CO 2	2	1	1	2	1	-	-	2	1	-	1	2	3	2	1	-
CO 3	2	1	1	2	1	-	-	2	1	-	1	2	3	3	1	-
CO 4	2	2	2	3	3	1	1	2	2	1	2	3	3	3	3	1
Avg	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Environmental Biotechnology	**L-T-P-C: 2-0-0-2**

Course Objective(s): The Syllabus aims to make the student understand how biotechnology can help in monitoring or removing the pollutants and developing an understanding of new trends such as biofuels, renewable energy sources, or development of stress-tolerant plants which can minimize the harmful impact of pollutants thereby making the planet earth a better dwelling place.

Course Outcomes: Students will be able to

CO1: Understand the basic concepts and principles of environmental biotechnology and its applications.

CO2: Explain the role of microorganisms in environmental processes and their potential for biotechnological applications.

CO3: Identify and analyze environmental issues and challenges, such as pollution, waste management, and resource depletion, and propose biotechnological solutions.

CO4: Apply bioremediation techniques to remove or reduce environmental pollutants, such as heavy metals, organic compounds, and contaminants in soil, water, and air.

Syllabus:

Unit 1: Biological Waste Treatment: (6hrs)

Biological wastewater treatment: Principles and design aspects of various waste treatment methods with advanced bioreactor configuration: Solid waste management: landfills, recycling and processing of organic residues, minimal national standards for waste disposal.

Unit 2: Biodegradation of Xenobiotic Compounds: (6hrs)

Xenobiotic compounds–Definition, examples and sources. Biodegradation- Introduction, effect of chemical structure on biodegradation, recalcitrance, co metabolism and biotransformation. Factors affecting biodegradation, microbial degradation of hydrocarbons.

Unit 3: Biotransformations and Biocatalysts: (6hrs)

Basic organic reaction mechanism- Common prejudices against enzymes, advantages & disadvantages of biocatalysts, isolated enzymes versus whole cell systems, biocatalytic application, catalytic antibodies; stoichiometry.

Unit 4: Bioremediation and Biorestoration: (8hrs)

Introduction and types of bioremediation, bioremediation of surface soil and sludge, bioremediation of subsurface material, In situ and Ex-situ technologies, phytoremediation- restoration of coal mines a case study. Biorestoration: reforestation through micropropagation, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals.

Unit 5: Eco-Friendly Bioproducts from Renewable Sources: (4hrs)

Fundamentals of composting process: scientific aspects and prospects of biofuel production: bioethanol, biohydrogen and biodiesel; biofertilizers and biopesticides.

Text Books/References:

1. Environmental Processes I-III, J. Winter, 2nd ed., Wiley Publications
2. Introduction to Wastewater Treatment- R. S. Ramalho, Academic Press.
3. Elements of Water Pollution Control Engineering – O.P. Gupta, Khannabooks.

Program Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO 1															
CO 2															
CO 3															
CO 4															
Average															

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Molecular and Nano diagnostics **L-T-P-C: 2-0-1-3**

Course Objective: The objective of the course is to make students aware of the various molecular and nano-diagnostic techniques and their use in diagnosing various diseases and causing agents for human, plants and animals.

Course Learning Outcomes:

The students will be able to:
CO1. Understand of the basic principles used in molecular and nano-diagnostics.
CO2. Think and understand new diagnostic tools and methods.
CO3. Gain information to develop a new diagnostic kit.
CO4. Develop analytical skills for detection of various analytes.

Syllabus

Unit 1 Overview of molecular diagnostics (7hrs)

Molecular diagnostics: past, present, and future. DNA polymorphism, RFLP, RAPD, and SNPs. PCR in molecular diagnostics and forensic science; Multiplex-PCR, quantitative real time PCR (qRT-PCR) and their varied applications in molecular diagnostics.

Unit 2 Fluorescent probes for analysis of proteins and nucleic acids (8hrs)

Labelling of proteins and nucleic acids by various fluorescent dyes. DNA diagnostic system: Molecular beacons and its variants for their applications in detection, in-situ hybridization (FISH). Rolling circle amplification (RCA), Applications of Padlock and Selector Probes.

Unit 3 Diagnostics for point-of-care and resource limited settings (8hrs)

Rapid diagnostic tests (lateral flow assays), smartphones in medical diagnostics, human chorionic gonadotropin (HCG or hCG) based detection kit. Concepts of microfluidics, fabrication for microfluidics, Bio MEMs in diagnostics.

Unit 4 Biosensors History and future scope (7hrs)

Definition and principle of biosensors: Classification of biosensors based of transducers and recognition elements, components and basic designing of biosensors, different types of biosensors, Nanotechnology and biosensors: Carbon nanotubes, gold nanoparticles, measurement of biological molecules like glucose, toxins and xenobiotics. DNA aptamers for nano-biosensing. Role of AI and ML in molecular diagnostics.

Practicals

1. RFLP based restriction digestion pattern analysis.
2. Gene specific detection of toxins/antibiotic resistance in food sample using PCR/QPCR.
3. Synthesis of gold nanoparticles by chemical reduction method.
4. Gold nanoparticle based Lateral flow devices for rapid detection of hormone and antigens.

