ADAMAS UNIVERSITY

School of Life Science & Biotechnology
Department of Biotechnology

B.Tech. Biotechnology

Course Structure
Program Code: BIT3403

Total Credit 170

2024-2025

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

VISION OF THE UNIVERSITY

To be an internationally recognized university through excellence in inter-disciplinary education,research and innovation, preparing socially responsiblewell-grounded individuals contributing to nation building.

MISSION STATEMENTS OF THE UNIVERSITY

M.S 01: Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology
M.S 02: Foster outcomes based education system for continuous improvement in education, research and all allied activities
M.S 03: Instill the notion of lifelong learning through culture of research and innovation
M.S 04: Collaborate with industries, research centers and professional bodies to stay relevant and up-to-date
M.S 05: Inculcate ethical principles and develop understanding of environmental and social realities

CHANCELLOR / VICE CHANCELLOR

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

VISION OF THE SCHOOL

To achieve global standard and **excellence in research** on various **interdisciplinary and multidisciplinary domains** of biological sciences through **biotechnological innovation** along with **producing global citizens** as graduates by **intensive teaching learning process** who would be vanguard to **sustainable societal development**.

MISSION STATEMENTS OF THE SCHOOL

M.S 01: To disseminate knowledge of life science and biotechnology for scholarly progression, intellectual development and strive for innovation.

M.S 02: To enable latest skill sets in the domain of microbiology, biotechnology, biochemistry (biological sciences) with ability to evolve and engage in learn-unlearn and relearn, being a lifelong learner.

M.S 03: To establish state of art infrastructure and research ambiance in attracting the best minds to serve under the single roof of school of life science and biotechnology in undertaking scientific investigation of social relevance.

M.S 04: To inculcate values, culture along with scientific knowledge to foster the spirit of self-reliance and entrepreneurship development.

DEAN / SCHOOL CONCERNED

DEAN / SCHOOL CONCERNED

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

VISION OF THE DEPARTMENT

To achieve **excellence in biotechnological education and research** for **societal development** through **innovation** and producing **technologically sound graduates** as **global citizens** fostering **life-long learning.**

MISSION STATEMENTS OF THE DEPARTMENT

M.S 01: Adopt and implement latest curriculum in biotechnology with futuristic approach and innovative pedagogy fostering knowledge, intellectual and skill development.

M.S 02: To enable and enhance biotechnological and allied subject skill sets through rigorous training and research through multidisciplinary approach.

M.S 03: To cater professional and societal need of cutting-edge biotechnological research through collaboration and industry-academia partnership.

M.S 04: To inculcate values, culture along with biotechnological knowledge to foster the spirit of self-reliance and entrepreneurship development.

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

Name of the Programme: B.Tech. Biotechnology

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1 **:** Graduates will acquire basic theoretical and practical domain knowledge in biotechnology and compete on a global platform to pursue their professional career either in Industry and Academia, or through entrepreneurship.

PEO2 **:** Graduates will pursue higher education and/or engage in continuous up gradation to identify research gaps, comprehend fundamentals and specialize in the domain of biotechnology.

PEO3 **:** Graduates with their fundamental strength in biotechnology, critical thinking, and innovative strategies would be able to analyze, design and solve complex Industry and Academia related problems.

PEO4 **:** Develop as professional aspirants and sustainable learners with a strong sense in ethics and code of professional practice.

PEO5 **:** Global outlook with imbibed human values.

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

Name of the Programme: B.Tech. Biotechnology

GRADUATE ATTRIBUTE / PROGRAMME OUTCOME (PO)

GA 01/ PO 01	**Academic excellence:** Apply the knowledge of engineering fundamentals, and engineering specializations for the welfare of human health and sustainable development.
GA 02/ PO 02	**Critical thinking:** Ability to correlate between courses and develop critical/logical thinking.
GA 03/ PO 03	**Skills:** Develop skill set related to biotechnology and allied fields
GA 04/ PO 04	**Modern tools and techniques usage:** Familiarized with classical as well as modern tools and techniques in biotechnology.
GA 05/ PO 05	**Problem solving:** Ability to identify scientific research gaps and problems pertaining to biotechnology and allied fields.
GA 06/ PO 06	**Analysis:** Explore the acquired knowledge and skills of biotechnology to identify approaches and solve problems using innovative strategies.
GA 07/ PO 07	**Proper solutions:** Ability to retrieve biological data for a meaningful solution.
GA 08/ PO 08	**Professional:** Decide upon career path, force the challenges and develop professional aspirations for Industry or Academia job, or as an entrepreneur.
GA 09/ PO 09	**Collaboration:** Uphold integrity and collaborative approach in workplace.
GA 10/ PO 10	**Sustainability:** To accept and implement learning towards sustainable development.
GA 11/ PO 11	**Ethics:** Practice ethical philosophies and systems in creating and partnering a progressive society.
GA 12/ PO 12	**Global citizen:** Develop as global citizen to contribute in the greater benefits of humanity.

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
B. Tech (Biotechnology) Program
Course Structure

FIRST-YEAR

SEMESTER I								
S. No	**Type**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs/wk**	**Credits**
1	Theory (BSC)	MTH11501	Engineering Mathematics-I	3	1	0	4	4
2	Theory (BSC)	PHY13201	Applied Sciences	2	0	1	4	3
3	Theory (ESC)	GEE11001	Electrical and Electronics Technology	2	0	0	2	2
4	Theory (HSSM)	ENG11053	English Communication	1	0	2	3	2
5	Theory (BSC)	BIT11003	Life Sciences	2	0	0	2	2
6	Theory (Mandatory, PC)	DGS11002	Design Thinking & Prototyping	2	0	2	4	3
7	Practical (ESC)	GEE12002	Electrical and Electronics Technology Lab	0	0	4	4	2
8	Practical (ESC)	MEE12001	Engineering Workshop	0	0	4	4	2
			Total	**12**	**1**	**13**	**27**	**20**

BSC: Basic Science Core
ESC: Engineerig Science Core
PC: Professional Core
HSSM: Humanities and Social Sciences including Management courses

SEMESTER II								
S. No	**Type**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs/wk**	**Credits**
1.	Theory (BSC)	MTH11502	Engineering Mathematics– II	3	1	0	4	4
2.	Theory (ESC)	MEE11002	Engineering Mechanics	2	1	0	3	3
3.	Theory (BSC)	EVS11112	Environmental Science	2	1	0	3	3
4	Theory (ESC)	CSE11001	Introduction to Programming	2	0	0	2	2
5	Theory	GEE11012	Disruptive Technology Innovations	1	0	2	3	2
6	Theory (Mandatory)	EIC11001	Venture Ideation	2	0	0	2	2
7	Practical (ESC)	CSE12002	Programming Lab	0	0	4	4	2
8	Practical (ESC)	CEE12001	Engineering Drawing and CAD	0	0	4	4	2
			Total	**12**	**3**	**10**	**25**	**20**

1st Year (Total Credit) 40

SEMESTER III								
S. No	**Type**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs/wk**	**Credits**
1	Theory (BSC)	MTH11527	Probability, Statistics and Numerical Methods	3	1	0	4	4
2	Practical (BSC)	MTH12531	Numerical Methods Lab	0	0	4	4	2
3	Theory (PC)	BIT11058	Biochemistry & Bioenergetics	3	1	0	4	4
4	Theory (PC)	BIT11059	Microbiology	3	1	0	4	4
5	Practical (PC)	BIT12060	Biochemistry Lab	0	0	4	4	2
6	Practical (PC)	BIT12061	Microbiology Lab	0	0	4	4	2
7	Practical (Mandatory)	IDP14001	Interdisciplinary Project	0	0	3	3	3
8	Practical (Mandatory)	SOC14100	Community Service[#]	0	0	1	1	1
9	Practical (PC)	BIT14113	Professional Development Training-I	0	0	1	2	1
			Total	**9**	**3**	**17**	**30**	**23**

SEMESTER IV								
S. No	**Type**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs/wk**	**Credits**
1	Theory (PC)	BIT11126	Cell Biology & Genetics	3	1	0	4	4
2	Theory (PC)	BIT11065	Biophysical Techniques & Instrumentation	2	1	0	3	3
3	Theory (PC)	BIT11110	Bioprocess Technology	2	1	0	3	3
4	Practical (PC)	BIT12127	Cell Biology & Genetics Lab	0	0	4	4	2
5	Practical (PC)	BIT12069	Biophysical Techniques & Instrumentation Lab	0	0	4	4	2
6	Practical (PC)	BIT12070	Bioprocess & Fermentation Technology Lab	0	0	4	4	2
7	Theory (HSSM)	ECO11505	HSSM-IV (Economics for Engineers)	3	0	0	3	3
8	Theory (Mandatory)	PSG11021	Human Values and Professional Ethics	2	0	0	2	2
9	Practical (PC)	BIT14114	Professional Development Training-II	0	0	1	2	1
			Total	**12**	**3**	**13**	**29**	**22**

2nd Year (Total Credit) 45

SEMESTER V								
S. No	**Type**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs/wk**	**Credits**
1	Theory (PC)	BIT11072	Molecular Biology	3	1	0	4	4
2	Theory (PC)	BIT11074	Bioinformatics	2	1	0	3	3
3	Theory (PE)	BIT11075 BIT11076	Professional Elective-I	2	1	0	3	3
4	Theory (PE)	BIT11079 BIT11080	Professional Elective-II	2	1	0	3	3
5	Theory (PC)	BIT11107	Bioethics, Biosafety & IPR	2	1	0	3	3
6	Practical (PC)	BIT12081	Molecular Biology Lab	0	0	4	4	2
7	Practical (PC)	BIT12083	Bioinformatics Lab	0	0	4	4	2
8	Practical (PE)	BIT12077/ BIT12078	Professional Elective I Lab	0	0	4	4	2
9	Practical (PC)	BIT14115	Professional Development Training-III	0	0	1	2	1
			Total	**11**	**5**	**13**	**30**	**23**

PC: Professional Core
PE: Professional Elective
PE 1: Genomics, Proteomics & Metabolomics (BIT11075)/ Recombinant DNA Technology (BIT11076)
PE 1 Lab: Genomics, Proteomics & Metabolomics Lab (BIT12077)/ Recombinant DNA Technology Lab (BIT12078)
PE 2: Nanobiotechnology (BIT11079)/ Bioenergy for Sustainable Development (BIT11111)

SEMESTER VI								
S. No	**Type**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs/wk**	**Credits**
1	Theory (PC)	BIT11085	Immunotechnology	2	1	0	3	3
2	Theory (PC)	BIT11128	Plant & Agricultural Biotechnology	2	1	0	3	3
3	Theory (PC)	BIT11087	Animal Biotechnology	2	1	0	3	3
4	Theory (PE)	BIT11091/ BIT11101	Professional Elective-III	2	1	0	3	3
5	Theory (OE)	BIT11093/ BIT11102	Open Elective-I	2	1	0	3	3
6	Practical (PC)	BIT12088	Immunotechnology Lab	0	0	4	4	2
7	Practical (PC)	BIT12129	Plant & Animal Biotechnology Lab	0	0	4	4	2
8	Practical (PC)	BIT15095	Technical Seminar	0	0	2	2	2
9	Practical (PC)	BIT14116	Professional Development Training-IV	0	0	1	2	1
			Total	**10**	**5**	**11**	**27**	**22**

3rd Year (Total Credit) 45

PC: Professional Core
PE: Professional Elective
OE: Open Elective
PE 3: Medical Biotechnology (BIT11091)/ Advances in Crop Biotechnology (BIT11101)
OE 1: Advances in Microbial Biotechnology (BIT11093)/ Protein Engineering (BIT11102)

SEMESTER VII								
S. No	**Type**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs/wk**	**Credits**
1	Theory (HSSM)	MGT11402	HSSM-V (Industrial Management)	2	1	0	3	3
2	Theory (PC)	BIT11109	Industrial Biotechnology	2	0	0	2	2
3	Theory (PE)	BIT11096/ BIT11097	Professional Elective-IV	2	1	0	3	3
4	Theory (PE)	BIT11092/ BIT 11094	Professional Elective-V	2	1	0	3	3
5	Theory (OE)	BIT11100/ BIT11103	Open Elective-II	2	1	0	3	3
6	Theory (OE)	BIT11104/ BIT11106/ BIT11108	Open Elective-III	2	1	0	3	3
7	Practical (PE)	BIT12098/ BIT12099	Professional Elective-IV Lab	0	0	4	4	2
8	Practical (PC)	BIT14109	Minor Project	0	0	8	8	4
9	Practical (PC)	BIT14110	Industrial Training[#]	-	-	-	-	2
10	Practical (PC)	BIT14117	Professional Development Training-V	0	0	1	2	1
			Total	**12**	**6**	**13**	**32**	**26**

HSSM: Humanities, Social Science & Management

PC: Professional Core **PE**: Professional Elective **OE**: Open Elective
PE 4: Food Biotechnology (BIT11096)/ Environmental Biotechnology (BIT11097)
PE 4 Lab: Food Biotechnology Lab (BIT12098)/ Environmental Biotechnology Lab (BIT12099)
PE 5: Molecular modeling and drug design (BIT11094)/ Stem Cell Biotechnology (BIT11092)
OE 2: Agricultural Biotechnology (BIT11100)/ Gene Expression (BIT11103)
OE 3: Biocatalysis (BIT11104)/ Research Methodology and GLP (BIT11108)/ Systems Biology (BIT11106)
Industrial Training for 4-12 weeks will be taken at the end of the 6th Semester and will be evaluated in the 7th Semester

SEMESTER VIII								
S. No	**Type**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs/wk**	**Credits**
1	Practical (PC)	BIT14111	Major Project	0	0	20	20	10
2	Practical (PC)	BIT15112	Comprehensive Viva- Voce	0	0	0	0	4
			Total	**0**	**0**	**20**	**20**	**14**

4th Year (Total Credit) 40

Credit Distribution

Sl. No.	Category	Breakup of Credits	AU Credit Distribution (%)	AICTE Credit Distribution (%)
1	Humanities & Social Sciences Courses	2	5	7
2	Management + Economics + Commerce Courses	6		
3	Basic Science Courses	22	13	16
4	Engineering Science Courses	15	9	15
5	Professional Core Courses	95	57	40
6	Professional Elective Courses	19	11	11
7	Open Elective Courses	9	5	11
	Total Credits	168	100	100

SEMESTER I

MTH11501	Engineering Mathematics-I	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	12^{th} level Mathematics				
Co-requisites	--				

Course Objectives

1. To help the student to understand basic concept of abstract and vector algebra with its uses in engineering science.
2. To give emphasis about concepts of differential calculus and enable students to apply these topics in real life problems.
3. To give the students a perspective to learn integral calculus and its importance in advanced study in engineering science.
4. To enable students acquire fundamental concept of ordinary differential equation and it's applications in engineering science.

Course Outcomes

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

CO1 **Develop** the idea of basic concepts of abstract algebra and geometrical idea of vector analysis with real world applications.

CO2 **Explain** the fundamental concepts of differential calculus and apply these topics in real life problems

CO3 **Illustrate** the fundamental concepts of Integral Calculus and apply these topics in real life problems.

CO4 **Understand** and apply the various solution procedures of Ordinary Differential equations in engineering problems.

CO5 **Integrate** and **assess** the knowledge of scalar and vector fields to create models involving gradient, curl, divergence, and vector products.

Catalog Description

For engineering course, Mathematics is the backbone. Students will be having good engineering skills if their idea for Mathematics is clear. In this course the focus will be to learn Mathematics in depth which will motivate students to grow their thinking ability for Engineering also. By knowing the theory student will be able to apply that successfully to all kind of problems of Engineering and science. Class participation is a fundamental aspect of this course. Students will be encouraged to actively take part in all group activities (Problem solving, presentation etc.)

Course Content

Unit I: Differential Calculus [20H]

Introduction to limit, continuity, derivative for function of one variable, Successive differentiation, Leibnitz's theorem; Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin's theorems with remainders, Indeterminate forms, Concavity and convexity of a curve, Points of inflexion

Limit, continuity, and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, chain rule, total derivative, derivatives of composite and implicit functions, homogeneous function, Euler's theorem on homogeneous functions, Jacobian of variable transformation, maxima and minima of functions of several variables, Lagrange's method of multipliers.

Unit II: Integral Calculus [15H]

Reduction formulae, Improper integral, convergence of improper integrals, tests of convergence, Beta and Gamma functions, elementary properties, Rectification, double and triple integrals, computations of area, surfaces and volumes, change of variables in double integrals, applications

Unit III: Linear Algebra [18H]

Symmetric and skew-symmetric matrices, orthogonal matrices, complex matrices, Hermitian and skew-Hermitian matrices, Unitary matrices, Elementary row and column operations on a matrix, Rank, echelon form, Inverse of a matrix using elementary operations, solution of system of linear equations, Consistency, Characteristic equation, Caley-Hamillton theorem, eigenvalues and eigenvectors, algebraic and geometric multiplicity, diagonalization

Unit IV: Vector Algebra [7H]

Scalar and vector fields, Vector product, Scalar triple product and their interpretation, directional derivative, gradient, Curl, divergence

References:

1. Erwyn Kreyszig : Advanced Engineering Mathematics, John Wiley and Sons
2. B.V. Ramana, Higher Engineering Mathematics Tata McGraw-Hill.
3. B.S.Grewal : Higher Engineering Mathematics, Khanna Publications
4. C B Gupta, S R Singh, Mukesh Kumar: Engineering Mathematics, McGraw Hill Publication.
5. R.K.Jain and S.R.K.Iyengar : Advanced Engineering Mathematics, Narosa Publishing House, 2002

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Scheme:

Components	**Class assessment**	**End term**
Weightage (%)	**50**	**50**

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Develop the idea of basic concepts of abstract algebra and geometrical idea of vector analysis with real world applications.	**PO2, PO3, PO4, PO12**
CO2	Explain the fundamental concepts of Differential Calculus and apply these topics in real life problems	**PO2, PO3, PO4, PO12**
CO3	Illustrate the fundamental concepts of Integral Calculus and apply these topics in real life problems.	**PO2, PO3, PO4, PO12**
CO4	Understand and apply the various solution procedures of Ordinary Differential equations in engineering problems.	**PO2, PO3, PO4, PO12**
CO5	Integrate and assess the knowledge of scalar and vector fields to create models involving gradient, curl, divergence, and vector products.	**PO2, PO3, PO4, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Adequate strong skills in learning new programming…	The ability to understand the evolutionary changes in …	Ability to analyze the impact of computer science and …
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3

MTH11501	Engineering Mathematics- I														

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	2	3	3	3	3	2	3	3	2
CO2	3	3	3	2	3	3	3	3	2	3	3	3
CO3	3	3	3	2	3	3	3	3	2	3	3	2
CO4	3	3	3	2	3	3	3	3	2	3	3	2
CO5	3	3	3	2	3	3	3	3	2	3	3	2
Avg	3	3	3	2-	3	3	3	3	2	3	3	3

PHY13201	Applied Sciences	L	T	P	C
Version 1.0	Contact Hours - 45	2	0	1	3
Pre-requisites/Exposure	12^{th} level Physics, Chemistry, and Mathematics				
Co-requisites	--				

Course Objectives

1. To develop the capability of the students for understanding fundamental aspects of physics.
2. To give students theoretical background, the key prerequisite for performing laboratory experiments.
3. To build up the foundations for further studies in physics and engineering.
4. Learn to analyze and evaluate various thermodynamic cycles used for energy production - work and heat, within the natural limits of conversion
5. To impart the knowledge of measurement of the rate of a chemical reaction and to gain knowledge of electrochemical procedure

Course Outcomes

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

CO-1	**Illustrate** the basics of vector calculus, its application in mechanics, and different harmonic motions.
CO- 2	**Explain** the knowledge of physical optics and related application.
CO- 3	**Develop** the basic concepts of electromagnetic theory and em wave.
CO -4	**Utilize** fundamental concepts of thermodynamics to engineering applications, estimate thermodynamic properties of substances in gas and liquid states, and determine thermodynamic feasibility and efficiency of various energy related processes.
CO- 5	**Integrate and assess** the rate law, effect of temperature on the rate of a chemical reaction and determine the activation energy and determine the role of a catalyst on the rate of a chemical reaction, calculate the cell potential for a nonstandard cell.