Text books:

1. Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications, Maribeth L. Flaws Ph.d , Lela Buckingham Publisher: F A Davis Co
2. Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory Wayne W. Grody, Robert M. Nakamura, Frederick L. Kiechle, Charles Strom, Publisher: Academic Press; ASIN: B003FQM2OI
3. Molecular Diagnostics, 2nd Edition, Academic Press, 2010, ISBN: 9780123745378.
4. Primrose SB and Twyman, Principles of Gene Manipulation and Genomics by R; 7th edition. Blackwell publishing, 2006

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	1	2	1	-	-	2	1	-	1	1	3	1	1	-
CO 2	2	1	1	2	1	-	-	2	1	-	1	2	3	2	1	-
CO 3	2	1	1	2	1	1	1	2	1	-	1	2	3	3	1	1
CO 4	2	2	2	3	3	1	1	2	2	1	2	3	3	3	3	1
Avg	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Data Analysis and Simulations	**L-T-P-C: 2-0-1-3**

Course Objective:

In this course, the students will learn the principles and methods of statistical analysis, but will also put them into practice using a range of real-world data sets. The objective of the course is to provide a basic understanding of data analysis using statistics and to use computational tools on problems of applied nature. Applications of data science techniques such as machine learning, deep learning and their applications in biological data.

Course Outcomes:

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

CO1. Perform basic analysis using data visualization.
CO2. Present their research results in probabilistic terms using statistical significance.
CO3. Analyze machine learning models and evaluate them;
CO4. Demonstrate deep learning techniques and their applications in biological and healthcare data.

Syllabus:

Unit 1: Data pre-processing and visualization: (7hrs)

Types of data, dealing with missing data, data visualization: Scatter Plot, histogram, group plots, box plots etc., dimensionality reduction.

Unit 2: Data analysis: (8hrs)

Statistical analysis, hypothesis testing, significance of p-value, chi-square, T-test, ANOVA, Bayesian Probability. Mining Frequent Patterns: Associations and Correlations, Data mining,

Unit 3: Machine learning: (8hrs)

Supervised, unsupervised, logistic regression, SVMs, decision trees, clustering and model evaluation. Basics of Artificial Intelligence.

Unit 4: Artificial neural networks: (7hrs)

Types of ANN, case studies for the application of deep learning in biology and health care research. Feature processing methods.

Practical:

1. Plotting graphs using MS Excel.
2. Statistical data analysis using PSPP.
3. Implementing machine learning algorithms.
4. Deep learning using Deep Learning Studio Desktop.
5. Graph-pad Prism, SPSS for statistical analysis

Text Books/References:

1. Introduction to Machine Learning using Python, Jeeva Jose, Khanna Publishing House, 2019.
2. Data Mining: Concepts and Techniques by Jiawei Han, Jian Pei, Micheline Kamber, Elsevier; Third edition 2007.
3. Deep Learning by Ian Goodfellow, Yoshua Bengio, MIT Press 2017.
4. Data Visualization – A Practical Introduction by Kieran Healy, Princeton University Press 2019.
5. Deep Learning – Rajiv Chopra, Khanna Publishing House, 2019.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

PROJ 3108	Project – II	L	T	P	C
Version 1.0		0	0	1	1
Pre-requisites/Exposure					

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

	Program Elective - I	L	T	P	C
Version 1.0		2	1	0	3
Pre-requisites/Exposure					

SEMESTER VII

	Animal and Plant Biotechnology	**L-T-P-C: 2-1-1-4**

Course Objectives: The broad objective of the present core course is to provide an overview of plant and animal biotechnology. In this respect, students will be acquainted with principles and applications of different techniques of plant and animal cell/tissue culture and genetic transformation.

Course Outcome: Students will be able to

CO1. Understand the principles and applications of plant tissue and animal cell culture.
CO2. Development of plant transformation vectors specifically designed to facilitate transfer of improved/unique genetic traits to plants.
CO3. Apply knowledge on diverse genetic transformation technologies available for the production of transgenic plants in crop improvement programs.
CO4. Apply techniques for generation of knock-out and transgenic animals to model disease and study gene function.

Syllabus:

Unit 1. Introduction to Animal Biotechnology: (9hrs)

Brief history of animal cell culture; cell culture media and reagents (buffer and pH; blood buffering system). Basic techniques of mammalian cell culture. Organotypic and histotypic cultures, Primary culture, secondary culture, continuous cell lines (cancer cell line), suspension cultures. Cell synchronization and transformation. Clonal selection, cell fusion and monoclonal antibody production.

Unit 2: Applications of Animal Biotechnology: (9hrs)

Animal cell culture for virus isolation and production of human and animal viral vaccines. Application of animal cell culture for disease modelling and high throughput drug screening. Application of animal cell culture for isolation of pharmaceutical proteins and recombinant anti-bodies. Development of iPSC and human specific disease modeling. Multiple Ovulation and Embryo Transfer Technology.

Unit 3. Principles of plant tissue culture: (9hrs)

History plant tissue culture, Media constituents and preparation. Micropropagation and clonal fidelity testing, Meristem culture for production of virus free plants. Somatic Embryogenesis, Organogenesis, Micrografting, Hardening and acclimatization.

Unit 4: Applications of plant tissue culture: (9hrs)

Production of triploids, embryo culture, embryo rescue, protoplast isolation, culture and fusion, production of secondary metabolites, cryopreservation and synthetic seed technology.

Unit 5. Applications of transgenic technology: (9hrs)

Introduction to Agrobacterium tumefaciens and Ti Plasmids. Chloroplast Transformation. Detection, characterization and expression of transformants (Genetic markers, reporter genes and transgene stability). Conferring resistance to biotic stresses (pests, viruses, fungi) and abiotic stresses (salt, drought, heat). Enhancing nutritional quality of crops. Knock-out/in animal development using embryonic stem cells technology. Transgenic animal development to model disease and study gene function

Practical:

1. Preparation of reagents and media for cell culture.
2. Cell counting and plating
3. Maintenance of Adherent (Monolayer) and Suspension Cell Culture
4. Cryopreservation of cell lines
5. Cell Viability Assay (MTT reagent)

6. Cell Cytotoxicity Assay (Trypan Blue Assay)
7. Transfection in Mammalian Cell Lines
8. Preparation and sterilization of standard tissue culture media.
9. Preparation of competent cells, transformation, and colony PCR for confirmation of transformation in Agrobacterium tumefaciens.
10. Agrobacterium mediated transformation of plants.

Textbooks/References:

1. Culture of Animal Cells by R.I. Freshney.
2. Animal Cell Biotechnology 2007, Humana Press by Portner R.
3. Basic Cell Culture Second Edition, Oxford University Press by Davis, J.M.
4. Principles of Plant Genetics and Breeding by George Acquaah 2007. Blackwell Publishing.
5. An introduction to Plant Tissue culture by MK Razdan. M.K. 2003. Oxford & IBH Publishing Co, New Delhi, 2003.
6. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.
7. Biochemistry & Molecular Biology of Plants. Bob Buchanan, Wilhelm Gruissem, Russell Jones. John Wiley & Sons, 2002.

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	1	2	1	-	-	2	1	-	1	1	3	1	1	-
CO 2	2	1	1	2	1	-	-	2	1	-	1	2	3	2	1	-
CO 3	2	1	1	2	1	-	-	2	1	-	1	2	3	3	1	-
CO 4	2	2	2	3	3	1	1	2	2	1	2	3	3	3	3	1
Avg	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**1**

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)- 20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**

ESE		**30**

Modes of Evaluation for Practical Exams: Continuous Assessment- 70% and End semester Examination (ESE) -30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Experimental Performance	30
	Viva voce	20
	Lab Record	20
ESE	Major Experiments (Practical	20
	Viva voce	10
	Total	**100**

Proteomics and Protein Engineering	**L-T-P-C: 2-0-1-3**

Course Objectives: Proteomics seeks to identify and to characterize all the proteins synthesized in a cell or a tissue. Protein Engineering offers understanding in analysis and prediction of how the 3D structure of a protein is related to its specific function; and to evaluate how specific proteins should be produced, purified, analyzed, and utilized in industrial processes.

Course outcome:

After completing course, students will be able to:

CO1. Understand the importance of proteomics and different tools and techniques used to analyze proteins.

CO2. Comprehend the importance of R groups of the amino acids in any protein.
CO3. Know relationship between structure and function of a protein
CO4. Design different strategies for protein engineering and protein design.

Syllabus

Unit 1: Proteomics: (12hrs)
Basic concepts of Proteomics, components of proteomics, importance and application of proteomics in biological functions, Tools of proteomics: separation methods- SDS-PAGE, IEF, and 2D-PAGE analysis.

Unit 2: Strategies for protein detection and staining: **(12hrs)**
commonly used software for spot analysis. Protein modification in proteomics: Introduction to Post translation modifications in proteins, phosphoproteins, glycoproteins, Ubiquitin etc. Difference gel electrophoresis (DIGE), Electromobility shift assay (EMSA).

Unit 3: Identification methods: (9hrs)

Mass Spectrometry (ESI and MALDI), mass fingerprinting, different software for analysis, Tandem-MS, ICAT-MS analysis, yeast hybrid systems.

Unit 4: Protein Engineering: (12hrs)

Definition and Design: Advantages and purpose, overview of methods, protein engineering and design – biochemical and molecular methods of protein engineering, underlying principles with specific examples.

Reference books:

1. Protein-Protein Interactions: Techniques and Applications (2018) O'Neill PB, Larsen and Keller Education, ISBN: 978-1635496536.
2. Protein Engineering and Design (2017) Torres A, Syrawood Publishing House, ISBN: 978-1682864029.
3. Protein Engineering Techniques: Gateways to Synthetic Protein Universe (2016) 1st ed., Poluri KM and Gulati K, Springer; ISBN: 978-9811027314.
4. Handbook of Protein Engineering (2015) 2nd ed., Callisto TA, ISBN: 978-1632394101
5. Protein Engineering (Nucleic Acids and Molecular Biology) (2010) Koehrer C and Raj Bhandary UL, Springer, ISBN: 978-3642089923
6. Protein Engineering, Principles and Practice (2006) Cleland JL and Craik CS, Vol 7, Springer Netherlands. ISBN: 978-0471103547.
7. Structure in Protein Chemistry (2006) 2nd ed. Kyte J, Garland publishers, ASIN: B013J9NXQG.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10

	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

	Project - III	L	T	P	C
Version 1.0		0	0	3	3
Pre-requisites/Exposure					

	Program Elective - II	L	T	P	C
Version 1.0		2	1	0	3
Pre-requisites/Exposure					

	Program Elective - III	L	T	P	C
Version 1.0		2	1	0	3
Pre-requisites/Exposure					

SEMESTER VIII

Intellectual Property Rights (IPR), Ethics and Regulatory Issues	L-T-P-C: 2-1-0-3

Course Objective(s): The course aims to disseminate knowledge on patents, patent regime in India and abroad and registration aspects. Make students aware about current trends in IPR and Govt. supports in promoting IPR. Classify the role of regulatory committees in controlling the risk. It also is tailored to develop the students' understanding of ethical aspects in biotechnology research.

Course Outcomes: Students will be able to
CO1. Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life
CO2. Recognize importance of biosafety practices and guidelines in research
CO3. Comprehend benefits of GM technology and related issues
CO4. Recognize importance of protection of new knowledge and innovations and its role in business

Syllabus

Unit 1. Regulatory guidelines: **(9hrs)**
For Biotechnological products, transgenics, GMOs.

Unit 2. GMOs': **(9hrs)**
Use of GMO's and their release, GM products, issues in use of GMO's, risk for animal/human/agriculture and environment owing to GMOs.

Unit 3. Bioethics: **(9hrs)**
Introduction and need of bioethics, its relation with other branches, types of risk associated with genetically modified microorganisms, Ethical Issues involving GMOs; ethics related to human cloning, human genome project, prenatal diagnosis, agriculture and animal rights, data privacy of citizens health**;** ethical issues in India and abroad through case studies; Socio-economic impact of biotechnology.