Catalog Description

Applied science is a discipline that is used to apply existing scientific knowledgeto develop more practical applications, for example: technology or inventions. In applied science different aspects of Mathematical Physics is used to develop information to explain phenomena in the natural world. This information is then put to use for practical endeavors through a controlled Laboratory

environment. Applied science is generally engineering, which develops technology, although there might be dialogue between basic science and applied science (research and development).In this course the focus will be on improving the logical learning moved into a physical environment. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies, such as group discussions, cooperative group solving problems, analysis of video scenes and debates. Class participation is a fundamental aspect of this course.

Basic knowledge in chemistry is essential for understanding various energy-work relationships. Student will be able to develop engine. They will be able to increase the efficiency of an engine. Student will understand the different processes in chemical and physical science and their feasibility. The basic knowledge of the molecular structure and their bonding will impart the knowledge of the reactivity and the application of different molecules. The knowledge of electrochemistry will impart a deep sense in preparing different electrochemical cells and their applications. Students will be encouraged to develop new models. We will apply different methodologies to inspire our students combining traditional classes with modern techniques. They will also take part in different project work in fundamental as well as in practical fields.

Course Content

Module 1: Mechanics [10 lecture hours]

Basic ideas of Vector Calculus Potential energy function, Conservative and non-conservative forces. Conservation laws of energy & momentum. Central and non-central forces, Gravitation, Kepler's Laws, Angular Velocity and Torque, Moment of Inertia, SHM, Damped, Undamped and forced Oscillations (no derivations).

Module 2: Optics [5 lecture hours]

Principle of Superposition and Interference from parallel thin films, Single slit and Double slit diffraction, Diffraction grating, dispersive power of Grating, resolving power of prism and grating.production of plane polarized light by different methods, Brewster and Malus Laws. Double refraction, Nicol prism, specific rotation.

Module 3: Electromagnetic Theory [10 lecture hours]

Gauss's Law in Electrostatics, Boundary Value problems, Dielectrics, Motion of Charged Particles in crossed electric & magnetic fields, Velocity Selector & Magnetic focussing, Gauss law, continuity equation, Biot-Savart Law and its applications, inconsistency in Ampere's Law, Maxwell's equations (differential and integral forms), Poynting vector, Poynting Theorem (Statement only).

Module 4: Thermodynamics [10 lecture hours]

Importance and scope, definition of system and surroundings: type of systems (isolated, closed and open); extensive and intensive properties; steady state versus equilibrium state; concept of thermal equilibrium and the zeroth law of thermodynamics; thermodynamic coordinates, state of a system, equation of state, state functions and path functions; concept of heat and work (IUPAC convention); first law of thermodynamics, internal energy (U) as a state function; enthalpy as a state function; energy conservation in the living organism; heat changes at constant volume and constant pressure; relation between C_p and C_v using ideal gas; Thermodynamics of Chemical Processes, Concept of entropy, 2^{nd} law of thermodynamics, Idea of Chemical potential, Equilibrium conditions for closed systems.

Module 5: Reaction Kinetics, Catalysis & Electrochemistry [10 lecture hours]

Rate laws, 1^{st}Order reaction & 2^{nd}order reaction, Arrhenius equation, Mechanism and Theories of reaction rates, kinetic and thermodynamic control of reaction; idea of rate determining step; steady-state approximation; Characteristics and types of Catalyst, Theories of Catalysis, Electrode potential, Redox reaction & Nernst Equation.

List of Practicals

Experiments: Physics (45 hours total)

1. Determination of Young's Modulus of a Beam by traveling microscope by FLEXURE method.
2. Carry Foster's Method to Determine Resistance of a Given Coil.
3. Determination of the Coefficient of viscosity of water by Poiseulle's Capillary Flow method.
4. To determine the wavelength of sodium light by forming Newton's Ring.
5. Determination of Rigidity Modulus by dynamical method.
6. Determine the Planck's constant using photocell.
7. To verify Stefan's law by electrical method.
8. To study the temperature dependence of reverse saturation current in a junction diode and hence to determine the Band gap.
9. Determination of specific charge (e/m) of electron by J.J. Thomson's method.
10. Determination of the Rydberg constant by studying hydrogen or helium spectrum.
11. Determination of dielectric constant of a given dielectric material.
12. Determination of Hall coefficient of Semiconductor.
13. Study current – voltage characteristic load response of photovoltaic solar cells.

Experiments: Chemistry (Any Four)

1. Determination of total hardness of water by complexometric titration method
2. Determination of carbonate and bicarbonate in water
3. Estimation of iron (ferrous ion in Mohr salt) by permanganometry.
4. Determination of strength of an unknown HCl solution with standardized NaOH solution by conductometric titration.
5. Dissolved oxygen by Winkler's method

Text Books

1.	Principles of Engineering Physics by S. P. Kuila, (Volume I) New Central Book Agency (P) Ltd.
2.	Principles of Engineering Physics by S. P. Kuila, (Volume II) New Central Book Agency (P) Ltd.
3.	Engineering Physics by Partha Pratim Das and Abhishek Chakraborty
4.	Engineering Physics I by S. K. Bhattacharya and Soumen Pal
5.	Engineering Physics II by S. K. Bhattacharya and Soumen Pal
6.	Engineering Chemistry (Cambridge University Press-Ist Edition) –Shikha Agarwal
7.	P. W. Atkins, Physical Chemistry, ELBS/Oxford, 10th Edition, 2014

Reference Books

1.	Optics by Ajoy Ghatak, Mc-graw Hill
2.	Introduction to Electrodynamics, David J. Griffiths, Pearson Education Limited
3.	Engineering Chemistry (Pearson Ed.)- K. Sesha Maheswaramma and MridulaChugh
4.	Physical Chemistry (Sarat Book House)- P. C. Rakshit

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Illustrate** the basics of vector calculus, its application in mechanics, and different harmonic motions.	**PO1, PO5**
CO2	**Explain** the knowledge of physical optics and related application.	**PO1**
CO3	**Develop** the basic concepts of electromagnetic theory and em wave.	**PO1, PO3, PO5, PO6**
CO4	**Utilize** fundamental concepts of thermodynamics to engineering applications, estimate thermodynamic properties of substances in gas and liquid states, and determine thermodynamic feasibility and efficiency of various energy related processes.	**PO1, PO2, PO3, PO5**
CO5	**Integrate and assess** the rate law, effect of temperature on the rate of a chemical reaction and determine the activation energy and determine the role of a catalyst on the rate of a chemical reaction, calculate the cell potential for a nonstandard cell..	**PO1, PO2, PO3, PO5**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHY13201	Applied Sciences												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

GEE11001	Electrical and Electronics Technology	L	T	P	C
Version 1.0		2	0	0	2
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	Basic idea of semiconductor devices and electromagnetism				

Course Objectives

1. To familiarize with passive components, active components and measuring instruments.
2. To familiarize the working of diodes, transistors, MOSFETS and integrated circuits.
3. To implement mini projects based on concept of electronics circuit concepts.
4. To understand d.c network theorems and apply these theorems to calculate the voltage, current and power for a given circuit.
5. To explain the concept of active power, reactive power, power factor, quality factor, steady state sinusoids.

Course Outcomes

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

CO1**. Analyze** and apply network theorems (Thevenin's, Norton's, and Maximum Power Transfer) in DC circuit analysis and solve problems using Kirchhoff's Law, mesh, and nodal analysis.

CO2. **Apply** phasor representation and analyze single-phase AC circuits, calculating power, power factor, resonance, and bandwidth in series-parallel RLC circuits.

CO3. **Evaluate** the operation and advantages of three-phase AC circuits, including star and delta connections, power measurements, and phase voltage/current relationships.

CO4. **Understand and analyze** the behavior of semiconductors and PN junctions, including current flow, breakdown conditions, and the effects of forward and reverse bias.

CO5. **Integrate and create** digital logic circuits and switching circuits using MOSFETs and apply their understanding of transistor configurations (NPN, PNP) in amplification and switching applications.

Catalog Description

Present technology requires necessary knowledge of ELECTRONICS in most fields. Avionics, Autotropic, Agrotronics, Physics, Process Chemistry, Health Services, etc., already employ components or even whole systems based on Electronics. Thus, there is an increasing number of professionals in these and many other fields who need adequate knowledge and training. Taken this into account, ADAMAS has developed the Basic Electronics and Electricity Integrated Laboratory, capable of covering different levels of difficulty. It is based on a series of self-taught modules, each one referring to a specific area of Electronics.

Course Content

Unit I: 7 lecture hours

D.C. Circuit Analysis and Network Theorems: Concept of network, Active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and

bilateral elements, R, Land C as linear elements, source transformation, Kirchoff's Law, mesh analysis and nodal analysis, star-delta transformation, network theorems: Thevenin's theorem, Norton's theorem, maximum power transfer theorem, network analysis with dependent sources.

Unit II: 7 lecture hours

Steady State Analysis of Single Phase A.C. Circuits: Sinusoidal, square and triangular waveforms-average and effective value, form the peak factors, concept of phasor, phasor representation of sinusoidal voltage and current, analysis of series-parallel RLC circuits. Apparent, active and reactive powers, power factor, causes and problems of low power factor, power factor improvement, resonance in series and parallel circuits, bandwidth and quality factors.

Unit III: 6 lecture hours

Three Phase A. C. Circuits: Its necessity and advantages, meaning of phase sequence, star and delta connections, balanced supply and balanced load, line and phase voltage/current relation, three phase power measurements, two wattmeter method.

Unit IV: 6 lecture hours

Basics of Semi-Conductors and PN Junction: Introduction; Carrier Concentrations- the Fermi Level; Electron and Hole Concentration at Equilibrium; Temperature Dependence of Carrier Concentration; Drift and diffusion current; The Hall Effect; Optical Absorption, Luminescence; PN Junction Diode in Equilibrium Conditions; PN Junction Diode in Forward Biased and Reverse Biased Condition; Breakdown in PN Junction Diodes.

Unit V: 6 lecture hours

Bipolar Junction Transistors: Introduction, Types: NPN and PNP; Current Components; Early Effect Ebber's Moll Model; Different Configurations of a Transistor and its Characteristics; Transistor as an Amplifier (CE, CB, CC); Transistor as a Switch

Unit VI: 6 lecture hours

Field Effect Transistors: Introduction, JFET and MOSFET, Realization of digital logic circuit using MOSFET (AND, OR, NOT etc.), Realization of switching circuit using MOSFET

Unit VII: 7 lecture hours

Electronics Instruments & Digital Electronics Fundamental:

Signal generator, Multimeter, operation of CRO and its application.Number systems, Conversions and codes, Logic gates and truth tables.

Text Books

5. Electronic Devices & Circuit Theory: Boyelstad & Nashelsky
6. Electronics Fundamental and application: D.Chattopadhyay and P C Rakshit
7. Electronic Principle: Albert Paul Malvino
8. Digital circuits and design by S Salivahanan and S Arivazhagan
9. V. N. Mittal and A. Mittal, *Basic Electrical Engineering*, Tata McGraw-Hill Publishing Company Ltd, 2006.

Reference Books

1. Electronic Circuits, Discrete and Integrated- Charles Belove and Donald L. Schilling
2. Principles of Electrical Engineering and Electronics- V K Mehta, Rohit Mehta, S Chand and Company, New Delhi
3. Solid State Electronic Devices- Ben G. Streetman and Sanjay Kumar Banerjee, PHI.
4. Fundamental of Digital Circuits by Anand Kumar 2nd Eddition,PHI LearningPal, Rajendra

and Korlahalli, J.S. (2011) Essentials of Business Communication. Sultan Chand & Sons. ISBN: 9788180547294.

5. Theodore Wildi,*ElectricMachines, Drives and Power Systems*, Pearson, 2005.
6. Vincent Del Toro, *Electrical Engineering Fundamentals*, 2nd Ed., Prentice Hall India Learning Pvt. Ltd., 1989.
7. J. Millman, C. Halkias and C. D. Parikh, *Millman's Integrated Electronics: Analog and Digital Circuits and Systems*, 2nd Ed., McGraw Hill Education, 2017.
8. D. P. Leach, A. P. Malvino and G. Saha, *Digital Principles and Applications*, 8th Ed., McGraw Hill Education, 2014.

Modes of Evaluation: Quiz/Assignment/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Analyze and apply** network theorems (Thevenin's, Norton's, and Maximum Power Transfer) in DC circuit analysis and solve problems using Kirchhoff's Law, mesh, and nodal analysis.	**PO1, PO5**
CO2	**Apply** phasor representation and analyze single-phase AC circuits, calculating power, power factor, resonance, and bandwidth in series-parallel RLC circuits.	**PO1, PO2, PO5, PO7**
CO3	**Evaluate** the operation and advantages of three-phase AC circuits, including star and delta connections, power measurements, and phase voltage/current relationships.	**PO1, PO4, PO5, PO6, PO7**
CO4	**Understand and analyze** the behavior of semiconductors and PN junctions, including current flow, breakdown conditions, and the effects of forward and reverse bias.	**PO1**
CO5	**Integrate and create** digital logic circuits and switching circuits using MOSFETs and apply their understanding of transistor configurations (NPN, PNP) in amplification and switching applications.	**PO1**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO 2	PO3	PO 4	PO5	PO6	PO 7	PO8	PO9	PO10	PO1 1	PO1 2
GEE11001	Electrical and Electronics Technology												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

ENG11053	English Communication	L	T	P	C
Version 1.0		1	0	2	2
Pre-requisites/Exposure	12^{th} level English				
Co-requisites	--				

Course Objectives

1. To know the importance and techniques of communication skills in order to improve professional skills
2. To enhance the knowledge of the students on vocabulary, syntax, and grammatical skills
3. To improve writing skills by applying writing techniques, tools in practice sessions
4. To achieve an overall enhancement in terms of reading, listening and speaking

Course Outcomes:

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

CO1. **Illustrate** communication processes and to know the practical implications and its challenges at the workplace
CO2. **Explain** the practical uses of English grammar and to use grammar correctly and unambiguously understand different formats of business communication like reports, letters, and other technical writings
CO3. **Build** competence in speaking, reading, listening, and writing in English.
CO4. **Summarize** English pronunciation and use neutral accent successfully and to understand different other accents of spoken English
CO5 **Develop** effective writing skills by composing business letters, reports, CVs, application letters, and various types of compositions (essays, précis, and paragraphs) with proper structure and clarity.

Catalog Description

Effective communication is one of the basic requirements of a successful career. Both verbal and nonverbal communication is important to exchange ideas among the employees within the organization and outside the organization as well. In this course, the focus will be on improving LSRW skills, i.e. listening, speaking, reading and writing. Students will learn how to communicate effectively through prescribed syllabus. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies, such as group discussions, role play, small skit enactments, analysis of video scenes and debates. Class participation is a fundamental aspect of this course. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapers etc.

Course Content

Module I: 6 lecture hours

Communication Level 1: Basics of Communication, Means of Communication, Barriers of Communication

Module II: 6 lecture hours

Grammar and Syntax Level 1: Tense: types and uses, Idioms, One Word Substitutes, Discussion on the use of Articles and related exercises, Discussion on the use of Prepositions and related exercises, Exercises on Sentence –Making (Syntax), Practice exercises on Voice change, Class Exercises on Synonyms and Antonyms.

Module III: 6 lecture hours

Reading and Listening Skills Level 1: Introduction to listening skills: purposes and practice, Discussion on types of listening: difference between listening and hearing, Active listening: introduction listening exercises, Elementary level listening exercise, Intermediate level listening exercise, Advance level listening exercise, Introduction to Reading Skills, Strategies of reading, Skimming, Scanning and Summarizing, Comprehension exercises.

Module IV: 6 lecture hours

Speaking Skills Level 1: Introduction to Speaking Skills: Mother tongue influence, Discussion on various kinds of narrative styles and techniques: Welcome speech, Vote of Thanks, Farewell Speech, Debate and Elocution, Class Exercises on Descriptive narration, Practical Exercises on Narration styles, Presentation of small skits, Practicing Extempore in the class, Mock practices of Group discussion, Practicing speaking in pairs, Mock practice of job interviews.

Module V: 6 lecture Hours

Writing Skills Level 1: Business letters: definition, types and format, Practice exercises, Business reports: definition, types and format, Practice exercises, CV and Application letters: types and formats, Practice exercises, Compositions: Essays, precis paragraph writing

Text Books:

1.Kaul Asha. Effective Business Communication. PHI Learning Pvt Ltd. 2014.
2.Wren and Martin. High School Grammar And Composition. S. Chand, 1995.
3.Gupta, A. English Reading Comprehension. Ramesh Publishing House, 2009.

Reference Book:

1. Lewis, Norman. Word Power Made Easy. Anchor: 2014.
2. Riordan, Daniel G & Pauley Steven A. :Technical Report Writing Today. 2004.
3. Hamp-Lyons and Heasely, B . Study Writing; A Course in Written English. For Academic and Professional Purposes, Cambridge Univ. Press, 2006.
4. Quirk R., Greenbaum S., Leech G., and Svartik, J. A Comprehensive Grammar of the 5.English language, Longman:London, 1985.
6. Balasubramaniam, T. A Textbook of English Phonetics for Indian Students. Macmillan: 2012.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Illustrate** communication processes and to know the practical implications and its challenges at the workplace	**PO1, PO3, PO8,**
CO2	**Explain** the practical uses of English grammar and to use grammar correctly and unambiguously understand different formats of business communication like reports, letters, and other technical writings	**PO1, PO3,**
CO3	**Build** competence in speaking, reading, listening, and writing in English.	**PO1, PO6, PO8**
CO4	**Summarize** English pronunciation and use neutral accent successfully and to understand different other accents of spoken English	**PO1, PO 7, PO8, PO 9, PO12**
CO5	**Develop** effective writing skills by composing business letters, reports, CVs, application letters, and various types of compositions (essays, précis, and paragraphs) with proper structure and clarity.	**PO1, PO 7, PO8, PO 9, PO12**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
ENG11053	English Communication Theory												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11003	**Life Sciences**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 30**	2	0	0	2
Pre-requisites/Exposure	Class XII Science				
Co-requisites	--				

Course Objectives:

- Introduction to Basics of Biology which includes cell, the unit of life, Types of cell and classification of living organisms.
- Understanding biomolecules present in a cell, their structure function and their role in a living organism. Application of certain bio molecules in Industry.
- Brief introduction to human physiology, which is essential for bioengineering field.
- Understanding the hereditary units, that is genes and genetic materials (DNA and RNA) present in living organisms.
- How biology can be applied in our daily life using different technology, for production of medicines to transgenic plants and animals to designing new biotechnological products

Course Outcomes:

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

CO 1: Explain the fundamental principles of life sciences, including cell biology, genetics, and evolution.
CO 2: Analyze the structure and function of various biological systems, including metabolic pathways, ecosystems, and organismal physiology.
CO 3: Apply the knowledge of life science concepts to address real-world biological challenges..
CO 4: Evaluate recent discoveries and advancements in life sciences, focusing on their impact on human health, biotechnology, and the environment.
CO 5: Integrate knowledge and **design** research proposals that address key questions in life sciences using experimental methodologies.

Course Description:

Cell is the structural and functional unit of living organism, it is well known throughout the universe, but mystery the molecular mechanism for performing the different kinds of functions of

cell organelle (along with their development in both plant and animal system) and their integration into a beneficial outcome for living organism and as well as the outcome of physiological responses is almost unknown. So the course consists of structure function relationship of cell organelles, trafficking of different molecules between different cellular compartments and their secretion, creation of physiological responses and their assessment by several kinds of instrumentation techniques which can create a common platform between science of engineering and biological science.

Course Content:

UNIT I: Integration of Biology and Engineering (6 hrs)

(Re)connect human nature connection , Bioinspired invention, Biomimicry: History of biomimicry, types of biomimicry, Biomimicry Thinking - Creating, brainstorming, Explaining biology through Physics and chemistry, expressing biological processes through mathematics, concept of system and systems biology

UNIT II: Forms of Life (6 hrs)

Brief introduction to five kingdoms of classification. Introduction to the basic classification of plant and animal kingdom up to class.