Unit 4. Intellectual Property Rights (IPR): **(9hrs)**
Introduction to IPR, types of IP (patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs), treaties in IPR.

Unit 5. Patent laws: **(9hrs)**
Covering IPR's in India, IPR Protection, patent filing in biotechnology, provisional and complete specification, patentable and non-patentable items.

Text Books/References:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3. V Sreekrishna, 2017. Bioethics and Biosafety in Biotechnology by New Age International publishers.
4. Biotechnology and Safety Assessment Thomas J.A., Fuch R.L Academic Press 3rd Edition 2002
5. Biological safety Principles and practices Fleming D.A., Hunt D. ASM Press 3rd. ed. 2000
6. Bioethics Ben Mepham Oxford University Press 2008
7. Bioethics & Biosafety R Rallapalli&Geetha Bali APH Publication 2000.

Reviews: Latest publications to be included.

E-resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. World Intellectual Property Organization. (2004). WIPO Intellectual Property Handbook. (https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf)

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10

	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Good Manufacturing & Laboratory Practice **L-T-P-C: 1-1-0-2**

Course Objective(s): The course aims to facilitate basic understanding of the regulatory requirement for GMP and GLP, the principles and importance of GMP and GLP in the pharmaceutical, biotechnology, or other regulated industries.

Course Outcomes:

CO1. Understand that the areas that come under the Good Laboratory Practices are: personnel and organizational, testing facilities, equipment, testing and controls, records, reports, and protocol for and conduct of non-clinical labs.

CO2. Comprehend the areas that come under GMP are: facilities and buildings, equipment, production, process control, packaging and labeling, laboratory controls, and returned/salvaged drug products.

CO3. Analyze the importance of GMP and GLP for drug regulation.

Syllabus:

Unit 1: Introduction to Good Manufacturing and Laboratory Practice (7hrs)

Requirement of GLP and GMP compliance for regulatory approval, Ethics in manufacturing and control, Principles of quality by design (QBD).

Unit 2: Introduction to the concept of Design of Experiment (8hrs)

(DOE) Application of QBD principles in Biotech product development. Case studies: Example of QBD and DOE in Process Development, Example of DOE in analytical development,

Unit 3: Introduction to ICH guidelines and their usage (7hrs)

National and international regulatory authorities and their function, Pharmaceutical Jurisprudence and Laws related to Product design, Drug Development & Approval Process, Regulation of Clinical and Preclinical Studies,

Unit 4: Formulation Production Management, Authorization and marketing of drugs. (8hrs)

Computer simulation on process design.

Text Books/References:

1. GMP starter guide: Principles in Good Manufacturing Practices for Beginners, Emmet P. Tobin, Createspace Independent Publishing Platform, April 2016.

2. Good Manufacturing Practices for Pharmaceuticals: GMP in Practice, B Cooper, Createspace Independent Publishing Platform, July 2017.

3. Sarwar Beg and Md Saquib Hasnain, Pharmaceutical Quality by design: Principles and application, Academic press, March 2019.

4. Ron S. Kenett, Shelemyahu Zacks, Daniele Amberti, Modern Industrial Statistics: with applications in R, MINITAB and JMP, 2nd Edition, Wiley, January 2014.

5. N Politis S, Colombo P, Colombo G, M Rekkas D.Design of experiments (DoE) in pharmaceutical development, Drug Dev Ind Pharm. 2017 Jun;43(6):889-901. doi: 10.1080/03639045.2017.1291672.

6. Andrew Teasdale, David Elder, Raymond W. Nims, ICH quality guidelines- An implementation guide, Dec 2017.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

	Project – IV	L	T	P	C
Version 1.0		0	0	0	9
Pre-requisites/Exposure					

	Program Elective – IV	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure					

Syllabus for Programme (Major) Electives

Rational Drug Discovery	**L-T-P-C: 2-1-0-3**

Course Objective(s): This course is aimed at imparting knowledge and skill to understand the drug discovery process, rational methods to identify and design molecules for new medications greatly shortening the discovery phase of drug development by computational methods.

Course Outcomes: Students will have:

CO1. Exposure to various methods of rational drug design.

CO2. Learn modelling of protein and target-small molecule interactions,

CO3. Understand and apply molecular docking, lead optimization, combinatorial chemistry and library design, CO4. Analyze Virtual screening, Toxicity (ADMET) property analysis, Pharmacophore and QSAR.

Syllabus:

Unit 1 Molecular Modelling in Drug Discovery: **(9hrs)**
Drug discovery process, Role of Bioinformatics in drug design, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand based drug design, modelling of target-small molecule interactions, Molecular simulations. Protein Modelling.

Unit 2 Quantum Mechanics and Molecular Mechanics: **(8hrs)**
Features of molecular mechanics force fields; Bond structure and bending angles – electrostatic, van der Waals and non – bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

Unit 3 Molecular Dynamics simulation methods: **(8hrs)**
Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time – dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

Unit 4 Molecular Docking and lead optimization: **(11hrs)**
Molecular Docking; Types of Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Strategy for target identification and Validation, lead identification, optimization and validation. Combinatorial chemistry and library design, virtual screening, drug likeness and compound filtering, Absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer based tools for drug design.

Unit 5 Pharmacophore and QSAR: **(9hrs)**
Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery; QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principal Components Analysis in the QSAR equations.

Text Books/References:

1. Computational methods in drug design Fred E. Cohen, Walter Hamilton Moos Publisher: ESCOM Science, 1993.
2. Molecular Modelling for Beginners - Alan Hinchliffe Publisher: John Wiley & Sons Inc, 2008. ISBN: 978-0470513149.
3. Combinatorial Library Design and Evaluation: Principles, Software, Tools, Applications in Drug Discovery – Arup Ghose, Vellarkad Viswanadhan Publisher: CRC Press, 2001. ISBN: 0-8247-0487-8.
4. Molecular Modeling Basics - Jan H. Jensen Publisher: CRC Press, 2010. ISBN 978-1420075267.
5. 3D QSAR in Drug Design: Recent Advances – Hugo Kubinyi, Gerd Folkers, Yvonne C. Martin Publisher: Springer Science & Business Media. ISBN: 0-306-46858-1.
6. Computational Chemistry and Molecular Modeling - K. I. Ramachandran, Gopakumar Deepa, Krishnan Namboori Publisher: Springer – Verlag Berlin Heidelberg. ISBN: 978-3540773023.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Stem Cell Technology **L-T-P-C: 2-1-0-3**

Course Objective: The objective of this paper is to familiarize the students with stem cell technology and its applications for betterment of the society. The course is designed to give a broad view of mammalian stem cells, reviewing where they are found in the body, the different types and how they are cultured. The topics will cover the basic biology of these stem cells as well as bioengineering and application of these stem cells to potential treatments of human diseases.

Course Outcomes: The Students will be able to:

CO1. Comprehend the concept of stem cells, different types of stem cells

CO2. Describe the concept of stem cell cloning and its applications

CO3. Recognize treatment of human diseases connected to stem cell therapy.

Syllabus

Unit 1 Stem cells and types: **(10hrs)**

Stem cells- Definition, Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. –

Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties

Unit 2 Stem cells in plants and animals: (10hrs)

Stem cell and founder zones in plants –particularly their roots – stem cells of shoot meristems of higher plants. Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles –tumour stem cells.

Unit 3 Stem cells differentiation (10hrs)

Factors influencing proliferation, physical, chemical and molecular methods for differentiation of stem cells – hormonal role in differentiation.

Unit 4 Regenerative and experimental methods: (8hrs)

Germ cells, hematopoietic organs, and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, - Stem cell Techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging.

Unit 5 Application and ethical issues: (7hrs)

Stem cell Therapy for neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns, skin ulcers, muscular dystrophy and orthopaedic applications. Stem cell policy and ethics, stem cell research: Hype, hope and controversy.

Text/ Reference books:

1. Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
2. Stem Cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
3. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Genome Editing	**L-T-P-C: 2-1-0-3**

Course Objective(s): The course will provide the technical details and applications of modern tools for precision gene targeting and editing. The course will also provide information about targeted gene silencing.

Course Outcomes: At the end of this course the students will

CO1. Understand and systematically analyze technical details of recent advent in precise gene editing tools.

CO2. Analyze the domains and ideate how such genome manipulating technologies can be effectively used in various streams of healthcare.

CO3. Apply techniques of gene editing in the field of medicine, agriculture and environment. They will also learn risk, safety and ethics of gene editing tools.

Syllabus

Unit 1 Introduction to genomics: (8hrs)

Gene regulation, and genetic engineering – organization, and structure of genomes; gene regulation and diseases. Breakage and Repair of Genomic DNA, DNA Recombination.

Unit 2 Gene manipulation techniques: (7hrs)

Transgenesis and site-specific recombination: Cre-Lox, Phi31 integrase. Genome editing: ZFNs, TALENs, CRISPR/Cas9. Multi-gene assemblies and high-throughput DNA assembly techniques.

Unit 3 Sequencing and mapping genomes (10hrs)

Sanger sequencing, Next Generation Sequencing, Techniques utilizing NGS: Chip-seq, RNA-seq, single-cell transcriptomics. Application to disease phenotyping.

Unit 4 Molecular imaging (8hrs)

Fluorescent tagging of fixed and live cells, CRISPR-based DNA tagging, rainbow imaging. Quantitative and high-throughput single-cell image analysis

Unit 5 Applications of genome editing: (12hrs)

In treating human diseases, Genome engineered Disease modeling, Engineered immune cells for cancer therapy, Personalized therapy; Challenges: safety and specificity, Ethical concerns: Germline gene editing.

Text Books/References:

1. CRISPR Gene Editing, Methods and Protocols, Editors: Luo, Yonglun (Ed.)
2. Genome Editing and Engineering, From TALENs, ZFNs and CRISPRs to Molecular Surgery. Edited by Krishnarao Appasani.
3. Progress in Molecular Biology and Translational Science Vol 149-Genome Editing in Plants. Edited by Donald P. Weeks and Bing Yang. Academic Press.
4. Precision Medicine, CRISPR, and Genome Engineering, Moving from Association to Biology and Therapeutics, Editors: Tsang, Stephen H. (Ed.). Springer.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Gene Expression and Transgenics **L-T-P-C: 2-1-0-3**

Course Objective(s): The course will provide the technical details and use of different gene expression systems for overexpression of recombinant proteins and protein complexes for different applications. The course will also provide details about purification of proteins expressed in different expression systems. The course will teach about generation of transgenic animals for research.

Course Outcomes: At the end of this course the students will be able to:
CO1. Understand protein expression in different heterologous host systems and application.
CO2. Comprehend the expression vectors and tags for protein that could be used in multidisciplinary research.
CO3. Apply the methods for creation of transgenic animals and their use in biotechnology research.

Syllabus:

Unit 1 Introduction to Gene Expression: **(8hrs)**

mRNA processing, mRNA export, regulation of gene expression, translation, protein folding, protein translocation.