UNIT III: Basic structure and Function of a Cell (6 hrs)

Cell: What is a Cell, Cell theory, structure of a Cell, The Plant Cell and animal Cell, protoplasm, prokaryotic and eukaryotic Cell; Carbohydrates, proteins, Amino acid, nucleic acid (DNA and RNA) and their types, chromosomes, Cell cycle and cancer

UNIT IV: Physiological processes in living beings (6 hrs)

Nutrition (Classes of nutrients or food substances), Digestive systems, Respiratory system (two kinds of respiration – aerobic and anaerobic) Respiratory organs, respiratory cycle. Excretory system

UNIT V: Microbes and Diseases (6 hrs)

Basics of immune system: innate and adaptive immunity, antibodies and T cells, Microbes breaching our immune system, Diseases caused by microbes, treatment of diseases, Vaccine

Text Books

T1. Biology for Engineers by Arthur T. Johnson. CRC Press, 1 edition, 2010.
T2. Campbell Biology (10th Edition) 10th edition by Reece, Jane B., Urry, Lisa A., Cain, Michael L., Wasserman, (2013)

Reference Books

R1.Applied Cell and Molecular Biology for Engineers by Gabi Nindl Waite and Lee R. Waite. McGraw-Hill Education, 1 edition, 2007.
R2.Samson Wright's Applied Physiology.
R3. Biomimicry Innovation Inspired by Nature by Janine M Benyus, Herper Collins, 2002

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Continuous assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO-1	**Explain** the fundamental principles of life sciences, including cell biology, genetics, and evolution.	**PO1, PO2, PO10**
CO-2	**Analyze** the structure and function of various biological systems, including metabolic pathways, ecosystems, and organismal physiology.	**PO1, PO3, PO4, PO10**
CO-3	**Apply** the knowledge of life science concepts to address real-world biological challenges..	**PO3, PO4, PO5, PO10**
CO-4	**Evaluate** recent discoveries and advancements in life sciences, focusing on their impact on human health, biotechnology, and the environment.	**PO1, PO4, PO6, PO10**
CO-5	**Integrate** knowledge and **design** research proposals that address key questions in life sciences using experimental methodologies.	**PO2, PO3, PO5, PO8 , PO10**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11003	**Life Sciences**												

1=weakly mapped

2= moderately mapped

3=strongly mapped

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	1	1	1	1	1	1	1	3	1	1
CO2	3	1	3	3	1	1	1	1	1	3	1	1
CO3	1	1	3	3	3	1	1	1	1	3	1	1
CO4	3	1	1	3	1	3	1	1	1	3	1	1
CO5	1	3	3	1	3	1	1	3	1	3	1	1
Avg	2.2	1.8	2.2	2.2	1.8	1.4	1	1.4	1	3	1	1

GEE12002	Electrical and Electronics Technology Lab	L	T	P	C
Version 1.0		0	0	4	2
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites					

Course Objectives

1. To study basic electronic components
2. To observe characteristics of electronic devices
3. To study basic electrical circuits

Course Outcomes

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

CO1**.** Study different meters and instruments for measurement of electronic quantities and **Interpret** network theorems.
CO2. **Interpret** the characteristics of different semiconductor devices like diode, BJT, FET etc and carbon tungsten filament lamps experimentally.
CO3. **Design** and experiment with various application circuits using diodes
CO4. **Interpret** R-L-C circuits
CO5. **Integrate and design** three phase circuits

Catalog Description

Present technology requires necessary knowledge of ELECTRONICS in most fields. Avionics, Autotronics, Agrotronics, Physics, Process Chemistry, Health Services, etc., already employ components or even whole systems based on Electronics. Thus, there is an increasing number of professionals in these and many other fields who need adequate knowledge and training. Taken this into account, ADAMAS has developed the Basic Electronics and Electricity Integrated Laboratory, capable of covering different levels of difficulty. It is based on a series of self-taught modules, each one referring to a specific area of Electronics.

Course Content

List of experiments (Electrical Part):

1. Verification of Thevenin's theorem and Norton's theorem.
2. Verification of Superposition theorem.
3. Verification of Maximum power transfer theorem.
4. Study of R-L-C series circuit.
5. Study of R-L-C parallel circuit.
6. Performance study of fluorescent, LED, tungsten and carbon lamps.
7. Measurement of power in a three-phase circuit using two-wattmeter method.

List of experiments (Electronics Part):

1. Familiarization of bread board and electronics elements such as R, L, C, diode, and BJT etc.
2. Familiarization of Function generator and measuring instruments such as CRO and multimeter.
3. Study the V-I characteristic of PN junction diode and find knee voltage.
4. Study the input and output characteristic of bipolar junction transistor (BJT): Common emitter (CE) configuration
5. Study the transfer and drain characteristic of junction field-effect transistor (JFET), hence determine the drain resistance, transconductance factor, amplification factor.
6. Study the transfer and drain characteristic of MOSFET, hence determine the drain resistance, transconductance factor, amplification factor.
7. Realization of digital logic circuit using MOSFET (AND, OR, NOT etc.).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Study different meters and instruments for measurement of electronic quantities and **Interpret** network theorems.	**PO1**
CO2	**Interpret** the characteristics of different semiconductor devices like diode, BJT, FET etc and carbon tungsten filament lamps experimentally.	**PO3**
CO3	**Design** and experiment with various application circuits using diodes.	**PO3, PO4**
CO4	**Interpret** R-L-C circuits	**PO1, PO3, PO4**
CO5	**Integrate and design** three phase circuits	**PO1**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12
GEE1 2002	Electrical and Elecronics Technology Lab												

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

MEE12001	Engineering Workshop	L	T	P	C
Version 1.0		0	0	4	2
Pre-requisites/Exposure	Knowledge in dimensions and units, Usage of geometrical instruments and analytical ability				
Co-requisites	--				

Course Objectives

- To develop general machining skills in the students.
- To develop a skill in dignity of labour, precision, safety at work place, team working and development of right attitude

Course Outcomes

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

CO1. **Design** and model different prototypes in the carpentry trade such as Cross lap joint, Dove tail joint.

CO2. **Design** and model various basic prototypes in the trade of fitting such as Straight fit, V- fit.

CO3. Ability to **build** various basic prototypes in the trade of Tin smithy such as rectangular tray, and open Cylinder.

CO4. **Design** and **assess** models of various basic prototypes in the trade of Welding such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint.

CO5. **Integrate and assess** sheet metal work by fabricating cones and frustums from sheet metal as per given dimensions, ensuring high-quality craftsmanship and dimensional accuracy.

Catalog Description

Workshop practice is the backbone of the real industrial environment which helps to develop and enhance relevant technical hand skills required by the technician working in the various engineering industries and workshops. Our workshop intends to impart basic know-how of various hand tools, power tools, machine tools and their use in different sections of manufacturing. Irrespective of branch, the use of workshop practices in day to day industrial as well domestic life helps to dissolve the real life problems. The workshop experiences would help to build the understanding of the complexity of the industrial job, along with time and skills requirements of the job. Workshop curriculum builds the hands on experiences which would help to learn manufacturing processes and production technology courses in successive semesters. Workshop practice is also important since only practice can make the man perfect. The students are advised to undergo each skill experience with remembrance, understanding and application with special emphasis on attitude of enquiry to know why and how for the various instructions and practices imparted to them in each shop. A resource in the workshop not only helps to complete engineering syllabus practical but also supports to undertake under graduate projects, creative competitive working models manufacturing to the post graduate and PhD research projects of social and industrial relevance.

Course Content

List of Experiments (Any ten)

1	To make a single piece pattern from the given work piece and dimensions.
2	To make a double piece match pattern from the given dimensions.
3	To make a single piece cylindrical (solid) pattern from the given dimensions.
4	To make a cone from sheet metal as per given dimensions.
5	To make a frustum from sheet metal as per given dimensions.
6	To prepare a sand mould, given the single piece pattern and casting.
7	To prepare a sand mould, given the double piece match pattern and casting with different dimensions and shape
8	To make a square fitting from the given mild steel piece and the dimensions.
9	To make a square fitting from the given mild steel piece and the dimensions.
10	To make a single 'V' butt joint between two metal plates by using ARC welding.
11	To make a square butt joint between metal plates by using gas welding.
12	To perform various types of machining operations (cantering, facing and turning) on a given mild steel rod followed by the given dimensions.
13	To perform various types of machining operations (chamfering, grooving, thread cutting, and knurling) on a given mild steel rod followed by the given dimensions.

Reference Books

- Workshop Technology I,II,III, by S K Hajra, Choudhary and A K Chaoudhary. Media Promoters and Publishers Pvt. Ltd., Bombay
- Workshop Technology by Manchanda Vol. I,II,III India Publishing House, Jalandhar.
- Manual on Workshop Practice by K Venkata Reddy, KL Narayana et al; MacMillan India Ltd.
- Basic Workshop Practice Manual by T Jeyapoovan; Vikas Publishing House (P) Ltd.,New Delhi
- Workshop Technology by B.S. Raghuwanshi, Dhanpat Rai and Co., New Delhi.
- Workshop Technology by HS Bawa, Tata McGraw Hill Publishers, New Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Design** and model different prototypes in the carpentry trade such as Cross lap joint, Dove tail joint.	**PO1, PO3, PO4**
CO2	**Design** and model various basic prototypes in the trade of fitting such as Straight fit, V- fit.	**PO1, PO3, PO4, PO5**
CO3	Ability to **build** various basic prototypes in the trade of Tin smithy such as rectangular tray, and open Cylinder.	**PO1, PO3, PO4**

CO4	**Design** and **assess** models of various basic prototypes in the trade of Welding such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint.	**PO1, PO3, PO4**
CO5	**Integrate and assess** sheet metal work by fabricating cones and frustums from sheet metal as per given dimensions, ensuring high-quality craftsmanship and dimensional accuracy.	

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

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global Citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MEE12001	**Engineering Worksop**	3		3	3								

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

DGS11002	Design Thinking & Prototyping	L	T	P	C
Version 1.0		2	0	2	3
Pre-requisites/Exposure	Knowledge of analyzing society problems and product usage problems and a zeal to improve the current situation, in addition to knowing to using laptop/computers, internet, social media interaction, file sharing and uploading, email and communication etiquettes.				
Co-requisites	-				

Course Objectives

1. To enable students to understand Design Thinking Fundamentals
2. To enable students to master the Design Thinking Process
3. To enable students to develop User-Centered Solutions:
4. To make them prototype the model

Course Outcomes

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

1. **Remember**: Students will be able to recall the key principles and processes involved in design thinking.
2. **Understand**: Students will be able to explain the phases of the design thinking process and how they contribute to problem-solving and innovation.
3. **Apply**: Students will be able to apply design thinking methodologies to identify and solve complex problems in various contexts.
4. **Analyze**: Students will be able to evaluate different design thinking strategies and approaches to determine the most effective solution for a given problem.
5. **Evaluate**: Students will be able to integarate and assess the impact of design thinking on organizational and societal innovation and change

Catalog Description

The Design Thinking course introduces design thinking principles, history, and applications through case studies and activities, laying the foundation for human-centered problem-solving. It explores various design thinking frameworks, comparing them with other methodologies to understand the process comprehensively. The course teaches user research techniques and problem-framing tools to identify and define user needs, focusing on ideation and concept development through brainstorming, sketching, and collaborative design. It covers prototyping and iteration, guiding students to create and refine prototypes based on user feedback. This completely online course is offered to first-year undergraduate programs across all streams and is designed to help students understand the steps followed in the process of designing a solution to a problem.

Course Content

Unit 1: Introduction to Design Thinking **Lecture Hours: 8**

What is Design Thinking?, History and Evolution of Design Thinking, Key Principles of Design, Thinking: Empathy, Collaboration, and Experimentation, Case Studies of Successful Design Thinking Applications

Unit 2: Design Thinking Process and Frameworks **Lecture Hours: 8**

The Design Thinking Model: Overview of the Phases, Different Frameworks: Stanford d.school, IDEO, and Double Diamond, Comparison of Design Thinking with Other Problem-Solving

Unit 3: Discover and Define Phases **Lecture Hours: 8**

Discover Phase, Research Methods: Interviews, Surveys, Observations, and Ethnography
Identifying User Needs and Pain Points, Tools: Empathy Maps, User Personas
Define Phase: Synthesizing Research Findings, Framing the Problem: How Might We Statements
Tools: Journey Maps, Problem Statements

Unit 4: Develop Phase **Lecture Hours: 8**

Ideation Techniques: Brainstorming, Mind Mapping, SCAMPER, Collaborative Design: Co-creation with Stakeholders, Concept Development: Sketching, Storyboarding, and Wireframing
Tools: Idea Boards, Concept Sheets, Brainstorming sessions, and mind mapping exercises
Creating storyboards and wireframes for proposed solutions

Unit 5: Prototyping **Lecture Hours: 8**

Importance of Prototyping in Design Thinking, Types of Prototypes: Low-Fidelity vs. High-Fidelity, Tools and Techniques: Paper Prototypes, Digital Prototypes, 3D Printing, Testing, Refining and Improving Prototypes,

Reference Books

1. Brown, Tim. "What We Can Learn from Barn Raisers." Design Thinking: Thoughts by Tim Brown. Design Thinking, 16 January 2015. Web. 9 July 2015.
2. Knapp, Jake. "The 8 Steps to Creating a Great Storyboard." Co.Design. Fast Company & Inc., 21 Dec. 2013. Web. 9 July 2015.
3. van der Lelie, Corrie. "The Value of Storyboards in the Product Design Process." Journal of Personal and Ubiquitous Computing 10.203 (2006): 159–162. Web. 9 July 2015. [PDF].
4. Millenson, Alisson. "Design Research 101: Prototyping Your Service with a Storyboard." Peer Insight. Peer Insight, 31 May 2013. Web. 9 July 2015.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Remember**: Students will be able to recall the key principles and processes involved in design thinking.	**PO1, PO11, PSO1- PSO3**
CO2	**Understand**: Students will be able to explain the phases of the design thinking process and how they contribute to problem-solving and innovation.	**PO1,PO2, PSO1- PSO3**
CO3	**Apply**: Students will be able to apply design thinking methodologies to identify and solve complex problems in various contexts.	**PO1, PO2, PO4, PSO1- PSO3**

CO4	**Analyze**: Students will be able to evaluate different design thinking strategies and approaches to determine the most effective solution for a given problem.	**PO1, PO2, PO5, PSO1- PSO3**
CO5	**Evaluate**: Students will be able to integrate and assess the impact of design thinking on organizational and societal innovation and change.	

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Plan the manufacturing of given mechanical components and systems using engineering analysis & design tools,	Understand the dynamics of machine components and design components including power transmission, pressure	Determine the performance of thermal and fluid systems including IC engines, refrigeration and air-conditioning, and
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
DGS11002	Design Thinking & Prototyping															

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

CO / PO	PO 01 (Academic Excellence)	PO 02 (Critical Thinking)	PO 03 (Skills)	PO 04 (Modern Tools)	PO 05 (Problem Solving)	PO 06 (Analysis)	PO 07 (Proper Solutions)	PO 08 (Professional)	PO 09 (Collaboration)	PO 10 (Sustainability)	PO 11 (Ethics)	PO 12 (Global Citizen)
CO 1	3	2	2	2	1	2	1	1	1	1	1	1
CO 2	3	3	2	2	2	2	1	1	1	1	1	1
CO 3	3	2	3	3	3	3	2	2	2	1	1	1
CO 4	2	3	2	2	3	3	2	1	1	1	1	1
CO 5	3	2	2	1	3	3	2	1	1	1	1	2
Average	2.8	2.4	2.2	2	2.4	2.6	1.6	1.2	1.2	1	1	1.2

SEMESTER II

MTH11502	Engineering Mathematics II	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	--				

Course Objectives

1. To help the student to understand the basic concepts of matrix theory with its uses in engineering science.
2. To give emphasis about concepts of Eigen value and Eigen vector, vector space and linear transformation and enable students to apply these topics for analysing engineering problems.
3. To help the student to understand the use of vector calculus in engineering.
4. To give the students a perspective to learn about functions of complex variables, pole, and residues and their importance in advanced study of engineering science.
5. To enable students to acquire the knowledge of different transformation techniques and their applications in engineering science.

Course Outcomes

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

CO1 **Utilize** the knowledge of matrix theory for finding solution of a related engineering problem

CO2 **Illustrate** the Eigen value(s) and Eigen vector(s) of a matrix

CO3 **Explain** the concept of vector space and linear transformation between the vector spaces

CO4 **Build** the knowledge of vector calculus and apply it for solving related problems

CO5 **Integrate and develop** the concept of complex variable and its application

Course Description

For any engineering program, Mathematics is the backbone. With a sound knowledge in fundamental mathematics, an engineering student can become a very skillful engineer. In this course, the focus will be on learning Mathematics in depth, which will motivate students to grow their thinking ability in different fields of engineering. Students will be able to apply this knowledge to tackle almost all kinds of problems in engineering and science successfully. Class participation is a fundamental aspect of this course. Students will be encouraged to actively take part in all group activities (Problem solving, presentation etc.).

Course Content

Unit- I **[18]**

Linear Algebra: Elementary row and column operations on a matrix, Rank, echelon form, normal form, Inverse of a matrix using elementary operations, solution of system of algebraic equation, consistency, Caley-Hamillton theorem, eigenvalues and eigenvectors, Symmetric and skew-symmetric matrices, orthogonal matrices, complex matrices, Hermitian and skew-Hermitian matrices, algebraic and geometric multiplicity, diagonalization, vector spaces, linear dependence of vectors, basis, linear transformations.

Unit- II **[14]**

Vector Calculus: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Line, surface and volume integrals of Vector fields, Gauss' divergence theorem, Green's and Stokes Theorems and their applications.

Complex Variables: Limit, continuity, differentiability and analyticity of functions, Cauchy-Riemann equations, line integrals in complex plane, Cauchy s integral theorem, independence of path, existence of indefinite integral, Cauchy's integral formula, derivatives of analytic functions, Taylor's series, Laurent's series, zeros and singularities, Residue theorem, evaluation of real integrals.

Unit- III **[10]**

Fourier Series: Periodic functions, Definition of Fourier series, Euler's formulae, Dirichlet conditions, Change of interval, Even and odd functions, half range Fourier Sine & Cosine series.

Unit-IV **[18]**

Introduction to Transform Calculus: Introduction to Laplace transform and its properties (without proof), Inverse Laplace transform, Definition of Fourier integrals, Fourier Sine & Cosine integrals, complex form of Fourier integral, Fourier sine & cosine transforms, inverse Fourier transform, introduction to Z- Transform and its properties, Inverse Z- Transform, Inverse Z- transform by partial fraction and residue methods.

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill
3. David C. Lay, Linear algebra and its application, (Latest edition), Pearson publication, New Delhi
4. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications

5. C B Gupta, S R Singh, and Mukesh Kumar, Engineering Mathematics, Mc Graw Hill Publication
6. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Utilize** the knowledge of matrix theory for finding solution of a related engineering problem	**PO1, PO5**
CO2	**Illustrate** the Eigen value(s) and Eigen vector(s) of a matrix	**PO1**
CO3	**Explain** the concept of vector space and linear transformation between the vector spaces	**PO1, PO2, PO5**
CO4	**Build** the knowledge of vector calculus and apply it for solving related problems	**PO1, PO5**
CO5	**Integrate and develop** the concept of complex variable and its application	**PO1, PO2, PO5, PO6**

MTH1 1502	Course Code	
Engineering Mathematics II	Course Title	
	PO1	Academic excellence
	PO 2	Critical thinking
	PO 3	Skills
	PO4	Modern tools and techniques usage
	PO5	Problem solving
	PO6	Analysis
	PO 7	Proper solutions
	PO 8	Professional
	PO 9	Collaboration
	PO 10	Sustainability
	PO 11	Ethics
	PO 12	Global citizen

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

Course code: EVS11112	Course Name: Environmental Science	L	T	P	C
Version 1.1	**Contact Hours – 30**	2	1	0	3
Pre-requisites/Exposure	Basic physics, chemistry, mathematics of +2 level.				
Co-requisites	--				
Academic year	2022-23				

Course Objectives

1. To understand the intrinsic relation between humans and the environment, our position in the ecosystem around us
2. To comprehend the significance of the biodiversity surrounding us.
3. To figure out the importance and need for energy resources, various sources of energy, renewable and non-renewable sources, conventional and unconventional sources.
4. To have basic concepts about sustainability, our dependence on nature, and the consequences of overexploitation.
5. To enable students to appreciate the importance and how much we owe to the earth systems for our survival.
6. To have a basic concept about the types of pollution and mitigation procedures.
7. To have an overall idea about the environmental legal framework in our country and about the EIA and environmental audit procedures.