Unit 2 Cis-acting elements and Trans-acting factors: **(10hrs)**

Eukaryotic RNA polymerases and basal transcription factors, Diversity in core promoter elements, Diversity in general transcription factors, Proximal & Distal Promoter Elements, Enhancers and Silencers, Gene-specific Regulators, Transcription factors – DNA binding domains, transcription activation domain

Unit 3 Synthesis and processing of mRNA: **(10hrs)**

Role of RNA Pol II in mRNA capping and mRNA splicing mRNA processing – Role of RNA Pol II in polyadenylation & mRNA editing Regulation of RNA Pol I transcription Regulation of RNA Pol III transcription

Unit 4 Recombinant protein expression systems: (10hrs)

Cloning and Expression vectors Eukaryotic protein expression systems - Eukaryotic protein expression systems - II Eukaryotic protein expression systems – III: Gene expression in mammalian cells using viral vectors

Unit 5 Gene therapy and Transgenic Technology: (7hrs)

Human Gene Therapy, DNA vaccines, Transgenic animals, Transgenic plants, Knockout mice. Regulation of Eukaryotic Gene Expression by Small RNAs (RNA Interference, RNAi), Genomics & Proteomics Metabolic Engineering & Synthetic Biology.

Reference books:

1. From Genes to Genomes: Concepts and Applications of DNA Technology. Jeremy W Dale, Malcolm van Schantz John Wiley & Sons, Ltd

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Tissue Engineering	**L-T-P-C: 2-1-0-3**

Course Objectives: This course will enable Students to understand thoroughly the key concepts of tissue organization, remodeling and strategies for restoration of tissue function. This will enable them to design tissue regeneration and tissue injury repair strategies.

Course Outcomes:

The Students will be able to:

CO1. Comprehend the structural organization of cells and tissues, the role of cell interaction, cell migration, wound healing and cellular processes.

CO2. Describe the different biomaterials and its properties, design, fabrication and biomaterials selection criteria for tissue engineering scaffolds.

CO3. Apply the techniques of tissue engineering.

Syllabus

Unit 1. Introduction: (8hrs)

Basic definition, Introduction to tissue engineering, Cells as therapeutic agents with examples. Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.

Unit 2. Structural and organization of tissues: (10hrs)

Tissue organization, Tissue Components, Tissue types, Functional subunits. Tissue Dynamics, Homeostasis in highly prolific tissues and Tissue repair. Angiogenesis. Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing.

Unit 3. Molecular & Cellular aspects: (10hrs)

Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

Unit 4. Biomaterials & Scaffold: **(10hrs)**

Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver, Bioreactors for Tissue Engineering.

Unit 5. Case study and regulatory issues: **(7hrs)**

Case study of multiple approaches: cell transplantation and engineering for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

Text books:

1. Principles of tissue engineering, Robert. P.Lanza, Robert Langer & William L. Chick, Academic press.
2. The Biomedical Engineering –Handbook, Joseph D. Bronzino, CRC press.
3. Introduction to Biomedical Engg. , Endarle, Blanchard & Bronzino, Academic press.
4. Tissue Engineering, B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino, CRC- Taylor & Francis
5. Nanotechnology and Tissue engineering - The Scaffold", Cato T. Laurencin, Lakshmi S. Nair, CRC Press

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Biosimilars Technology **L-T-P-C: 2-1-0-3**

Course Objective: To introduce students about the design and development of different kinds of biologics, biomimetics and biosimilars. Students will learn about their different biotechnological applications. Further the course will introduce the regulatory framework about the Biosimilars.

Course Outcomes:

The course gives the student a perspective of the complexity to establish biosimilarity of therapeutic proteins and biologics.

Syllabus:

Unit 1: Introduction to Biopharma **(10hrs)**

Generics in Biopharma, definition of biologics, biosimilars, super biologics, differences between chemical genetics and biosimilars. The developmental and regulatory challenges in biosimilar development, Prerequisites for Biosimilar development, Biosimilar market potential.

Unit 2: Types of biosimilar drugs **(8hrs)**

Peptides, proteins, antibodies, Enzymes, Vaccines, Nucleic acid based therapies (DNA, RNA, etc), Cell based therapies (including stem cells)

Unit 3: Characterization methods **(10hrs)**

Aggregation- precipitation, floccule strength, precipitate ageing & kinetics, adsorption of proteins & peptides on surfaces, effect of temperature on protein structure, hydration & thermal stability of proteins - solid powders, suspension on non-aqueous solvents, reversed micelles, aqueous solution of polyols, analytical and spectrophotometric characterization of proteins, protein sequencing and structure determination

Unit 4: Bioequivalence studies **(10hrs)**

Immunogenicity & allergenicity of biosimilars; factors affecting immunogenicity - structural, post-translational modifications, formulations, impurities, manufacturing and formulation methods for biosimilars; types of bioequivalence (average, population, individual), experimental designs & statistical considerations for bioequivalence studies (Non-replicated designs – General Linear Model, Replicated crossover designs), introduction to “ORANGE BOOK” & “PURPLE BOOK”.

Unit 5: Biosimilar products **(7hrs)**

Erythropoietin, growth hormone, granulocyte stimulating factors, interferons, streptokinase, monoclonal antibodies.

Text Books/References:

1. Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow, Biosimilar Drug Development, Drugs and Pharmaceutical Sciences, Vol 216, CRC Press.
2. Cheng Liu and K. John Morrow Jr., Biosimilars of Monoclonal Antibodies: A Practical Guide to Manufacturing, Preclinical and Clinical Development, Wiley, Dec 2016.
3. https://www.drugs.com/medical-answers/many-biosimilars-approved-united-states-3463281/

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Precision Medicine & Wellness **L-T-P-C: 2-1-0-3**

Course Objectives:
Explore the possibilities, promises, and pitfalls of precision medicine, using real-world examples. It is intended to bridge the gap between basic and translational research and its practical clinical applications, which will help prepare any student interested in research or health professions careers. Provide students with knowledge about prolonging health and treating disease that will empower them to make shared informed decisions with their physicians.