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

CO 1: Compare between various types of ecosystems, ecosystem dynamics, perceive and appreciate the surrounding nature.

CO 2: Perceive the intrinsic relation between humans and the environment, our position in the ecosystem around us, and the importance of biodiversity.

CO 3: Identify the presence of various pollutants, their significance, and impacts, and develop the underlying concepts involved in various air pollution prevention and mitigation measures.

CO 4: Estimate the importance of natural resources including energy resources.

CO 5: Integrate and assess the legal framework in our country for safeguarding the environment including pollution prevention, control, management, and wildlife management.

Catalog Description

To distinguish between various types of ecosystems, ecosystem dynamics, perceive and appreciate the surrounding nature and feel connected, develop the concept of the innate relationship of humans and biodiversity, need for conservation, and different conservation strategies. The students will be developed in a way so that they can spontaneously comprehend the importance of studying the various air pollutants, their significance, and impacts, and develop the underlying concepts involved in various air pollution prevention and mitigation measures, understand fundamental water chemistry, deduce the relationship between various water pollutants, and understand the principles of various water and wastewater treatment procedures. They will understand the routes of generation, classification, management, and environmental significance of solid waste, apply the basic concepts of waste management in their daily lives, understand the need of the 5Rs of waste management, the importance of waste minimization.

Detailed syllabus

Unit I: Resources

Multidisciplinary nature of environmental sciences; scope and importance; need for public awareness; concept of sustainability and sustainable development

Forest resources: Function of forests, cause and effects of deforestation, case studies.

Water resources: distribution of water, hydrological cycle, use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies

Food Resources: World food problems and environmental concern, Food security, case studies

Energy resources: Concept of energy, SI Units of Work, Heat and Power, World energy use, Energy consumption pattern in India and U.S., Environmental aspects of energy utilization Renewable and non-renewable sources; Fossil fuel: types, use and environmental impacts, Solar energy: Solar Radiation – Passive and active solar systems – Flat Plate and Concentrating Collectors – Solar direct Thermal Application– Fundamentals of Solar Photo Voltaic Conversion- advantages and disadvantages of Solar Power generation, Solar energy status in India; Wind Energy: site selection, Wind turbine: basic working principle and types, Wind energy status in India, advantages and disadvantages of Wind Power generation; Hydroelectric power : How is it generated, advantages and disadvantages; Biomass energy: various types, generations of biofuel, Biogas plants, Bio diesel; Geothermal Energy: source, advantages and disadvantages, Nuclear Power: nuclear fission, moderation of reaction, nuclear reactor: pressurized water reactor, advantages and disadvantages

Unit II: Ecosystems and Biodiversity and its conservation

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Food chains, food webs and ecological pyramids, energy flow, ecological succession, Levels of Biodiversity: genetic, species and ecosystem diversity. Biogeographical classification of India, Values of biodiversity, Biodiversity at global, National and local levels, India as a mega-diversity nation, Biodiversity hotspots, Threats to Biodiversity, In-situ and Ex-situ conservation of Biodiversity

Unit III: Environmental Pollution and Waste Management

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, marine pollution; case studies. Nuclear hazards and human health risks.

Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes, Recycling of waste material. Waste minimization technologies.

Unit IV: Global Issues and Environmental Acts if India

Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, habitat loss, Holocene Extinction.

International agreements on Environmental conservation and pollution prevention.

Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution)

Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. Waste Management Rules, 2016 and other important acts.

Text Books:

1. Principles of Environmental Science, 4th edition by Cunningham, W.P. and Cunningham, M.A. (2002), Tata McGraw-Hill Publishing Company, New Delhi

2. Basic Environmental Engineering & Elementary Biology by Monidranath Patra and Rahul Kumar Singha, Aryan Publishing house

3. Introduction to Environmental Engineering and Science, by Masters, G.M., Prentice Hall of India, Second Indian Reprint.

Reference Books:

1 Wastewater Engineering: Treatment and Reuse, 4th Edition, Metcalf and Eddy, Inc. McGraw-Hill, Inc., New York, 2002

2 Environmental Engineering", Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, McGraw-Hill Education (India) Private Limited, New Delhi

3 Introduction to Environmental Engineering, 2nd Ed. by Davis, M. L. and Cornwell D. A. McGraw Hill, Singapore.

4 Environmental Sciences: The Environment and Human Impact by Jackson, A.R.W. and Jackson, J.M., Longman Publishers

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs):

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Compare between various types of ecosystems, ecosystem dynamics, perceive and appreciate the surrounding nature.	**PO2, PO5**
CO2	Perceive the intrinsic relation between humans and environment, our position in the ecosystem around us, and importance of biodiversity.	**PO2, PO5, PO6**
CO3	Identify the presence of various pollutants, their significance, and impacts, and develop the underlying concepts involved in various pollution prevention and mitigation measures.	**PO2, PSO7**
CO4	Estimate the importance of natural resources including energy resource.	**PO2, PO5, PO6**
CO5	Integrate and assess the legal framework in our country for safeguarding the environment including pollution prevention, control, management, and wildlife management.	**PO2, PO5, PO6**

		Chemistry Knowledge: To understand basic facts and concepts in Chemistry while retaining the exciting aspects of Chemistry so as to develop an interest in the study of chemistry as a discipline.	**The Chemist and society:** To appreciate the achievements in Chemistry and to know the role of Chemistry in nature and in society.	**Computer usage in Chemistry:** To design and apply appropriate experiment techniques along with IT tools to solve chemical problems. Attain familiarity with the applications of computers in chemistry: Modelling and simulation of chemical phenomena.	**Practical Skills:** To develop skills in the proper handling of apparatus and chemicals.	**Analytical Skills:** To be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.	**Professional growth:** The students after completing the postgraduate course would have equipped their ability in the field of chemical analysis by their exposure to the sophisticated analytical instruments.	**Effective Communication:** Students will be able tocommunicate efficiently through project report writing, documentation and effective presentations.	**Skill Enhancement:** The postgraduate programme in Chemistry will enhance soft skills among students which is essential for future employability through activities such as seminar, communication skills, industrial visit, internship, and dissertation.	Postgraduate will encompass noteworthy opportunities in various service domains both at national and international level, and can work as scientist, analyst at testing facilities/labs, quality controller in production industries, academics, research laboratories etc.	To cultivate in –depth knowledge in Organic chemistry, Inorganic chemistry, Physical chemistry, Analytical chemistry, Spectroscopy, Pharmaceutical technique etc.	Students will acquire deep knowledge in the study of physical, chemical, electrochemical and magnetic properties, structure elucidation using various sophisticated techniques and their applications to study various organic and inorganic materials.	Students will imbibe research acumen and inculcate innovative thinking so as to become a good researcher/academician as well as will perk up analytical and logical capability so as to import the ability to solve new and complex problems.	Postgraduate students will be able to communicate effectively the scientific information and research results in written and oral formats, to both professional scientists and to the public.	Postgraduate students will attain leadership quality to handle all kind of circumstances in diversities by providing interdisciplinary and multidisciplinary learning environment with team work philosophy.	Students will evolve the culture of continuous learning to learn and adopt new skills and techniques for making of good society.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
EVS1 1112	Environmental Science															

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

CSE11001	Introduction to Programming	L	T	P	C
Version 1.0		2	0	0	2
Pre-requisites/Exposure	10+2 Level Science, Knowledge of Basics of Computer				
Co-requisites	Knowledge of Logical Reasoning and Analysis				

Course Objectives

1. To understand the nature of programming as human activity.
2. To practice the programming construct to solve multi-dimensional problems.
3. To relate and implement mathematical concepts through programming in order to solve computational problems.
4. To enable students to acquire structure and written expression required for their profession.
5. To understand the principles of data storage and manipulation.

Course Outcomes

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

CO1. **Define** basics concepts of programming structure and implement the basics concepts of Programming.

CO2. **Solve** and execute various problems using programming language and select the best solution.

CO3. **Utilize** modularized solution and design such programs to appraise the solution

CO4. **Illustrate** the basic usage of memory and construct such memory in terms of array in a program. Students will also be able to define user defined data types using structure and Union. Create and manipulate permanent storage access through File Handling.

CO5. **Integrate and assess** different data structures for various collections of data.

Catalog Description

Programming skills are mandatory for designing or solving problems through digital devices. It is the language through which computational/digital devices are communicated rather interfaced. To develop any software programming language is a must. In the present era almost all aspects of life are somehow largely related to virtualization and digital data/information. Devices from smartphones to other handheld devices, drones, cameras, medical instruments etc. all need programming at some part. In engineering it has become quintessential for the students/research scholars to learn programming. In this course, students will learn how to solve problems in various domains through a programming language. This course enables students with the basic skills of C Programming Language. Five Different related modules comprise this course. First Unit familiarizes students with the basics of computers, algorithmic methods to solve problems, and introduction to generic programming. Basics of C Programming is upto iterative structure is depicted in Unit II. In Unit III students will learn about modularization using functions and one advanced concept of C Programming, Pointers. Unit IV will cover one of the most important concepts in C Programming, Array and Strings. Unit V will accomplish this course with advanced concepts like Structure, Union and File Handling. After this course students will grow their analytical ability to solve problems and logical skills. Also, this course effectively creates the ability to grasp any other Programming Language in an easier manner.

Course Content

Unit I: 4 lecture hours

Basic Concepts of Programming: Introduction to components of a Computer System (disks, memory, processor, where a program is stored and executed, operating systems, compilers, etc.), Idea of Algorithm: steps to solve logical and numerical problems, Representation of Algorithms: Flowchart/Pseudocode with examples, From Algorithms to Programs; source code, variables and memory locations, Syntax and Logical Errors in compilation, Object and Executable code

Unit II: 10 lecture hours

Basics of C Programming : Characters used in C, Identifiers, Keywords, Data type & sizes, Constants & Variables, Various Operators used such as Arithmetic Operators, Relational & Logical Operators, Increment & Decrement Operators, Assignment Operators, Conditional or Ternary Operators, Bitwise Operators & Expressions; Standard Input & Output, formatted input scanf( ), formatted output printf( ); Flow of Control, if-else, switch-case, Loop Control Statements, for loop, while loop, do-while loop, nested loop, break, continue, goto, label and exit( ) function

Unit III: 10 lecture hours

Functions and Pointers: Definition of Function, Declaration or Prototype of Function, Various types of Functions, Call by Value, Call by Reference, Recursion, Tail Recursion, Definition of Pointer, Declaration of Pointer, Operators used in Pointer, Pointer Arithmetic, Functions with Pointer

Unit IV 17 lecture hours

Arrays and String: Definition, Single and Multidimensional Arrays, Representation of Arrays - Row Major Order, and Column Major Order, Application of arrays – searching and sorting, Sparse Matrices and their representations. Definition of a String, Declaration of a String, Initialization of a String, Various String Handling Functions with example

Structures and Unions: Definition of a Structure, Declaration of a Structure & Structure Variable, Initialization of a Structure, Operators used in Structure, Structure within Structures, Union, Difference between a Structure and a Union

Files: Types of File, File Processing, Handling Characters, Handling Integers, Random File Accessing, Errors During File Processing

Unit V 4 lecture hours

Overview of Stacks and Queues: Introduction to Stack, Primitive operations on Stack, Real-life applications of Stack, Introduction to Queues, Primitive operations on Queues, Real-life applications of Queues.

Text Books

1. Balagurusamy, E., n.d. Programming In ANSI C. 5th ed. Bangalore: mcgraw-hill.
2. Gotfreid (196) *Schaum's Outline of Programming with C*, 2 edn., USA: McGraw-Hill
3. Brian W. Kernighan, Dennis Ritchie (1988) *C Programming Language*, 2 edn., : Prentice Hall.

Reference Books

1. Al Kelley, Ira Pohl (1988) *A Book on C*, 4 edn., : Addision Wesley Longman

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Define** basic concepts of programming structure and implement the basics concepts of Programming.	**PO1**
CO2	**Solve** and execute various problems using programming language and select the best solution.	**PO1, PO2, PO5, PO6**
CO3	**Utilize** modularized solution and design such programs to appraise the solution	**PO1, PO2, PO5, PO6, PO7**
CO4	**Illustrate** the basic usage of memory and construct such memory in terms of array in a program. Students will also be able to define user defined data types using structure and Union. Create and manipulate permanent storage access through File Handling.	**PO1, PO5**
CO5	**Integrate and assess** different data structures for various collections of data.	**PO1, PO5**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CSE11001	Introduction to Programming												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

MEE11002	**Engineering Mechanics**	L	T	P	C
Version 1.0	**Contact Hours 60**	2	1	0	3
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	--				

Course Objectives

- To make the students to know the importance of this subject in the field of engineering particularly Mechanical Engineering.
- To make them learn the fundamentals of Mechanics, equation of static equilibrium & dynamic equilibrium of particles and rigid bodies.

- To learn the effect of friction on equilibrium.
- To learn kinematics, kinetics of particle and rigid body, related principles.
- To implement the above know how to solve practical problems.

Course Outcomes

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

CO1	Recall and explain fundamental concepts of statics, including force systems, equilibrium of coplanar force systems, and the use of free body diagrams in determining reactions.
CO2	Apply the principles of parallel and distributed forces, resolve forces into components, and analyze centroids and moments of inertia using direct integration and composite bodies.
CO3	Analyze and evaluate various types of friction (dry and wet), applying them to practical scenarios such as block, ladder, and wedge friction in machine components.
CO4	Apply the principle of virtual work to determine equilibrium and analyze mechanical systems under virtual displacements.
CO5	Integrate and assess the basic principles of dynamics, including laws of motion, projectile motion, D'Alembert's principle, work-energy theorem, and impulse-momentum relationships to solve practical problems.

Catalog Description

Engineering mechanics is a discipline devoted to the solution of engineering and mechanics problems through integrated application of mathematical, scientific, and engineering principles. Special emphasis is placed on the physical principles underlying modern engineering design.

Course Content

Unit 1: Basics of Statics and Concurrent Forces **12 Lecture Hours**

Statics of Particles: Force System: Force, classification & representation, force as a vector, composition and resolution of forces, principle of superposition and transmissibility of forces.

Statics of Rigid bodies: Equilibrium of coplanar force system, free body diagrams, determination of reactions, equilibrium of a body under three forces, Lami's theorem. Moment of a force about a point and an axis, moment of coplanar force system, Varignon's theorem.

Unit 2: Parallel and Distributed Forces **12 Lecture Hours**

Parallel forces in a plane, Distributed Parallel forces in a plane, couple, resolution of a force into a force and a couple, moment of a couple. Centroid and Moment of Inertia: Determination of centre of gravity, centre of mass and centroid by direct integration and by the method of composite bodies, area moment of inertia of composite plane figures and mass moment of inertia, radius of gyration, parallel axis theorem, Pappus theorems, polar moment of inertia.

Unit 3: Friction **12 Lecture Hours**

Introduction to wet and dry friction, laws of dry friction, cone of friction, block friction, ladder friction, wedge friction, application of friction in machines.

Unit 4: Virtual Work **12 Lecture Hours**
Virtual displacement, principle of virtual work.

Unit 5: Introduction to Dynamics **12 Lecture Hours**
Laws of motion, Projectile motion, D'Alembert's Principle, Work and energy, impulse and momentum, impact of bodies.

Text Books
1. Engineering Mechanics [Vol-I & II] by Meriam&Kraige, 5th ed. – Wiley India
2. Engineering Mechanics by S.S. Bhavikatti and K.G. Rajashekarappa – New Age International
3. Mechanics of Solids by Crandall,Dahl and Sivakumar-MC Graw Hill ,5th Edition, 2015, New Delhi

Reference Books
1. Engineering Mechanics: Statics & Dynamics by I.H.Shames, 4th ed. – PHI
2. Engineering Mechanics by Timoshenko , Young and Rao, Revised 4th ed. – TMH

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes

CO1	Recall and explain fundamental concepts of statics, including force systems, equilibrium of coplanar force systems, and the use of free body diagrams in determining reactions.	**PO1, PO6**
CO2	Apply the principles of parallel and distributed forces, resolve forces into components, and analyze centroids and moments of inertia using direct integration and composite bodies.	**PO1**
CO3	Analyze and evaluate various types of friction (dry and wet), applying them to practical scenarios such as block, ladder, and wedge friction in machine components.	**PO1, PO2, PO5**
CO4	Apply the principle of virtual work to determine equilibrium and analyze mechanical systems under virtual displacements.	**PO1, PO3,**
CO5	Integrate and assess the basic principles of dynamics, including laws of motion, projectile motion, D'Alembert's principle, work-energy theorem, and impulse-momentum relationships to solve practical problems.	**PO1, PO3, PO5,**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global Citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MEE11002	**Engineering Mechanics**												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-

CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

CSE12002	**Programming Lab**	L	T	P	C
Version 1.0		0	0	4	2
Pre-requisites/Exposure	10+2 Level Science, Knowledge of Basics of Computer				
Co-requisites	Knowledge of Logical Reasoning and Analysis				

Course Objectives

1. To comprehend the practical nature of programming by solving through computer systems.
2. To practice the programming construct to solve multi-dimensional problems.
3. To relate and implement mathematical concepts through programming in order to solve computational problems.
4. To enable students to acquire structure and written expression required for their profession.
5. To understand the principles of data storage and manipulation.

Course Outcomes

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

CO1. List and memorize various Unix commands. Also, students be able to **construct** various basic programs and appraise them.

CO2. **Design** and execute iterative statement in a program. Also, students be able todifferentiate among different iterative structure.

CO3. **Construct** such programs that used to define user defined functions and to design library functions.

CO4. Implement array concept in 1-Dimensional and 2-Dimensional construct. Hence be able to **develop** string functions to cater to various character array related problem.

CO5. Integrate and assess the concept of Stack, Queue, and Linked List and **appraise** them in different cases.

Catalog Description

Practical Programming skills are mandatory for designing or solving problems through digital device by implementation. To develop any software the behavior of a programming language is a must through problem solving. In present era almost all aspect of life is somehow largely related to virtualization and digital data/information. Devices from smartphones to other handheld devices, drones, cameras, medical instruments etc. all needs programming at some part. In engineering it has

become quintessential for the students/research scholars to learn programming. In this course, students will learn how to solve problems in various domains through a programming language. This course enables students with the basic skills of C Programming Language. Five Different related modules comprise this course. First Unit familiarizes students with basics of computers, algorithmic method to solve problem, introduction to generic programming construct. Basics of C Programming is upto iterative structure is depicted in Unit II. In Unit III students will learn about modularization using functions and one advance concept of C Programming, Pointers. Unit IV will cover one of the most important concepts in C Programming,

Array and Strings. Unit V will accomplish this course with the advance concept like Structure, Union and File Handling. After this course students will grow their analytical ability to solve problem and logical skill. Also, this course effectively creates the ability to grasp any other Programming Language in easier manner. In all these modules related programming problems are practiced to understand the syntactical and semantical correctness of a program. Gradually students become more comprehensive through the progress of the course.

Course Content

Experiments:

1. **Familiarization with LINUX commands and vi editor. [8h]**
2. **Programs to demonstrate Decision Making, Branching and Looping, Use of break and continue statement etc. [8h]**
3. Implementation involving the use of Arrays with subscript, String operations and pointers. **[8h]**
4. **Implementation involving the use Functions and Recursion. [8h]**
5. **Implementation involving the use Structures and Files. [8h]**
6. **Implementation based on Stack Queues and Linked List for example Insertion and Deletion. [5h]**

Text Books

1. Balagurusamy, E., n.d. Programming In ANSI C. 5th ed. Bangalore: McGraw-hill.
2. Gotfreid (196) *Schaum's Outline of Programming with C*, 2nd ed., USA: McGraw-Hill
3. Brian W. Kernighan, Dennis Ritchie (1988) *C Programming Language*, 2nd ed., : Prentice Hall.
4. Das Sumitabha, UNIX Concepts and Applications, 4th Ed., New Delhi, Tata McGraw-Hill

Reference Books

1. Al Kelley, Ira Pohl (1988) *A Book on C*, 4th ed. Addision Wesley Longman

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs

	Course Outcomes (COs)	Mapped Program Outcomes
CO1	List and memorize various Unix commands. Also, students be able to **construct** various basic programs and appraise them.	**PO3**
CO2	**Design** and execute iterative statement in a program. Also, students be able to differentiate among different iterative structure.	**PO1, PO4**
CO3	**Construct** such programs that used to define user defined functions and to design library functions.	**PO1, PO7**
CO4	Implement array concept in 1-Dimensional and 2-Dimensional construct. Hence be able to **develop** string functions to cater to various character array related problem.	**PO1, PO2, PSO1**
CO5	Integrate and assess the concept of Stack, Queue, and Linked List and appraise them in different cases.	**PO1, PO5, PO11**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO12
CSE1200 2	Programmi ng Lab												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

CEE12001	**Engineering Drawing and CAD**	L	T	P	C
Version 1.0	**Contact hours 45**	0	0	4	2
Pre-requisites/Exposure	Class XII Science				
Co-requisites					

Course Objectives

1. To comprehend general projection theory, with an emphasis on the use of orthographic projection to represent three-dimensional objects in two-dimensional views.
2. To understand the application of industry standards and techniques applied in engineering drawing.
3. To apply auxiliary or sectional views to most practically represent engineered parts.
4. To Dimension and annotate two-dimensional engineering drawings.
5. To employ freehand 3D pictorial sketching to aid in the visualization process and to efficiently communicate ideas graphically.

Course Outcomes

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

CO1. Recall and explain the principles of engineering drawing, the usage of drawing instruments, and the significance of conic sections, cycloids, and various types of scales.
CO2. Apply the principles of orthographic projections to project points, lines, and planes inclined to both reference planes, using auxiliary views when necessary.
CO3. Analyze and project regular solids inclined to both planes, creating accurate auxiliary views for the proper representation of solid shapes.
CO4. Create sectional views and develop the surfaces of right angular solids like prisms, cylinders, pyramids, and cones, using appropriate auxiliary views for accurate representation.
CO5. Integrate and assess the principles of isometric projections, creating isometric views of lines, planes, and solids, and converting them to orthographic views as required.

Catalog Description

I n this fundamental course, students will be introduced to the basics of engineering drawing. Terms and definitions used in industries, such as manufacturing and construction, may also be covered. Specific skills introduced in this course may include sketching, geometric construction, auxiliary drawing, computing dimensions and lettering. Students will be also introduced to computer-aided drawing (CAD) software or techniques.

Course Content

Module 1 **Contact Hr. 9**

Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module 2 **Contact Hr. 9**

Orthographic Projections covering, Principles of Orthographic Projections Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes.

Module 3 **Contact Hr. 8**

Projections of Regular Solids covering, those inclined to both the Planes- Auxiliary Views.

Module 4 **Contact Hr. 9**

Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone.

Module 5 **Contact Hr. 10**

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

Reference Books

1. Engineering Drawing, N. D. Bhat, Charotar Publishing House (2012).
2. Shah, M.B. & B.C. Rana (2008), Engineering Drawing and Computer Graphics, Pearson Education.
3. Engineering Drawing & Graphics using Autocad, T. Jeyapoovan, Vikas Publishing House Pvt. Ltd.-Noida; Third edition (2010).
4. https://nptel.ac.in/courses/112103019/

Modes of Evaluation: Quiz/Assignment/ Written Examination

Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recall and explain the principles of engineering drawing, the usage of drawing instruments, and the significance of conic sections, cycloids, and various types of scales.	**PO1, PO3**
CO2	Apply the principles of orthographic projections to project points, lines, and planes inclined to both reference planes, using auxiliary views when necessary.	**PO1, PO3, PO5**

CO3	Analyze and project regular solids inclined to both planes, creating accurate auxiliary views for the proper representation of solid shapes.	**PO1, PO2, PO3, PO5, PO6**
CO4	Create sectional views and develop the surfaces of right angular solids like prisms, cylinders, pyramids, and cones, using appropriate auxiliary views for accurate representation.	**PO1, PO3, PO6**
CO5	Integrate and assess the principles of isometric projections, creating isometric views of lines, planes, and solids, and converting them to orthographic views as required.	**PO1, PO3, PO5**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CEE12001	Engineering Drawing and CAD												

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

Course Code EIC11001	**Venture Ideation**	L	T	P	C
Version 2.0		2	0	0	2
Pre-requisites/Exposure	Basic knowledge of English and computer applications such as Internet Explorer and MS Office				
Co-requisites	--				

Course Objectives

1. To help the students understand the way to be an Entrepreneur
2. To identify the right business opportunity
3. To empower students to perform a technical feasibility study and thereby developing a prototype

4. To help students in identifying their customers using primary and secondary research methods.
5. Expose students to various factors of market and competition with the help of market feasibility study, forecasting techniques, business model canvass and insights about financial statements.
6. To prepare students with finalizing their entrepreneurial Portfolio

Course Outcomes

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

CO1. **Assess** personal capacity in the context of the entrepreneurial process
CO2. **Assess** characteristics of successful entrepreneurs and entrepreneurial forms and processes
CO3. **Utilize** resources, research and tools for Entrepreneurial ventures
CO4. **Examine** and apply opportunity identification techniques, feasibility terminology, processes and models
CO5. **Integrate and develop** ideation and planning documents for entrepreneurial venture

Catalog Description

Over the last decade, the core of our economy has been transitioning from one of industrial might, large monolithic corporations and mass production towards one of networks, flexible enterprises comprising many smaller units and unique value. This new economy is based on innovation originating in creativity and design; it is also disrupting long-standing and established employment patterns and bringing to the fore the importance of entrepreneurship. This core unit will bring together creativity, design and entrepreneurship at the conceptual and more practical level. It aims to explore the nature, determinants and consequences of creativity, design and entrepreneurship as well as the interaction between them.

Course Content

Unit 1. Introduction 6 hours

Preview of the Course, Introduction to the Course, Guest Lecture with U.S. Secretary of Commerce Penny Pritzker – Meaning of Innovation, Entrepreneurial opportunities, Factors influencing the feasibility of an innovation, Innovation strategy: technology-push or market-pull, Product-market fit, How to develop a business model, Walkthrough of the business model canvas, Welcome to Innovation for Entrepreneurs: From Idea to Marketplace.

Unit 2. Customer Discovery and Validation 6 hours

Customer types, Customer archetypes, Customer segments and business models, Customer segments, value propositions, product features, value mapping, interviewing customer, insights of your customers.

Unit 3: Product Understanding and Marketing. 6 hours

Customer value, The DNA of customer-centricity, Crossing the chasm, Qualitative and quantitative marketing research, importance and methods of market segmentation, Focusing on the target market, Beyond the chasm, Strategic implications of beyond the chasm, E-commerce: The internet as a selling platform.

Unit 4. Prototyping and Testing. 6 hours

Planning for prototyping, Rapid prototyping and development, Lean startup MVPs, Choosing a wire framing/UX prototyping tool, Anatomy of an experience map, What you'll learn from

user testing, Analytics and insight, Troubleshooting your customer discovery, Levels of a product/service.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Components	Presentation/Assignment/ etc	End term
Weightage (%)	**50**	**50**

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Assess** personal capacity in the context of the entrepreneurial process	**PO6, PO11**
CO2	**Assess** characteristics of successful entrepreneurs and entrepreneurial forms and processes	**PO6, PO11**
CO3	**Utilize** resources, research and tools for Entrepreneurial ventures	**PO1, PO6, PO8, PO11**
CO4	**Examine** and apply opportunity identification techniques, feasibility terminology, processes and models	**PO1, PO6, PO8, PO11**
CO5	**Integrate and develop** Ideation and planning documents for entrepreneurial venture	**PO6, PO8, PO11**

1=Weakly mapped
2= Moderately mapped
3=Strongly mapped

EIC11001	Course Code	
Venture Ideation	Course Title	
	PO1	Academic excellence
	PO2	Critical thinking
	PO3	Skills
	PO4	Modern tools and techniques usage
	PO5	Problem solving
	PO6	Analysis
	PO7	Proper solutions
	PO8	Professional
	PO9	Collaboration
	PO10	Sustainability
	PO11	Ethics
	PO12	Global citizen

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	1	3	-	-	-	-	3	-	3	-	3
CO2	3	1	3	-	-	-	-	3	-	3	-	3
CO3	3	1	3	-	-	-	-	3	-	3	-	3
CO4	3	1	3	-	-	-	-	3	-	3	-	3
CO5	3	1	3	-	-	-	-	3	-	3	-	3
Avg	3	1	3	-	-	-	-	3	-	3	-	3

GEE11012	Disruptive Technology Innovations	L	T	P	C
Version 1.0	Contact Hours - 45	1	0	2	2
Pre-requisites/Exposure					
Co-requisites	--				

Course outcomes

CO1 Recall the key concepts of Artificial Intelligence (AI) and Machine Learning (ML), distinguish between AI and ML, and explain their significance in various industries.

CO2 Apply data analytics techniques using tools like Microsoft Excel, Tableau, and Power BI to clean, preprocess, visualize, and analyze structured and unstructured data.

CO3 Explain the basic components and applications of the Internet of Things (IoT) and apply hands-on exercises using Arduino and Raspberry Pi for IoT projects.

CO4 Analyze cybersecurity threats and apply security best practices and technologies (such as firewalls, encryption, and antivirus software) to protect systems and data.

CO5 Integrate and evaluate emerging trends in robotics and additive manufacturing (AM), and create prototypes using 3D printing and rapid prototyping methods for various applications.

Unit 1: AI/ML lecture:10 hrs

Introduction To Artificial Intelligence, Definition And Brief History Of Ai, Key Ai Concepts And Terminology, Importance And Impact Of Ai In Various Industries, Machine Learning Basics, Distinction Between Ai And Ml, Types Of Machine Learning: Supervised, Unsupervised, And Reinforcement, The Role Of Data In Machine Learning, Evaluation Metrics In Ml, Natural Language Processing (Nlp), Text Preprocessing And Tokenization, Basic Sentiment Analysis,applications Of Nlp In Real-world Scenarios, Generative Ai And Large Language Models, Introduction To Generative Ai, What Are Large Language Models?, Ai In Business And Industry, How Ai Is Transforming Various Industries (E.G., Healthcare, Finance, Retail), Case Studies Of Successful Ai Implementations, Business Opportunities And Challenges In Ai Adoption, Ai Ethics And Bias, The Importance Of Ethics In Ai, Ethical Considerations In Ai Development And Deployment

Unit 2: Data Analytics With Tools: lecture:6 hrs

Introduction To Data Analytics, The Importance Of Data In Decision-making, Types Of Data (Structured Vs. Unstructured), Role Of Data Analytics In Various Industries, Data Collection And Preprocessing, Data Collection Methods, Data Cleaning And Quality Assessment, Dealing With Missing Data, Data Transformation And Feature Engineering, Introduction To Data Analytics Tools, Overview Of Popular Data Analytics Tools, Introduction To Microsoft Excel For Data Analysis, Data Visualization With Advanced Tools (E.G., Tableau, Power Bi)

Unit 3:IOT lecture:10 hrs

Introduction To Iot, Definition And Concept Of The Internet Of Things, Significance And Impact On Various Industries, Iot Architecture And Components Overview, Iot Hardware Components

(Sensors, Actuators, Microcontrollers), Basocs Of Cloud Computing And Iot, Sensors And Actuators, Types Of Sensors (Temperature, Humidity, Motion, Etc.), Sensor Characteristics And Selection Criteria, Actuators And Their Role In Iot Systems, Practical Sensor And Actuator Examples, Iot Applications In Healthcare, Remote Patient Monitoring, Wearable Health Devices, Smart Citie, Agriculture And Environmental Monitoring, Augmented Reality (Ar) And Virtual Reality (Vr) In Iot, Digital Twins In Iot, Basics Of Arduino And Raspberry Pi, Hardware Components And Capabilities, Programming With Arduino Ide And Raspberry Pi, Hands-on Exercises With Arduino And Raspberry Pi

Unit 4: Cyber Security lecture:9 hrs

Introduction To Cybersecurity, Definition And Scope Of Cybersecurity, Historical Perspective And Evolution Of Cybersecurity, Cyber Threats And The Need For Protection, Overview Of Common Cyber Threats (Malware, Phishing, Ransomware, Etc.), Social Engineering Attacks, Confidentiality, Integrity, And Availability (Cia) Triad, Risk Assessment And Management, Security Policies And Procedures, Cybersecurity Best Practices, Security Technologies And Tools, Introduction To Antivirus Software, Firewalls And Intrusion Detection/Prevention Systems (Ids/Ips), Encryption And Secure Communication, Application Of Cybersecurity In Business, Healthcare, Finance, Critical Infrastructure, Emerging Trends In Cybersecurity (Ai In Cybersecurity, Iot Security, Etc.)

Unit 5: Robotic Process Automation lecture:6 hrs

Definition Of Robotics And Automation, Historical Overview Of Robotics, Types Of Robots And Their Applications, Role Of Automation In Various Industries, Current Trends And Future Prospects, Robot Anatomy, And Components, Sensors: Proximity, Vision, Force, Touch, Etc, Actuators And Motors: Dc Motors, Servos, Stepper Motors, Robot Programming: Python, C++, Etc, Introduction To Computer Vision, Types Of Robot End-effectors/Grippers, Pick-and-place Operations, Introduction To Cobots (Collaborative Robots), Safety Considerations And Standards, Emerging Trends And Research Areas: Soft Robotics, Swarm Robotics, Bio-inspired Robotics, Industry 4.0 And Smart Factories.

Unit 6: Additive Manufacturing (Am) And Rapid Prototyping (Rp) lecture:6 hrs

Evolution And History Of Am And Rp, Basic Principles Of Am And Rp, Comparison With Traditional Manufacturing Methods, Applications And Benefits Of Am And Rp, Stereolithography (Sla), Fused Deposition Modeling (Fdm), Selective Laser Sintering (Sls), Selective Laser Melting (Slm), Electron Beam Melting (Ebm), Materials For Am: Polymers, Metals, Ceramics, And Composites Used In Am, Applications Of Am And Rp: Aerospace And Automotive Industries, Medical And Healthcare Applications, Consumer Goods And Electronics, Art And Fashion, Customization And Personalization, Tooling And Jigs.

CO / PO	PO1: Engineering Knowledge	PO2: Problem Analysis	PO3: Design/Development of Solutions	PO4: Conduct Investigations of Complex Problems	PO5: Modern Tool Usage	PO6: The Engineer and Society	PO7: Environment and Sustainability	PO8: Ethics	PO9: Individual and Team Work	PO10: Communication	PO11: Project Management and Finance	PO12: Life-long Learning
CO1: Recall AI and ML Concepts	3	3	2	1	2	2	1	2	2	2	2	2
CO2: Apply Data Analytics Techniques	2	3	3	2	3	2	2	2	2	3	2	2
CO3: Explain IoT and Apply Hands-on Exercises	3	3	3	2	3	3	2	2	2	3	3	3
CO4: Analyze Cybersecurity Threats	3	3	2	3	3	3	2	3	2	2	2	2
CO5: Evaluate Robotics and AM Trends	3	2	3	3	3	2	3	2	2	3	2	3

SEMESTER III

MTH11527	Probability Statistics and Numerical Methods	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	--				

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

CO1: Understand and apply fundamental concepts of probability and statistical methods.
CO2: Analyze and interpret data using various statistical techniques.
CO3: Solve problems using numerical methods and algorithms.
CO4: Implement statistical software tools for data analysis.
CO5: Integrate and develop critical thinking and problem-solving skills in real-world applications.

Course Description:

This course introduces several techniques of statistical analysis, which are commonly applied to understand and analyse business problems. The course deals with simple tools and techniques, which will help a student in data collection, presentation, and to understand the basic descriptive properties of the data. This course introduces the concept of bivariate data and their application in several areas.
Numerical analysis is the subject of study to find the numerical solutions of mathematical problems by computational methods. It studies the numerical solutions to the problems

involving nonlinear equations, system of linear algebraic equations, interpolation and approximation, empirical laws for curve fitting, differences, integrals, ordinary and partial differential equations, finite differences, etc. Numerical methods are normally being used to find the solution to a problem whose analytical solution is difficult to achieve, thus it is felt that a study in applied sciences and engineering is essential and found wide applications in all

Statistics: definition, scope and limitation, presentation of data, diagrammatic and graphical representation of data, measures of central tendency, mean, median and mode, geometric and harmonic mean and their limitations, Measure of variations, Range, Quartile, Variance, Standard deviation, Skewness, moment and Kurtosis.
areas of science and engineering.

Course Content:

Module 1: **Lecture Hr. 16**
Correlation and Regression: Introduction to Correlation analysis, Karl Pearson correlation coefficient, Rank Correlation, Regression Analysis, Fitting Straight Lines, Method of least square, regression coefficients, properties of regression coefficients and applications

Module 2: **Lecture Hr. 18**
Probability: Introduction, Probability of an event, additive rule & multiplication rule, conditional probability Bayes' rule and applications.
Probability Distributions: Random variable, discrete and continuous probability distribution, Mathematical expectation, Variance of a random variable, Binomial, Hyper-geometric,

Geometric, Poisson distribution, Uniform, Normal, Exponential Distribution.
Test of hypothesis: Introduction, type I and type II Error, one and two tailed test, test on a single mean when variance is known & variance is unknown. Test on two means, test on a single mean population and test on two populations, one and two sample test for variance, - Test for goodness of fit and test for independence.

Module 3: **Lecture Hr. 16**

Numerical Methods: Introduction, Concept of Errors, Bisection Method, False Position Method, Secant Method, Newton-Raphson Method, Successive Approximation Method, Discussion of Convergence, Interpolation and Extrapolation, Calculus of difference, Newton's Forward Interpolation Formula and Backward Interpolation Formula, Lagrange's method, Newton's divided difference formula, Inverse Interpolation and its applications.
Numerical differentiation and integration: Differentiation formulae based on polynomial fit, trapezoidal, Simpson's and Gaussian quadrature formulae.

Module 4: **Lecture Hr. 10**

Solution of simultaneous linear equations and ordinary differential equations: Gauss elimination method, pivoting, ill conditioned equations, Gauss Seidel and Gauss Jacobi iterative methods, Taylor series and Euler methods, Modified Euler method, error analysis, Runge-Kutta method.

Text Books:

T1. S.C. Gupta and V K Kapoor; Fundamentals of Mathematical Statistics, S Chand & Sons
T2. T. Veerarajan, T Ramachandran; Numerical Methods.