Course Outcomes: After the completion of the course, student will be able to:
CO1 Understand how the diversity of life evolves over time by processes (leading to) of genetic change, particularly the role of genetic and genomic variation throughout the genome in health and disease.
CO2 Describe recent advances in disease risk prediction, molecular diagnosis and progression of diseases, and targeted therapies for individuals.
CO3 Comprehend translational research findings and technology for healthcare.
CO4 Describe the ethical, legal, and social implications of health privacy and policy laws for precision medicine and evaluate primary and secondary precision medicine research.
CO5 Utilize modern human genomic and transcriptomic methods to analyze health and disease data in dry and wet lab settings.

Syllabus:

Unit 1. Omics for disease conditions: **(8hrs)**
Use of genomics, transcriptomics, proteomics and metabolomics in understanding disease conditions.

Unit 2. Biomarker analysis **(10hrs)**
Biomarker identification and validation of a disease state. Minimal Genome project, Human Genome project. Cancer genome project.

Unit 3. Genetic analysis **(10hrs)**
Different types of genetic and non-genetic variations, Genetic screening and diagnosis: prenatal carrier testing and newborn screening for Mendelian diseases,

Unit 4. **Dosing and prediction analysis** **(7hrs)**
Pharmacogenomic testing for drug selection, dosing and predicting adverse effects of commonly prescribed drugs, Tumor profiling, Patient data and clinical decisions.

Unit 5. Risk analysis and ethics **(10hrs)**

Risk assessment through omics approach. Ethical, legal, and social implications of health privacy and policy laws for precision medicine.

Text Books:

Genomic and Precision Medicine, 3rd Edition, Geoffrey Ginsburg and Huntington Willard, 2016
The Language of Life: DNA and the Revolution in Personalized Medicine, Francis S. Collins, 201

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Waste Water Management & Upcycling **L-T-P-C: 2-1-0-3**

Course Objective(s):

1. To introduce fundamental aspects of types of waste and its management.
2. To disseminate knowledge on various waste management technologies.
3. To provide knowledge on how waste can be converted to wealth in a sustainable way.
4. To enable students to think innovative way to develop concepts in waste management.

Course Outcomes: The students will be able to

CO1. Gain adequate knowledge on waste and its sustainable management.

CO2. Understand safety guidelines of waste management.

CO3. Develop concepts in managing waste of their institutions.

CO4. Apply the concepts of waste management.

Syllabus:

Unit 1 Waste management: **(12hrs)**

The definition of waste, and its classification in the context of EU legislation, policy and other drivers for change, including the planning and permitting regime for the delivery of waste management solutions

Liquid waste collection, treatment and disposal systems: Segregation and mixing schemes; Pre-treatment and its role in the industrial wastewater management; Overview of wastewater treatment technologies and development of wastewater treatment schemes; Operation and maintenance of effluent treatment plants; and Case study of an industrial wastewater management system.

Air Pollution management and treatment: Overview of industrial emissions; Air pollution control systems and overview of air pollution control technologies; Development of schemes for the collection, treatment and discharge industrial emissions.

Unit 2 Technologies for Waste treatment technologies: **(8hrs)**

waste incineration and energy from waste, pyrolysis and gasification, anaerobic digestion, composting and mechanical biological treatment of wastes, managing biomedical waste.

Unit 3 Health considerations for operational facilities: **(8hrs)**

handling of materials and impact of outputs on the environment; Advances in waste recycling and recovery technologies to deliver added value products; Landfill engineering and the management of landfill leachate and the mining of old landfills.

Unit 4 Interface of waste and resource management **(10hrs)**

and civil engineering in the context of sustainable waste management in global cities and developing countries; and Use of decision support tools including multi-criteria analysis, carbon foot-printing and life-cycle analysis, as appropriate.

UNIT V : Water recycle: **(7hrs)**

Upcycling, waste reuse, Waste down cycling, waste upcycling a social enterprise, Case study in each area. Innovative technologies for sustainable waste management.

Text Books/References:

1. O.P. Gupta, “Elements of Solid & Hazardous Waste Management”, Khanna Publishing House, New Delhi, 2019.
2. George Tchobanoglous et.al., “Integrated Solid Waste Management”, McGraw-Hill Publishers, 1993.
3. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, “Waste Management”, Springer, 1994.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	**Type of Assessment**	**Total Marks**
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Nanobiotechnology **L-T-P-C: 2-1-0-3**

Course Objective(s): This course is designed to make students understand the intersection of nanotechnology and biology. It will also acquaint students with nano-devices of biomedical applications. Students will know about the use of nanotechnology in diagnostic biology and learn about health and environmental impacts of nanotechnology.

Course Outcomes: Students will know about:
CO1 The use of nano material and nano technology in basic biology and biomedical and agro applications.
CO2 How to design and fabricate nano materials and nano devices.
CO3 Learn and ideate different strategies for applications of nanomaterials in drug delivery.
CO4 Analyze the toxic effects of nanomaterials on plant, human and ecosystem health.

Syllabus:

Unit 1Basics of Quantum Mechanics and Atomic Structure: **(6hrs)**
Duality of light, de Broglie waves, electrons in potential well, structure of hydrogen atom, classic atomic bonding, LCAO theory, band theory, energy bands for metals, semi-conductors and insulators

Unit 2 Surface Science of Nanomaterials and characterization: **(12hrs)**
crystal structure, close packed structures – FCC, HCP and BCC, surface structure for close-packed surfaces, surface reconfiguration (surface relaxation & surface reconstruction) adsorption, wetting, surface area in nanomaterials. Carbon nanotubes (CNT), fullerene ('C60'), quantum dots and semiconductor nanoparticles, metal-based nanostructures, nanowires, polymer-based nanostructures, gold nanostructures
X-ray diffraction, electron microscopy, interaction between electron beam and solids, TEM, SEM, SPM (STM & AFM), AES, XPS.