Reference Books:

R1. Manish Goyal; Numerical methods and Statistical Techniques using 'C', Laxmi Publications pvt. Ltd
R2. S Dey and S Gupta; Numerical Methods ,Tata McGraw-Hill Education, 2013
R3. B.S. Grewal; Numerical methods in engineering and science, 42 Edition, Khanna*Publishers*

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs, POs and PSOs

Course Outcomes (COs)	Mapped POs and PSOs

CO-1	Understand and apply fundamental concepts of probability and statistical methods.	PO1,PO2
CO-2	Analyze and interpret data using various statistical techniques.	PO2,PO5
CO-3	Solve problems using numerical methods and algorithms.	PO2,PO5.PO7
CO-4	Implement statistical software tools for data analysis.	PO1,PO2,PO7
CO-5	Integrate and develop critical thinking and problem-solving skills in real-world applications.	PO1,PO2

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO 5	PO6	PO 7	PO8	PO 9	PO10	PO1 1	PO12
MTH11527	Probability, Statistics and Numerical Methods												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	2	-	-	-	2	-	3	1	3	3	3
CO2	-	2	-	-	-	2	-	3	1	3	3	3
CO3	-	2	-	-	-	2	-	3	1	3	3	3
CO4	-	2	-	-	-	2	-	3	1	3	3	3
CO5	-	2	-	-	-	2	-	3	1	3	3	3
Avg	-	2	-	-	-	2	-	3	1	3	3	3

MTH12531	Numerical Methods Lab	L	T	P	C
Version 1.0	**Contact Hours - 45**	0	0	4	2
Pre-requisites/Exposure	Knowledge of basic Mathematics, Numerical Techniques, 10+2 SCIENCE				
Co-requisites	--				

Course Objectives

The primary objective of this course is to provide students hands on experience of implications of the various techniques used in numerical computations through understanding algorithms and writing computer programs. These techniques include solving non-linear equations and system of linear equations, computing numerical interpolation and numerical integrations, and solving ordinary differential equations. The ultimate goal of this course is to enhance the skill to critically think, model and solve any mathematical problems.

Course Outcomes

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

CO1. Numerically **solve** non-linear equations related to univariate problems

CO2. Numerically **solve** system of linear equation related to multivariate problems

CO3. **Identify** interpolated value of a function that is known at a finite number of points

CO4. Numerically **identify** values of any definite integrals

CO5. **Integrate and assess** initial value problems representing systems with spatial/temporal variations

Catalog Description

Numerical computations play a crucial role in solving simple to complex problems in science and engineering. Growing power and efficiency of the modern computers has made the numerical computations more sophisticated, accurate and powerful. Practical knowledge of numerical computation techniques is very essential for modern science and engineering. This lab course is designed for under graduate and BTech students to provide them comprehensive knowledge and practical experience of solving various mathematical problems using suitable numerical techniques. In this course students will learn algorithms and write computer programs for the numerical techniques towards solving problems. The course includes techniques for solving non-linear equations and system of linear equations, computing interpolations and integrations of functions, and solving ordinary differential equations. The course will help students to build the skill to model and solve real-life problems with simple to moderate level of difficulty.

Course Content

Write C/ MATLAB programs to execute the followings: **(45 hours divided equally)**

1. The root of non-linear equation using Bisection method.
2. The root of non-linear equation using false position method.
3. The root of non-linear equation using Newton-Raphson method.
4. Interpolate values using Newton's forward Interpolation method.
5. Interpolate values using Newton's backward Interpolation method.
6. Interpolate values using Lagrange's interpolation method.
7. Solve a system of linear equation using gauss-elimination method.
8. Solve a system of linear equation using Gauss-Seidel method.
9. Evaluate the integral using different numerical integration rules.
10. Solve an ordinary differential equation using different numerical methods.

Text Books

1. S. Dey, S. Gupta, Numerical Methods, McGraw Hill Education (India) Pvt. Ltd., 2013.
2. Amritava Gupta, S.C. Bose, Introduction to Numerical Analysis, 3rd Ed., Academic Publishers, 2013.
3. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd Ed., AMS, 2002.
4. K. E. Atkinson, An Introduction to Numerical Analysis, 2nd Ed., John Wiley& Sons, 1989.

Reference Books

a. Laurene V. Fausett, Applied Numerical Analysis Using MATLAB, 2nd Ed., Pearson, 2007.

b. B.S. Grewal, Numerical Methods in Engineering & Science: with Programs in C & C++, 11th Ed., Khanna Publishers, 2013.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Numerically **solve** non-linear equations related to univariate problems	**PO1-6**
CO2	Numerically **solve** system of linear equation related to multivariate problems	**PO1-6,**
CO3	**Identify** interpolated value of a function that is known at a finite number of points	**PO1-6, PO9, PO11-12,**
CO4	Numerically **identify** values of any definite integrals	**PO1-6, PO9, PO11-12,**
CO5	**Integrate and assess** initial value problems representing systems with spatial/temporal variations	**PO1-6, PO9, PO11-12,**

		Fundamental Knowledge	Critical thinking	Skill Development	Modern tools and techniques	Research	Problem Solving	Data Analysis	Professional Development	Collaboration	Life Long Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MTH12531	Numerical Methods Lab												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT11058	Biochemistry & Bioenergetics	L	T	P	C
	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	12^{th} std English + Basic knowledge of science				
Co-requisites	--				

Course Objectives:

1. To gain a deeper understanding on Biochemistry & Bioenergetics.
2. To be able to distinguish between different types/orders of biochemical reactions.
3. To be able to explain metabolisms of different biomacromolecules.

Course outcome:

1. - Recall the fundamental concepts of biochemistry and bioenergetics, including the structures and functions of biomolecules.

2. Understanding:
- Analyze the mechanisms of enzyme action and the factors that influence enzyme activity.

3. Applying:
- Apply knowledge of carbohydrate metabolism to describe the pathways involved in glycolysis, gluconeogenesis, and the citric acid cycle.

4. Analyzing:
- Compare and contrast the metabolism of different macromolecules (carbohydrates, lipids, proteins) in terms of energy production and utilization.

5. Evaluating:
- Integrate and evaluate the impact of metabolic dysregulation on cellular function and overall health, including metabolic disorders such as diabetes and obesity.

Course Description:

Biochemistry and bioenergetics is integral part of living system. The series broadly cover the study of chemical processes in living organisms. In this course, students learn about the fundamentals of thermodynamics, energy producing pathways of glycolysis, Krebs cycle, oxidative phosphorylation, and fatty-acid oxidation. Coverage will also include a discussion of how biosynthetic processes are controlled and integrated with metabolism of the cell as well as gene regulation and biochemical aspects of evolution. This course is intended for students majoring in chemistry and provides more extensive coverage of the subject than a student will get in a comprehensive/introduction to biochemistry course.

Course Content:

Biochemistry & Bioenergetics (BIT11058)

Unit 1

Bioenergetics: 1st and 2nd laws of Thermodynamics. Gibb's Free Energy, enthalpy, Entropy and mathematical relationship among them; Standard free energy change and equilibrium constant. Coupled reactions & additive nature of standard free energy change; Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, and ATP.

Unit-2

Introduction to Enzymes and Biochemical reaction kinetics: Basic concepts of enzyme- substrate reactions; classification and nomenclature; Enzyme active site; Michaelis-Menten kinetics, Enzyme inhibition kinetics – basic concept.

Unit 3

Structure of Carbohydrate; Metabolic pathways of carbohydrates & their regulation: Glycolysis, TCA cycle, pentose phosphate pathway, Entner-Doudoroff pathway and Cori cycle; Oxidative phosphorylation: electron transport chain and ATP synthesis, regulation of oxidative phosphorylation; gluconeogenesis.

Unit 4

Structure of **Fatty Acid & Cholesterol**; Brief description of animal & plant hormones. Oxidation of Fatty acid: Beta oxidation & omega oxidation – saturated & unsaturated fatty acids. Catabolism of phospholipids. Biosynthesis of fatty acids, phospholipids, cholesterol & steroid

Unit 5

Structure of Amino acids & Proteins; Metabolism of Amino acids & Proteins: Catabolism & Anabolism; Catabolism of amino acids; general metabolism of amino acids. Catabolism of Tyrosine, Leucine, Glutamic acid & Arginine; Glucogenic amino acids, ketogenic amino acids. Urea cycle & its regulation.

Text Books:

1. Principles of Biochemistry, Lehninger, A, W.H. Freeman and Company
2. Molecular Biophysics by Igor N. Serdyuk, Nathan R. Zaccai, Joseph

Reference Books:

1. Principles of Physical Biochemistry, by K.E. van Holde, W. C. Johnson, and P.S. Ho. Prentice Hall; 2nd edition
2. Biophysics: Tools and Techniques by Mark C. Leake. 2016 by CRC Press, ISBN 9781498702430.
3. Biophysics and Biophysical chemistry by Debajyoti Das. Academic publishers 2012

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recall the fundamental concepts of biochemistry and bioenergetics, including the structures and functions of biomolecules.	**PO1, PO2, PO5, PO6**
CO2	Analyze the mechanisms of enzyme action and the factors that influence enzyme activity.	**PO1, PO2, PO5, PO6**
CO3	Apply knowledge of carbohydrate metabolism to describe the pathways involved in glycolysis, gluconeogenesis, and the citric acid cycle.	**PO1, PO2**

CO4	Compare and contrast the metabolism of different macromolecules (carbohydrates, lipids, proteins) in terms of energy production and utilization.	**PO1, PO2**
CO5	Integrate and evaluate the impact of metabolic dysregulation on cellular function and overall health, including metabolic disorders such as diabetes and obesity.	**PO1, PO2,**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11058	**Biochemistry & Bioenergetics** (THEORY)												

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

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	3	2	1	-	-	-	-	-
CO2	3	3	2	3	3	3	2	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	2.8	2.8	2.8	2.4	-	-	-	-	-

BIT11059	Microbiology	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	10+2 LEVEL SCIENCE				
Co-requisites	--				

Course Objectives

1. To gain a deeper understanding in the history and developments in the field of Microbiology.
2. To be able to distinguish between structures of prokaryotes and eukaryotes.
3. To be able to explain microbial nutrition, cultivation, isolation and preservation.

Course Outcomes

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

CO1. Knowledge: Students will be able to identify different types of microorganisms, their characteristics, and their role in the environment and in human health and disease.
CO2. Comprehension: Students will be able to explain the processes of microbial growth, metabolism, and genetics, and how these processes contribute to microbial diversity and adaptation.
CO3. Application: Students will be able to apply laboratory techniques and methods used in the study of microbiology to isolate, identify, and manipulate microorganisms for various purposes, such as research, diagnosis, and treatment.
CO4. Analysis: Students will be able to analyze and interpret data from microbiological experiments to draw meaningful conclusions and make informed decisions related to microbial processes and their impacts.
CO5. Evaluation: Students will be able to critically integrate and evaluate the significance of recent advances in microbiology, including emerging infectious diseases, antimicrobial resistance, and the use of microbiota in biotechnology and medical treatments.

Catalog Description

The core-course of 'general microbiology' will help to understand the classification, structure and evolution of microorganisms. This course includes comprehensive approach through studying bacteria, virus, algae, and fungi. Furthermore, the growth and cultivation of microorganisms are a plus. Application of different antimicrobial agents and their mode of action would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Microbiology (BIT11059)

UNIT I **(10 hours)**

Fundamentals, History & Evolution of Microbiology: Classification of microorganisms; Microbial taxonomy; Microbial phylogeny & current classification of bacteria. Microbial Diversity - Distribution & characterization Prokaryotic & Eukaryotic cells; Morphology & cell

structure of major groups of microorganisms - Bacteria, Algae, Fungi, Protozoa & unique features of viruses.

UNIT II **(10 hours)**

Cultivation & Maintenance of microorganisms: Nutritional groups of microorganisms; methods of isolation; Purification & preservation.

UNIT III **(10 hours)**

Microbial growth: Growth curve, Generation time, synchronous batch & continuous culture; measurement of growth & factors affecting growth of bacteria; Endospore & sporulation in bacteria.

UNIT IV

Microbial Metabolism - Metabolic pathways; amphi-catabolic & biosynthetic pathways; Bacterial Reproduction - Transformation, Transduction & Conjugation; **(10 hours)**

UNIT V

Control of Microorganisms: By physical, chemical & chemotherapeutic agents; Water Microbiology - Bacterial pollutants of water, coliforms & non-coliforms; Sewage composition & its disposal; Important microorganism in food Microbiology - Moulds, Yeasts, and bacteria; Major food born infections & intoxications; Preservation of various types of foods; Fermented Foods. **(20 hours)**

Textbook:

1. Microbiology by Pelczar, JR E.C.S Chan and noel R.Krieg. Fifth edition Tata Mc Graw Hill -2006
2. Willey, J.M.; Sherwood, L.; Woolverton, C.J. *Prescott's microbiology*. McGraw-Hill: 2013.

Reference books:

1. Tortora, G.J.; Funke, B.R.; Case, C.L. *Microbiology: An introduction*. Pearson Education: 2015.
2. www.pubmed.org
http://www.mhhe.com/biosci/cellmicro/prescott/student/olcstudn.mhtml

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	CO1. Knowledge: Students will be able to identify different types of microorganisms, their characteristics, and their role in the environment and in human health and disease.	**PO1, PO2**
CO2	CO2. Comprehension: Students will be able to explain the processes of microbial growth, metabolism, and genetics, and how these processes contribute to microbial diversity and adaptation.	**PO1, PO2**
CO3	CO3. Application: Students will be able to apply laboratory techniques and methods used in the study of microbiology to isolate, identify, and manipulate microorganisms for various purposes, such as research, diagnosis, and treatment.	**PO1, PO2, PO3, PO5**
CO4	CO4. Analysis: Students will be able to analyze and interpret data from microbiological experiments to draw meaningful conclusions and make informed decisions related to microbial processes and their impacts.	**PO1, PO2, PO5, PO6, PO10, PO11**
CO5	CO5. Evaluation: Students will be able to critically integrate and evaluate the significance of recent advances in microbiology, including emerging infectious diseases, antimicrobial resistance, and the use of microbiota in biotechnology and medical treatments.	**PO1, PO2, PO3, PO5, PO7, PO8**

		Academic excellence	Critical Thinking	Skills	Modern Tools and Techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global cutizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11059	Microbiology (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

Course Title	Biochemistry Lab	L	T	P	C
Course Code	BIT12060	0	0	4	2
Contact Hours	45 hr				
Pre-requisites/Exposure	12th level Science				

Course Objectives

1. To gain a deeper understanding on analytical biochemistry lab techniques
2. To gain a deeper understanding on biophysical chemistry lab techniques

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

No.	Course Outcomes
CO1	Knowledge: - Demonstrate an understanding of the principles and techniques used in biochemistry laboratory experiments.
CO2	Comprehension: - Explain the significance of the estimation of vitamins, carbohydrates, lipids, and proteins in biological systems.
CO3	Application: - Apply the appropriate methods and techniques for the estimation of vitamins, carbohydrates, lipids, and proteins in laboratory experiments.
CO4	Analysis: - Analyze and evaluate experimental data to draw conclusions about the presence and quantity of vitamins, carbohydrates, lipids, and proteins in biological samples.
CO5	Synthesis: - Develop and integrate innovative approaches for improving the accuracy and efficiency of biochemical estimation techniques.

Catalog Description

Familiarize students with the specific characteristics of a biochemistry laboratory. To know the basic methods commonly used in the clinical laboratory. This practical course covers the tools and techniques by which biological molecules are identified and analyzed.
This practical course covers fundamental biochemical and molecular biological laboratory techniques, supporting concepts, and data analysis. The aims of this course are 1. To provide students with practical knowledge and hands-on experience with some of the most common experimental methods used in biochemical research, and 2. to introduce students to the fundamentals of scientific writing.

Course Content

Unit I:

1. Introduction to Biochemistry Laboratory: practice and safety rules
2. Introduction to Biochemistry Laboratory: handling biomolecules, storage, temperature sensitivity, numerical.
3. Preparation of buffer
4. Estimation of vitamin C in lemon
5. Qualitative analysis of carbohydrates
6. Qualitative analysis of lipids
7. Qualitative analysis of proteins: precipitation reactions of proteins, Colour reactions of proteins
8. Titration curves of amino acids
9. Handling colorimeter
10. Colorimetric estimation of Glucose by DNS method
11. Colorimetric estimation of protein by Biuret method/Lowry's method.
12. Handling UV-Vis spectrophotometer

Books & Other Resources

Text Book(s)	
T1	Introduction To Practical Biochemistry by Plummer D T , 2006
T2	Biochemistry (Lippincott Illustrated Reviews Series) by R. Harvey
T3	Practical Physiological Chemistry: A Book Designed for Use in Courses in Practical Physiological Chemistry in Schools of Medicine and of Science (Classic Reprint) by Philip Bovier Hawk, 2017

T = Text Book

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	**Internal**	**End Term**
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Knowledge: - Demonstrate an understanding of the principles and techniques used in biochemistry laboratory experiments.	**PO1, PO2, PO3**
CO2	Comprehension: - Explain the significance of the estimation of vitamins, carbohydrates, lipids, and proteins in biological systems.	**PO1, PO3, PO4**
CO3	Application: - Apply the appropriate methods and techniques for the estimation of vitamins, carbohydrates, lipids, and proteins in laboratory experiments.	**PO1, PO2, PO3, PO4, PO6**
CO4	Analysis: - Analyze and evaluate experimental data to draw conclusions about the presence and quantity of vitamins, carbohydrates, lipids, and proteins in biological samples.	**PO1, PO3, PO5, PO6**
CO5	Synthesis: - Develop and integrate innovative approaches for improving the accuracy and efficiency of biochemical estimation techniques.	**PO1, PO4**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
BIT12060	Biochemistry Lab (PRACTICAL)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	1	-	1	-	-	-
CO2	3	3	2	3	3	3	2	-	2	-	-	-
CO3	3	3	3	3	3	3	3	-	2	-	-	-
CO4	3	3	3	3	3	3	3	-	2	-	-	-
CO5	3	3	3	3	2	3	3	-	2	-	-	-
Average	3	3	2.8	3	2.8	3	2.4	-	1.8	-	-	-

BIT12061	Microbiology Lab	L	T	P	C
Version 1.0	Contact Hours - 45	0	0	4	2
Pre-requisites/Exposure	10+2 LEVEL SCIENCE				
Co-requisites	--				

Course Objectives

1. To gain a deeper understanding in the history and developments in the field of Microbiology.
2. To be able to distinguish between Gram positive and Gram-negative bacteria.
3. To be able to perform and explain microbial nutrition, cultivation, isolation and preservation.

Course Outcomes

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

CO1. Remembering: Students will be able to recall and identify common laboratory equipment used in microbiology, such as microscopes, incubators, and autoclaves.

CO2. Understanding: Students will be able to explain the basic principles and techniques used in microbial isolation, cultivation, and identification.

CO3. Applying: Students will be able to perform aseptic techniques, streak plates for microbial isolation, and interpret the results of biochemical tests to identify specific microbial species.

CO4. Analyzing: Students will be able to analyze and interpret experimental data to draw conclusions about the characteristics of different microbial species.

CO5. Creating: Students will be able to design and conduct their own experiments to investigate specific microbiological questions or problems, and present their findings in a clear and organized manner.

Catalog Description

The core-course of ‘general microbiology’ will help to understand the classification, structure and evolution of microorganisms. This course includes comprehensive approach through studying bacteria, virus, algae, and fungi. Furthermore, the growth and cultivation of

microorganisms are a plus. Application of different antimicrobial agents and their mode of action would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Microbiology Lab (BIT12061)

UNIT I

Sterilization techniques along with introduction on Laboratory safety. 20 Lecture Hours
Media preparation using different sterilization techniques.

UNIT II

Microscopy and Micrometry. 8 Lecture Hours
Isolation, culture, enumeration and purification of microbes from a given sample.

UNIT III

Staining Techniques (Simple, Gram staining, spore staining, flageller staining, capsule staining, negative staining). 8 Lecture Hours

UNIT IV

Antibiotic Assay - Antimicrobial Sensitivity Test (Disc Diffusion Method). 5 Lecture Hours

UNIT V

Isolation of antibiotics producing bacteria and determination of the number of colony forming units. 4 Lecture Hours

Textbook:

1. Microbiology by Pelczar, JR E.C.S Chan and noel R.Krieg. Fifth edition Tata Mc GrawHill -2006
2. Willey, J.M.; Sherwood, L.; Woolverton, C.J. *Prescott's microbiology*. McGraw-Hill: 2013.