Unit 3 Nano biomaterials: **(12hrs)**
Biomimetic nanotechnology, protein-based nanostructures, Nano motors, bacterial (E. coli) and mammalian (Myosin family), DNA nanotechnology, nanostructures in cells study, microarray platforms, Nano printing of DNA, RNA, and proteins biochips applications in nano scale detection, lab-on-a-chip devices (LOC).

Unit 4 Nanotechnology and Applications: **(15hrs)**
micro- and Nano electromechanical devices in drug delivery, other applications in drug delivery, photodynamic therapy in targeted drug administration, Nano biosensors, applications of quantum dots in biotechnology, DNA based nanomaterials as biosensors. Engineered nanomaterial of relevance to human health, routes of entry into the body, toxic effects on health, plants and microbes are nanofactories.

Text Books/References:
1. Fundamentals and applications of nanomaterials by Guo Z and Tan L, Artech house (2009).
2. Nanobiotechnology by Balaji S, MJP Publishers (2010).
3. Nanobiotechnology: concepts, applications and perspectives by Niemeyer CM and Mirkin CA, Wiley-VCH (2004).
4. Introduction to Nanoscience by Lindsay SM, Oxford University Press (2010).

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Cancer Biology **L-T-P-C: 2-1-0-3**

Course Objectives: The objective of this course is to introduce current concepts and advances in the area of cancer biology. The Students will understand the role of oncogenes and suppressor genes and get knowledge on cancer related mutagens and pathways and cancer therapy

Course Outcomes:
Students will be able to

1. Comprehend pathogenesis, molecular mechanisms and identification of cancer
2. Explain cancer metastasis microenvironment and cancer therapy
3. Apply techniques for cancer diagnostics and therapy.

Syllabus

Unit1. Fundamentals of cancer biology: (10hrs)

Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer.

Unit 2.Principles of carcinogenesis: (10hrs)

Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis**.**

Unit 3. Principles of molecular cell biology of cancer: (8hrs)

Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto oncogene activity. Growth factors related to transformation. Telomerases.

Unit 4. Principles of cancer metastasis: (7hrs)

Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

Unit 5. Cancer diagnostic and therapy: (10hrs)

Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer. Different forms of therapy, chemotherapy, radiation therapy, detection.

Text books

1. Sverre Heim, Felix, Mitelman. Cancer Cytogenetics 3rd Edition Willy- Blackwell 2011.
2. Robin Hesketh. Introduction to Cancer Biology Cambridge, University Press 2013.
3. Fred Bunz. Principles of Cancer Genetics, Springer; 2008 edition.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20

	Total Continuous	50
MSE		20
ESE		30

Machine Learning	L-T-P-C: 2-1-0-3

Course Objective(s):

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To have a thorough understanding of the Supervised and Unsupervised learning techniques.
3. To study the various probability based learning techniques.
4. To understand graphical models of machine learning algorithms.

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

CO1. Distinguish between, supervised, unsupervised and semi-supervised learning
CO2. Apply the apt machine learning strategy for any given problem.
CO3. Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem.

CO4. Design systems that uses the appropriate graph models of machine learning.
CO5. Modify existing machine learning algorithms to improve classification efficiency.

Syllabus:

Unit 1: Introduction **(10hrs)**

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

Unit 2: Linear Models **(10hrs)**

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

Unit 3: Tree and Probabilistic Models **(10hrs)**

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map.

Unit 4: Dimensionality Reduction and Evolutionary Models **(8hrs)**

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process.

Unit 5: Graphical Models **(7hrs)**

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods.

Text Books:

1. Stephen Marsland, — Machine Learning – An Algorithmic Perspective||, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, —Machine Learning||, First Edition, McGraw Hill Education, 2013.
3. Jeeva Jose, - Introduction to Machine Learning using Python||, First Edition, Khanna Publishing House, 2019.

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10

	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**

Big Data Analytics **L-T-P-C: 2-1-0-3**

Course Objective: The course provides exposure to the vast field of computational biology, methodologies and techniques used in the field. Discusses various topics in depth by discussion around published research.

Course Outcomes:
CO1: Understand fundamental concepts of Big Data and its technologies
CO2: Apply concepts of MapReduce framework for optimization
CO3: Analyze appropriate SQL database techniques for storing and processing large volumes of structure and unstructured data
CO4: Apply data analytics solutions using Hadoop ecosystems

Syllabus:

Unit 1. Introduction to Big Data **(8hrs)**

Hadoop Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analyzing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere Big Insights and Big Sheets.

Unit 2. HDFS (Hadoop Distributed File System (10hrs)

The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop 1/0: Compression, Serialization, Avro and File-Based Data structures.

Unit 3. Map Reduce Anatomy (8hrs)

Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

Unit 4. Hadoop Eco System Pig (10hrs)

Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, Hive QL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL : Introduction

Unit 5. Data Analytics with R Machine Learning (9hrs)

Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.

Reference / Text Books:

1. Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters- A Beginner's Guide to R, Springer. 2009
2. Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch , James Giles, 2012 David Corrigan- Harness the Power of Big Data The IBM Big Data Platform , Tata McGraw Hill Publications
3. Shui Qing Ye- Big Data Analysis for Bioinformatics and Biomedical Discoveries, CRC 2015 Press
4. Ka-Chun Wong- Big Data Analytics in Genomics, Springer

Modes of Evaluation for Theory: Continuous Assessment- 50%, Mid Semester Examination (MSE)-20% and End Term Examination (ESE)-30%

Periodicity	Type of Assessment	Total Marks
Continuous	Surprise Test/Quiz	10
	Assignments	10
	Group Discussion/Presentations	10
	Project Based Learning/ Tutorials based learning	20
	Total Continuous	**50**
MSE		**20**
ESE		**30**