Reference books:

1. Tortora, G.J.; Funke, B.R.; Case, C.L. *Microbiology: An introduction*. Pearson Education: 2015.
2. www.pubmed.org
http://www.mhhe.com/biosci/cellmicro/prescott/student/olcstudn.mhtml

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs

	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Remembering: Students will be able to recall and identify common laboratory equipment used in microbiology, such as microscopes, incubators, and autoclaves.	**PO1, PO3**
CO2	Understanding: Students will be able to explain the basic principles and techniques used in microbial isolation, cultivation, and identification.	**PO1, PO3, PO6**
CO3	Applying: Students will be able to perform aseptic techniques, streak plates for microbial isolation, and interpret the results of biochemical tests to identify specific microbial species.	**PO1, PO2, PO3, PO4, PO5**
CO4	Analyzing: Students will be able to analyze and interpret experimental data to draw conclusions about the characteristics of different microbial species.	**PO1, PO2, PO5, PO6, PO10, PO12**
CO5	Creating: Students will be able to design and conduct their own experiments to investigate specific microbiological questions or problems, and present their findings in a clear and organized manner.	**PO1, PO2, PO3, PO5, PO7, PO8**

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

Course Code IDP14001	Inter-Disciplinary Project	L	T	P	C
Version 1.0		0	0	3	3
Pre-requisites/Exposure	Knowledge of Basic English				
Co-requisites	Knowledge of Basic Computer Skills				

Course Objectives

This course will develop a student's knowledge of and appreciation for the

- interdisciplinary nature of knowledge and learning
- importance and value of integrating knowledge and perspectives from multiple disciplines as a means to evaluating and understanding complex topics, problems, issues, phenomena, and events
- competencies learned during the educational process and to apply these competencies in a real-world application

Course Outcomes

Upon successful completion of the course, students will be able to

CO1. Remembering:- Recall and summarize key concepts and principles from different disciplines related to the project topic.

CO2. Understanding:- Explain the connections and relationships between different disciplines and their relevance to the project.

CO3. Applying:- Utilize knowledge and skills from multiple disciplines to design and implement a cohesive project plan.

CO4. Analyzing:- Break down the project into its constituent parts and examine how each discipline contributes to the overall goals and objectives.

CO5. Evaluating:- Critically assess the strengths and weaknesses of the interdisciplinary project, including the effectiveness of collaboration between disciplines.

Typical Progress Roadmap

- After discussion with the Project Advisor(s), each student shall prepare an initial outline of their assigned project indicating the major sections of discussion, list the principal research sources for each section, and explain the overall objective of the project, including a justification of the interdisciplinary nature of the work.
- Each student shall meet with the Project Advisor(s) regularly as per the weekly Time-Table. Other meetings may be scheduled at the discretion of the Project Advisor(s) at mutually agreed upon timings.
- Typically, the progress will include a combination of industrial and academic mentoring , self study sessions, case studies, trend studies, presentation by students, interactive sessions, industrial visits etc.
- Regular submission of progress reports shall be required of each student-group as notified through the Project Advisor(s) from time to time.

Mode of Evaluation

Students will be evaluated by team participation and a team presentation at the end of the project. Interactive & continuous, task/assignment- based evaluation methodology will be applied for the course.

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remembering:- Recall and summarize key concepts and principles from different disciplines related to the project topic.	**PO1, PO8, PO9, PO10**
CO2	Understanding:- Explain the connections and relationships between different disciplines and their relevance to the project.	**PO1, PO7, PO8, PO10, PO12**
CO3	Applying:- Utilize knowledge and skills from multiple disciplines to design and implement a cohesive project plan.	**PO10, PO12**
CO4	Analyzing:- Break down the project into its constituent parts and examine how each discipline contributes to the overall goals and objectives.	**PO1, PO11**
CO5	Evaluating:- Critically assess the strengths and weaknesses of the interdisciplinary project, including the effectiveness of collaboration between disciplines.	**PO1, PO9**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
IDP14001	Inter-Disciplinary Project												

1=weakly mapped
2= moderately mapped

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

Course Code SOC14100	**Community Service**	L	T	P	C
Version 1.0		0	0	1	1
Pre-requisites/Exposure	Knowledge of Basic English				
Co-requisites	Knowledge of Basic Computer Skills				

Course Objectives

1. To familiarise the students on the concept ‘giving back to the society’.
2. To familiarize the students on the issues faced by marginalized communities.
3. To provide an experiential platform to the students on any one or two issues as an internship.

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

CO1: **Interpret** the concept of social responsibility through an internship.
CO2: **Acquire** hands on experience in ‘giving back to the society’ through the concept of social responsibility through an internship.
CO3: Analyze and reflect on the psychosomatic, intellectual, career, and personal benefits of social service involvement.
CO4 : Evaluate the collective benefits of community service, such as strengthening interpersonal bonds and fostering social responsibility.
CO5: Integrate and create a comprehensive report reflecting personal experiences and the impact of volunteer work on both personal and community growth.

Catalog Description

Along with Intelligent Quotient, it is important for students to enhance their Emotional Quotient as well. The Social Internship offers opportunity to the student to be empathetic towards social issues facing our society. To help and support the affected community / cause through a field internship is the essence of the course in ‘giving back to the society’.

Course Content

Unit I:
Introduction to the course. A brief on social issues facing the society with both global and

Indian examples.

Unit II:
Minimum 24 hours of field work on a social issue and helping the marginalized / affected community / cause with photographs and testimonies.

Unit III:
Submission of individual reflection on the social service rendered.

The benefits that accrue to the students are

A.) Subjective

1. Psychosomatic benefits: Volunteering increases overall life satisfaction and also helps to relive stress and acts as an anti-depressant.
2. Intellectual benefits: Enhances knowledge through new experiences, and develops communication skills.
3. Career benefits : Enhances career prospects by acquisition of work-related skills, builds good references for employers and provides a forum to network with future potential employers. It also The experience allows gained helps students to take up leadership positions. Letters of recommendation can also be easily sought. Research shows that students who indulge in volunteer word perform better in studies as it invigorates their passion for learning
4. Personal benefits : Real world skills like leadership, problem-solving, collaboration with others, time management and communication skills, learn patience and empathy.
5. Connect learning to real world and enables deeper and lifelong learning.

B.) **Community**

1. Collective benefits: Strong interpersonal bonds are created, and leads to increased civic and social awareness and responsibility.

Further Reading :

1. Tadevosyan, Gohar & Schoenhuth, Michael. Participatory Research Approach : Principles, Challenges and Perspectives. http://ysu.am/files/01G_Tadevosyan_M_Schoenhuth.pdf
2. Bergold, Jarg & Thomas Stefan. Participatory Research Methods: A Methodological Approach in Motion http://www.qualitative-research.net/index.php/fqs/article/view/1801/3334

Plan of Work

1. Reading on social issues facing the society with both global and Indian examples.
2. Selecting an issue where the student wishes to contribute and wants to make a difference.
3. Areas - The internship may be broadly completed by getting in touch with NGO in your city / town / Police / Municipal Corporation / Local Gram Panchayat / Hospital / State Health Department / Women & Child Development Centre / CSR departments of Corporates /school / Old Age Home / Orphanage / Literacy Drive / Aanganwadi

Centres / etc.

4. **Online Discussion –** Through discussion, students elaborate their preferred area of work with reference to the Global Scenario and India. Reason for choosing that area also needs and resources of the people in their area of Social Internship and also submit the testimonials, which include signature of the authority where students initiated their work, or the signature of the authority in whose area students are currently working or photographs of work (photographs must include students working).
5. **Final Report Submission** - Submission of the Testimonials include signatures of the authorities you have worked with, or the signature of the authority in whose area you have worked or photographs of your work (photographs must include you working). Students' accomplishment in their area of operation along with the major successes student experienced and major challenges faced.
6. Students will submit the complete elaborated report along with testimonials and completion certificate in the form of signed Template
    - The registration for all students will open twice, during winter and summer breaks. They may enroll for the internship in either of the two breaks.
    - The student will have to submit a continuous record of their 10 to 15 days internship in the form of photographs and testimonies (wherever required).

Mode and Scheme of Online Evaluation:
Modes of Evaluation: Online – Quiz / Assignment / Discussions / Case Studies
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Interpret** the concept of social responsibility through an internship.	**PO8, PO9, PO10, PO12**
CO2	**Acquire** hands on experience in 'giving back to the society' through the concept of social responsibility through an internship.	**PO8, PO9, PO10, PO11, PO12**
CO3	**Analyze** and reflect on the psychosomatic, intellectual, career, and personal benefits of social service involvement.	
CO4	**Evaluate** the collective benefits of community service, such as strengthening interpersonal bonds and fostering social responsibility.	
CO5	**Integrate and create** a comprehensive report reflecting personal experiences and the impact of volunteer work on both personal and community growth.	

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
SOC14100	Community Service												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	3	-	-	3
CO2	-	3	3	1	3	3	3	3	3	-	-	3
CO3	-	3	3	1	3	3	3	3	3	-	-	3
CO4	-	3	3	1	3	3	3	3	3	-	-	3
CO5	-	3	3	1	3	3	3	3	3	-	-	3
Avg	-	3	3	1	3	3	3	3	3	-	-	3

BIT14113	Professional Development Training-I (Practical)	L	T	P	C
Version 1.0	Contact Hours - 30	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	--				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for students (preferably 3rd semester-7th semester of U.G)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Course learning outcomes:

CO1: Students will be able to **create** professional resumes and cover letters tailored to specific job applications, demonstrating effective resume-building techniques.

CO2: Students will **analyze** various interview scenarios to identify key strategies for successfully navigating different types of interview questions and formats.

CO3: Students will **apply** their aptitude and technical skills to solve real-world problems through mock tests and assessments, showcasing their problem-solving abilities.

CO4: Students will **evaluate** their personal branding and online presence, making necessary adjustments to enhance their professional image on platforms like LinkedIn.

CO5: Students will **integrate** knowledge and **demonstrate** effective communication skills in group discussions, presentations, and professional interactions, ensuring clear and confident expression of ideas.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

CO\PO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12
CO 1	1	0	0	0	0	0	0	3	0	0	0	0
CO 2	0	1	0	0	0	0	0	2	0	0	0	0
CO 3	0	0	3	0	3	3	0	0	0	0	0	0
CO 4	0	0	0	0	0	0	0	0	0	0	0	2
CO 5	0	2	0	0	0	0	0	0	0	0	0	0

SEMESTER IV

BIT11126	Cell biology and Genetics (Theory)	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	12th level Science				
Co-requisites	--				

Course Objectives:

1. To provide basic understanding of the structure and function of a cell.
2. To provide basic understanding of the molecular mechanism and regulation of cellular transport; cell cycle; altered cell signaling and cancer.
3. To provide students basic idea about Mendel's principle and chromosomal basis of heredity and knowledge about mechanism of genetic exchange in bacteria.
4. To provide students modern view about population genetics and evolutionary genetics.

Course Outcomes

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

CO1. Explain the fundamental structures and functions of cells, including organelles, membranes, and cellular processes.
CO2. Analyze the molecular mechanisms of cell division (mitosis and meiosis) and genetic inheritance.
CO3. Apply the principles of genetics to explain the molecular basis of genetic diseases and mutations.
CO4. Evaluate the impact of recent advancements in genomic technologies, such as CRISPR and gene therapy, on medicine and biotechnology.
CO5. Integrate and design experiments to explore cellular processes and genetic phenomena using modern laboratory techniques.

Catalog Description:

Cell biology course will help to understand the biology of cells of higher organisms: Structure, function, and biosynthesis of cellular membranes and organelles; cell cycle and its regulation, apoptosis and oncogenic transformation; receptors, and cell signaling. The topics on genetics will help to understand Mendel's principle and chromosomal basis of heredity. This includes comprehensive approach through studying different mechanism of genetic exchange in bacteria. Furthermore, the implication of population genetics and evolutionary genetics will also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator/s. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator/s.

Course Content:

CELL BIOLOGY AND GENETICS (BIT11126)

Unit1 **10 Lecture Hours**

Eukaryotic & prokaryotic cells: Membrane organization; cell organelles; cytoskeleton;

Transport across cell membranes

Unit2 **15 Lecture Hours**

Cell cycle: Components of cell cycle control system; Intracellular & Extracellular control of cell division; Programmed cell death / Apoptosis; intrinsic and extrinsic pathways of cell death; Apoptosis in relation to Cancer

Unit3 **12 Lecture Hours**

Cell Signaling and Cancer: Cell signaling & signal transduction pathways; Development & causes of cancer; tumor viruses, oncogenes, prevention & treatment of cancer.

Unit4 **13 Lecture Hours**

Introduction to Classical and modern genetics, and gene transfer: Mendelism**,** chromosomal basis of Mendelism Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropic gene interaction- epistatic and non-epistatic, interaction between gene(s) and environment. Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in *Drosophila*, detection of linked loci by pedigree analysis in humans and somatic cell hybridization for positioning genes on chromosomes. Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.

Unit5 **10 Lecture Hours**

Population genetics and Evolutionary genetics: Pedigree analysis and its application, Genetic control of development and sex determination, heredity and maternal effect, epigenetic mechanisms of transcriptional regulation & genomic imprinting. Variations in chromosome number- monosomy and trisomy of sex and autosomes. Variations in chromosome structure - inversions, deletions, duplications and translocations, Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability,quantitative trait loci (QTL) and their identification. Hardy- Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinbergprinciple, Evolutionary genetics: Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

Reference Books

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons.Inc.
2. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4/ISBN:0- 8153-1620-8.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Explain the fundamental structures and functions of cells, including organelles, membranes, and cellular processes.	**PO1, PO2, PO6, PO4**
CO2	Analyze the molecular mechanisms of cell division (mitosis and meiosis) and genetic inheritance.	**PO1, PO2, PO6, PO9, PO3**
CO3	Apply the principles of genetics to explain the molecular basis of genetic diseases and mutations.	**PO1, PO2, PO5, PO8**
CO4	Evaluate the impact of recent advancements in genomic technologies, such as CRISPR and gene therapy, on medicine and biotechnology.	**PO1, PO2, PO6, PO5**
CO5	Integrate and design experiments to explore cellular processes and genetic phenomena using modern laboratory techniques.	**PO1, PO11, PO12**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11126	Cell Biology & Genetic												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	1	3	1	3	1	1	1	1	1	1
CO2	3	3	3	1	1	3	1	1	3	1	1	1
CO3	3	3	1	1	3	1	1	3	1	1	1	1
CO4	3	3	1	1	3	3	1	1	1	1	1	1
CO5	3	1	1	1	1	1	1	1	1	1	3	3
Avg	3	2.6	1.4	1.4	1.8	2.2	1	1.4	1.4	1	1.4	1.4

BIT11065	Biophysical Techniques & Instrumentation	L	T	P	C
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	--				

Course Objectives:

1. The primary objectives of this course are to develop the skills to understand the theory and practice of bioanalytical techniques
2. Additionally, an overview of the instruments used in isolation and separation of molecules will also be provided.
3. To provide scientific understanding of analytical techniques and detail interpretation of results
4. This will enable the students to understand all subjects of Biotechnology as these tools and techniques will be used therein.

Course outcome:

The students will be able:

CO1. To **Interpret** the working principles, tools and techniques of analytical techniques in the field of biological science.

CO2. To **interpret** the functions, maintenance and safety aspect of the bioanalytical tools used in a Biotechnology lab.

CO3. To **demonstrate** the principle and applications of centrifuge, electrophoresis, chromatography and spectroscopy in research and related experiments.

CO4. To **examine** the strengths, limitations and creative use of techniques for problem solving.

CO5. To **integrate and design** the experiments with relevant techniques in order to accomplish the project work.

Course Description:

The main aim of this module is to provide an understanding about the theoretical aspects of key analytical techniques and instruments used in biosciences, including centrifugation techniques, chromatographic techniques, spectrophotometric methods, electrophoretic methods and microscopy. The subject is going to develop an analytical mindset among students in order to apply to different types of samples and research objectives, including selection of the most appropriate techniques and instrumentation for their research project. The couse is also going to teach about processing and analysis of data from the chosen instruments and demonstrate the understanding along with limitations and quality of the data. The students will gain an in depth understanding of this important techniques in order to design an analytical work-flow to acquire data and achieve the research objectives of their project.

Course Content:

Biophysical Techniques & Instrumentation (BIT11065)

UNIT I **15 Lecture hours**

Transport Phenomena: Transport across membrane - passive diffusion, facilitated diffusion & active transport - (definition and examples); gradient of chemical potential as driving force in transport, equilibrium & transport across membranes; diffusion, osmosis, sedimentation, osmotic pressure. Donnan equilibrium, diffusion potential, membrane potential. Gel Electrophoresis and its applications

UNIT II **15 Lecture hours**

Microscopy: General principles of optics in relation to microscopy; different components of light wave (UV, IR, visible); principles and applications of Compound Microscope; Light-, Dark-, Bright-field Microscopes; Phase Contrast Microscopy; Fluorescent Microscope; Electron Microscope; Resolving power; Numerical aperture: Chromatic Aberration.

UNIT III **10 Lecture hours**

Centrifugation and Chromatography: Principles of different types of centrifugation and its application. General principles of chromatography, adsorption chromatography, column, affinity, TLC, partition, ion exchange, gel filtration and permeation chromatography.

UNIT IV **15 Lecture hours**

Spectroscopic techniques: Principles and applications of spectroscopy: Electronic transition, Fluorescence, FRET, Imaging Techniques, Rotational and Vibrational Spectroscopy and application, Raman Spectroscopy in biomolecules. Light scattering: size and shape of macromolecules. Mass spectrometry and its applications.

UNIT V **5 Lecture hours**

Radioactivity: Radioisotope technique: nature of radioactivity, principles of radioisotopes and radiations, units, radioactive decay, detection and measurement of radioactivity.

Suggested Book:

1. Molecular Biophysics by Igor N. Serdyuk, Nathan R. Zaccai, Joseph Zaccai.
2. Principles of Physical Biochemistry, by K.E. van Holde, W. C. Johnson, and P.S. Ho. Prentice Hall; 2nd edition 2005.
3. Biophysics: Tools and Techniques by Mark C. Leake. 2016 by CRC Press, ISBN 9781498702430.
4. Biophysics and Biophysical chemistry by Debajyoti Das. Academic publishers 2012.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO-1	To **Interpret** the working principles, tools and techniques of analytical techniques in the field of biological science.	**PO1, PO2**
CO-2	To **interpret** the functions, maintenance and safety aspect of the bioanalytical tools used in a Biotechnology lab.	**PO1, PO3, PO4**
CO-3	To **demonstrate** the principle and applications of centrifuge, electrophoresis, chromatography and spectroscopy in research and related experiments.	**PO3, PO4, PO5**
CO-4	To **examine** the strengths, limitations and creative use of techniques for problem solving.	**PO1, PO4, PO6**
CO-5	To **integrate and design** the experiments with relevant techniques in order to accomplish the project work.	**PO2, PO3, PO5, PO8**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques	Problem Solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11 065	**Biophysical Techniques & Instrument ation** (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	2	3	3	3	2
CO4	3	2	3	2	2	2
CO5	3	2	3	2	3	2
Average	3	2.2	2.4	2.6	2.8	2.4

BIT11110	Bioprocess Technology	L	T	P	C
Version 1.0	Contact Hours - 45	2	1	0	3
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	--				

Course Objectives

- Understand the bases for media preparation, sterilization.
- Understand the basic structure of Bioreactors.
- Know the basic physiology of a microorganism and how their structure dictates their function in Process Industries.
- Outlining the relation between upstream processing and downstream processing.

Course Outcomes

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

CO1. Remember: Recall and explain key concepts, principles, and techniques used in bioprocess technology.

CO2. Understand: Interpret and differentiate different bioprocess technologies and their applications in various industries.

CO3. Apply: Utilize bioprocess technology principles to design, optimize, and troubleshoot bioprocesses in laboratory and industrial settings.

CO4. Analyze: Evaluate and compare different bioprocess strategies and technologies to achieve desired outcomes.

CO5. Evaluate: Integrate and assess the efficiency, effectiveness, and sustainability of bioprocess technologies in meeting industry standards and regulations.

Catalog Description

A fair knowledge of principles of main bioprocess unit operations like fermentation, downstream processing will be acquired. The focus of the course is on design of innovative microbial fermentations, for bio-products such as amino acids and monomers for bio-plastics, complemented with examples of marine and mammalian processes, for micro-algae products and bio-pharmaceuticals.

Course Content

Bioprocess Technology (BIT11110)

UNIT I **(5 hours)**

Microbial kinetics: Monod's equation, substrate inhibition, double substrate equations. Structured and unstructured substrate & product inhibition and models related to that, cybernetic models, segregated models.

UNIT II **(10 hours)**

Media and air sterilization: Sterilization kinetics, batch and continuous sterilization.

Agitation and aeration in bioreactor, different types of impellors, power requirements, kla determination, mixing, multiphase reaction.

UNIT III **(10 hours)**

Bioreactors: Types of bioreactor operation, batch, fed-batch, continuous, cell recycle and cascade mode, calculation of productivity, yield and reactor sizing. Extractive fermentation, high cell density culture, Scale-up and scale down of bioreactor. State and parameter estimation techniques for biochemical processes; computers and interfaces, Computer-based data acquisition, monitoring and control-LABVIEW Software.

UNIT IV **(10 hours)**

Stoichiometry of Cell growth and product formation, elemental balances, Bioreactor strategies for maximizing product formation; Bioprocess design considerations for plant and animal cell cultures. Isolation, preservation and improvement of industrially important micro- organisms, development of innocula for industrial fermentations; types of fermentations, Basic design & construction of fermentors and ancillaries, media design and sterilization for fermentation process. Overview of aerobic & anaerobic fermentation processes & their application; solid-substrate fermentation & its applications.

UNIT V **(10 hours)**

Unit Operation: Filtration, filter aids, filtration Equipment and filtration theory, Centrifugation process and related equipment, Cell disruption, Aqueous Two-Phase Liquid Extraction. Adsorption process and its operations, Chromatography: Theory and mechanism, Scaling-up chromatography.

Textbook:

1. Willey, J.M.; Sherwood, L.; Woolverton, C.J. *Prescott's microbiology*. McGraw-Hill: 2013.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

Reference books:

1. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
2. www.pubmed.org
http://www.mhhe.com/biosci/cellmicro/prescott/student/olcstudn.mhtml

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember: Recall and explain key concepts, principles, and techniques used in bioprocess technology.	**PO1, PO2**
CO2	Understand: Interpret and differentiate different bioprocess technologies and their applications in various industries.	**PO1, PO2, PO3**
CO3	Apply: Utilize bioprocess technology principles to design, optimize, and troubleshoot bioprocesses in laboratory and industrial settings.	**PO1, PO2, PO3**
CO4	Analyze: Evaluate and compare different bioprocess strategies and technologies to achieve desired outcomes.	**PO1, PO2, PO4, PO6**
CO5	Evaluate: Integrate and assess the efficiency, effectiveness, and sustainability of bioprocess technologies in meeting industry standards and regulations.	**PO1, PO2, PO3, PO5, PO10**

		Academic excellence	Critical Thinking	Skills	Modern Tools and Techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11110	Bioprocess Technology (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	3	2	3	3	3
CO3	3	2	2	3	3	3
CO4	3	3	2	3	2	3
CO5	3	2	2	3	3	3
Average	3	2.4	2	3	2.8	2.8

BIT12127	**CELL BIOLOGY & GENETICS LAB**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	0	0	4	2
Pre-requisites/Exposure	Intermediate level science				
Co-requisites	--				

Course Objectives

Students will be

1. to identify and understand a cell and its basic structure.

2. to distinguish between prokaryotes and eukaryotes.

3. to distinguish between plant and animal cell.

4. to understand the structure and function of plasma membrane and examine solvent/solute movement in different conditions.

5. to understand cell division and identify the different stages of cell cycle.

Course Outcomes

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

CO1. Students will be able to **demonstrate** effect of temperature and organic solvents on semi permeable membrane.
CO2. prepare onion root tips for **demonstrating** mitosis.
CO3. Observe and **interpret** the structure of any prokaryotic and eukaryotic cells.
CO4. **demonstrate** plasmolysis and deplasmolysis.
CO5. Integrate and assess histological slides of various mammalian tissue structures.

Catalog Description

Cell Biology Lab (Practical) provides experiments and observations to appraise the structural and functional diversity of a cell. The very nature of cell biology lab requires students to view different cells and sub cellular structures in different settings and to identify and describe them. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. All the experiments will be based on hands-on training in laboratory setup along with discussions of basic theories and advanced topics for practical implementation of knowledge. Classes will be conducted by hands-on lab training

and/or audio-visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

CELL BIOLOGY & GENETICS LAB (BIT12127)

1. Preparation of a temporary mount of onion peel and cheek epithelial cells to study their characteristics (3 hours)
2. Demonstration of plasmolysis and deplasmolysis (3 hours)
3. Demonstration of the effect of increasing concentration of ethanol and temperature on the permeability of cell membrane (3 hours)
4. Determination of stomatal index from leaf epidermal peel and cast (3 hours)
5. Study of various stages of mitosis in onion root tip (3 hours)
6. Study of various stages of meiosis in onion flower buds (3 hours)
7. Comparative study of bacterial, plant, and animal cells (3 hours)
8. Differential staining and identification of blood cells (3 hours)
9. Karyotype analysis (3 hours)
10. Model making and presentation (Experiential learning activity) (3 hours)

Text Books

1. Practical Handbook of Cytology: Protocols in Cell Biology 2016 by Chetan Jawale and Laxmikant Dama , Lap Lambert Academic Publishing
2. Cell Biology : Practical Manual Paperback - 2018 by Renu Gupta , Seema Makhija & Ravi Toteja, Prestige Publishers

Reference book

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

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

Mapping between COs and POs

	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Students will be able to **demonstrate** effect of temperature and organic solvents on semi permeable membrane.	**PO1, PO2, PO3, PO6, PO7, PO8, PO9,**
CO2	Prepare onion root tips for **demonstrating** mitosis.	**PO1, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12**
CO3	Observe and **interpret** the structure of any prokaryotic and eukaryotic cells.	**PO1, PO2, PO3, PO4, PO5, PO6, PO8, PO9**
CO4	**Demonstrate** plasmolysis and deplasmolysis.	**PO1, PO2, PO3, PO6, PO8, PO9**
CO5	**Integrate and assess** histological slides of various mammalian tissue structures.	**PO1, PO3, PO4, PO5, PO8, PO9**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT12127	Cell Biology & Genetics lab (practical)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT12069	Biophysical Techniques & Instrumentation Lab	L	T	P	C
Version 1.0	**Contact Hours - 45**	0	0	4	2
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	Biochemistry Lab in third semester				

Course Objectives:

1. The primary objectives of this course are to develop the skills to understand the theory and practice of bioanalytical techniques
2. Additionally, an overview of the instruments used in isolation and separation of molecules will also be provided.
3. To provide scientific understanding of analytical techniques and detail interpretation of results
4. This will enable the students to understand all subjects of Biotechnology as these tools and techniques will be used therein.

Course outcome:

The students will be able

CO1. to **Interpret** the working principles, tools and techniques of analytical techniques in the field of biological science.

CO2. to **interpret** the functions, maintenance and safety aspect of the bioanalytical tools used in a Biotechnology lab.

CO3. to **demonstrate** the principle and applications of centrifuge, electrophoresis, chromatography and spectroscopy in research and related experiments.

CO4. to **list** the strengths, limitations and creative use of techniques for problem solving.

CO5. to **integrate and design** the experiments with relevant techniques in order to accomplish the project work.

Course Description:

The main aim of this module is to provide an understanding about the theoretical aspects of key analytical techniques and instruments used in biosciences, including centrifugation techniques, chromatographic techniques, spectrophotometric methods, electrophoretic methods and microscopy. The subject is going to develop an analytical mindset among students in order to apply to different types of samples and research objectives, including selection of the most appropriate techniques and instrumentation for their research project. The course is also going to teach about processing and analysis of data from the chosen instruments and demonstrate the understanding along with limitations and quality of the data. The students will gain an in depth understanding of this important techniques in order to design an analytical work-flow to acquire data and achieve the research objectives of their project.

Course Content:

Biophysical Techniques & Instrumentation Lab (BIT12069)

1. Separation of insolubles by filtration / sedimentation / centrifugation
2. Chemical cell disruption and assay for intracellular products.
3. Mechanical cell disruption and assay for intracellular products
4. Ammonium sulphate precipitation
5. Dialysis for removal of salts

6. Gel analysis – SDS-PAGE for dialysed product
7. Visualization of DNA samples using agarose gel electrophoresis
8. Estimation of protein content and purity in given sample using UV-Vis spectrophotometer
9. Paper chromatography for isolation of pigments of leave sample
10. Ion Exchange chromatography/affinity/gel-filtration chromatography

SUGGESTED BOOK:

1. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO-1	Students will be able to **Interpret** the working principles, tools and techniques of analytical techniques in the field of biological science.	**PO1, PO2**
CO-2	Students will be able to **interpret** the functions, maintenance and safety aspect of the bioanalytical tools used in a Biotechnology lab.	**PO1, PO3, PO4**
CO-3	Students will be able to **demonstrate** the principle and applications of centrifuge, electrophoresis, chromatography and spectroscopy in research and related experiments.	**PO3, PO4, PO5**
CO-4	Students will be able to **list** the strengths, limitations and creative use of techniques for problem solving.	**PO1, PO4, PO6**
CO-5	Students will be able to **integrate and design** the experiments with relevant techniques in order to accomplish the project work.	**PO1, PO3, PO5, PO8, PO10**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem Solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT12 069	**Biophysical Techniques & Instrumentation Lab**												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

BIT12070	Bioprocess & Fermentation Technology Lab	L	T	P	C
Version 1.0	**Contact Hours - 45**	0	0	4	2
Pre-requisites/Exposure	Basic knowledge of Life science and Chemistry				
Co-requisites	--				

Course Objectives

4. Understand the bases for media preparation, sterilization.
5. Understand the basic structure of Bioreactors.
6. Know the basic physiology of a microorganism and how their structure dictates their function.

Course Outcomes

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

CO1. **Outline** the principle and applications of bioprocess technology. Can apply fundamental calculation in bioprocessing.
CO2. Students will be able to **demonstrate** different types of Bioreactors and able to design dedicated bioreactor for specific bioprocess.
CO3. Students will be able to **demonstrate** and design experiments for laboratory and pilot scale production of value-added products of microbial products in bioreactors
CO4. Students will be able to **explain** Rheology of microbial cultures and biopolymers and determination of various rheological constants
CO5. Integrate and apply the knowledge of using different modern tools and techniques in the field of bioprocessing which will help in their further academics.

Catalog Description

This course emphasizes the application of biological and engineering principles to problems involving microbial, mammalian, and biological/biochemical systems.

Course Content

Bioprocess & Fermentation Technology Lab (BIT12070)

5 Lecture Hours

1. Isolation of proteolytic organisms from soil samples.

4 Lecture Hours

2. Glucose assay by dDNS method.

4 Lecture Hours

3. Evaluation of enzyme kinetic parameters.

5Lecture Hours

4. Enzyme activity calculation.

5Lecture Hours

5. Determination of optimum pH for enzyme.

5 Lecture Hours

6. Determination of optimum temperature for an enzyme.

4 Lecture Hours

7. Effect of substrate concentration on biomass yield.

4 Lecture Hours

8. Solvent extraction techniques for product recovery.

4 Lecture Hours

9. Production of wine by yeast.

4 Lecture Hours

10. Production of Amino acid.

Suggested Books:

1. Laboratory Manual in Industrial Biotechnology by P. Chellapandi 2007
2. Bioreactors in Biotechnology: A Practical Approach by A.H. Scragg, 1991

Reference Books

2. Chellapandi P. (2007). Laboratory Manual In Industrial Biotechnology. Pointer Publishers.
3. Scragg AH. (1991). Bioreactors in Biotechnology: A Practical Approach. E. Horwood

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Outline** the principle and applications of bioprocess technology. Can apply fundamental calculation in bioprocessing.	**PO1, PO2, PO3**
CO2	Students will be able to **demonstrate** different types of Bioreactors and able to design dedicated bioreactor for specific bioprocess.	**PO1, PO10, PO11**
CO3	Students will be able to **demonstrate** and design experiments for laboratory and pilot scale production of value-added products of microbial products in bioreactors	**PO1, PO2, PO3, PO4, PO8**

CO4	Students will be able to **explain** Rheology of microbial cultures and biopolymers and determination of various rheological constants	**PO1, PO3. PO6, PO9**
CO5	Integrate and apply the knowledge of using different modern tools and techniques in the field of bioprocessing which will help in their further academics.	**PO1, PO4, PO8, PO12**

		Academic excellence	Critical Thinking	Skills	Modern Tools and Techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT12070	Bioprocess & Fermentation Technology Lab (Practical)												

1=weakly mapped
2= moderately mapped
3= Strongly mapped

CO Number	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**2**	**2**	**3**	**3**	**3**
CO2	**3**	**3**	**2**	**3**	**3**	**3**
CO3	**3**	**2**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**2**	**3**	**3**	**3**
CO5	**3**	**2**	**2**	**3**	**3**	**3**
Average	**3**	**2.4**	**2**	**3**	**3**	**3**

ECO11505	HSSM – IV (Economics for Engineers)	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	10+2 Science				
Co-requisites					

Course Objectives

1. Prepare engineering students to function in the business and management side of professional engineering practice.
2. Help students in general to analyse, understand and explain the past, present economic conditions of the country.
3. To forecast the future course of changes and development through their knowledge of policies and programmes set by the governments and other development agencies.
4. Evaluate the economic theories, cost concepts and pricing policies.
5. Apply the concepts of financial management for project appraisal.

Course Outcomes

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

CO1. **Interpret** the basic economic concepts and make economic analyses in the decision making.
CO2. **Utilize** principals of economics to analyze the behaviour of consumers and producers in a well- functioning economy and also in case of market failures.
CO3. **Develop** the ability to account for time value of money using factors and formulas, estimate annual and future worth comparisons for cash flows.
CO4. **Interpret** how factor market works, identify the manpower and resources management, need of credit/finance for initiating and accelerating projects.

Catalog Description

This paper introduces students to the terminology and analytic principles used in microeconomics, which is broadly defined as the study of markets, and to the application of these conceptual tools to several policy issues. As the design and manufacturing process become more complex, an engineer is required to make decisions that involve money more than ever before. The competent and successful engineer at present must have an improved understanding of the principles of economics. This paper is concerned the analysis of individual behaviors and market structure, and systematic evaluation of the benefits and costs of projects.

Course Content

Module 1: Basic Concepts of Economics: [10 lecture hours]

Introduction to the Literature of Microeconomics centering around Decision Making at Individual Level. Some Fundamental Concepts: Maximization, Equilibrium and Efficiency.

Module 2: Theories of Economics: **[12 lecture hours]**

The Theory of Consumer Choice and Demand, the Theory of Supply, market equilibrium, market structure, market failure and environmental issues, Game Theory, concept of yield and Theories of Term Structure, the Theory of Asset Pricing, decision-making under uncertainty: risk and insurance.

Module 3: Sustainability Study of a Project: **[5 lecture hours]**

Budget plan, estimation of the project cost, prices, fees and cost recovery, financing of recurrent costs, sustainability of the activities generated by the project.

Module 4: Economic Feasibility Study: **[12 lecture hours]**

Problem of pricing under oligopoly, problem of market stagnation, problem of volatility in open economy, problem of global meltdown, problem of financing a project.

Module 5: Project Report: **[6 lecture hours]**

Facets of project viability – commercial, technical, financial, outline of a model project report, a real life case study.

Text Books:

1. R. Panneersalvam, *Engineering Economics*, 2nd Ed., Prentice Hall of India, 2014.
2. James Riggs, *Engineering Economics*, 4th Ed., McGraw Hill Education, 2004.

Reference Books:

1. Donald G. Newnan, Ted G. Eschenbach and Jerome P. Lavelle, *Engineering Economic Analysis*, 13th Ed., Oxford University Press, 2017.
2. Chan S. Park, *Contemporary Engineering Economics*, 6th Ed., Pearson, 2015.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Interpret** the basic economic concepts and make economic analyses in the decision making.	**PO1, PO3, PO10**

CO2	**Utilize** principals of economics to analyze the behaviour of consumers and producers in a well-functioning economy and also in case of market failures.	**PO1, PO2, PO3, PO5, PO6, PO10**
CO3	**Develop** the ability to account for time value of money using engineering economy factors and formulas, estimate annual and future worth comparisons for cash flows.	**PO1, PO3, PO6, PO10**
CO4	**Interpret** how factor market works, identify the manpower and resources management, need of credit/finance for initiating and accelerating projects.	**PO2, PO3, PO10**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECO11505	HSSM–IV (Economics for Engineers)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

Course PSG11021	**Human Values and Professional Ethics**	**L**	**T**	**P**	**C**
Version 1.0		**2**	**0**	**0**	**2**
Pre-requisites/Exposure	**Knowledge of English**				
Co-requisites	**--**				

Course Objectives

- To inculcate human values and professional ethics in students.
- To enhance the understanding of students towards personal, professional & societal relationships and achieve harmony in life.
- To develop moral responsibilities and ethical vision.

Course Outcomes

At the completion of the course, the student should be able to:

CO1	Remembering: Students will be able to recall and understand the basic principles of human values and professional ethics, such as integrity, honesty, respect, and accountability.
CO2	Understanding: Students will be able to comprehend the importance of incorporating human values and ethics in decision-making processes and professional conduct.
CO3	Applying: Students will be able to apply ethical reasoning and critical thinking skills to real-life scenarios and dilemmas, and make ethical decisions based on their understanding of human values and professionalism.
CO4	Analyzing: Students will be able to analyze ethical issues and conflicts from multiple perspectives, considering the impact of their decisions on society as a whole.
CO5	Evaluating: Students will be able to integrate and evaluate the ethical implications of their actions and choices, reflecting on their personal values and professional responsibilities.

Catalog Description

This course aims to develop an understanding for a movement from rule-based society to a relationship-based society. Apart from teaching values, this course encourages students to discover what values are for them and for society. Self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs. It is designed in a way where students get familiar with the Ethical Code of Conduct, Ethical Dilemma, Conflict of Interest and all this will help them eventually in their professional life.

Course Content

Unit I: Introduction to Human Values: Character, Integrity, Credibility, Mutual Respect, Dedication, Perseverance, Humility and Perception. Self-Assessment & Analysis, Setting Life Goals, Consciousness and Self-Transformation. Team Work, Conflict Resolution, Influencing and Winning People, Anger Management, Forgiveness and Peace, Morality, Conscience. Yoga and Spirituality

Unit II: Harmony and Life Long Learning: Harmony in human being, Nature and Existence. Harmony in family and society –Responsibilities towards society, Respecting teachers. Transition from School to College - Freedom & Responsibilities, Respecting Cultural Diversity, Learning beyond the Classrooms, Independent study and research

Unit III: Introduction to Professional Ethics: Work Ethics, Engineering Ethics, Moral Dilemma, Moral Development Theories, Ethical Theories- Kantinism, Utilitarianism, etc , Case Studies for Choice of the theory, Code of Ethics

Unit IV: Individual to Global Issues: Industrial Standards, A Balanced Outlook on Law, Safety, Responsibility, Rights, Confidentiality, Conflict of Interest, Occupational Crime, Whistle Blowing, Environmental Ethics, Business Conduct in MNC, E-Professionalism (IPR, Internet Ethics & Privacy issues)

Text Books

1. Shetty, Foundation Course in Human Values and Professional Ethics [R.R. Gaur, R. Sangal, G.P. Bagaria]

Modes of Evaluation: Quiz/Assignment/ Seminar/Written Examination
Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Programme Outcomes**

CO1	Remembering: Students will be able to recall and understand the basic principles of human values and professional ethics, such as integrity, honesty, respect, and accountability.	**PO1, PO8, PO10, PO11**
CO2	Understanding: Students will be able to comprehend the importance of incorporating human values and ethics in decision-making processes and professional conduct.	**PO1,PO8, PO11**
CO3	Applying: Students will be able to apply ethical reasoning and critical thinking skills to real-life scenarios and dilemmas, and make ethical decisions based on their understanding of human values and professionalism.	**PO11, PO12**
CO4	Analyzing: Students will be able to analyze ethical issues and conflicts from multiple perspectives, considering the impact of their decisions on society as a whole.	
CO5	Evaluating: Students will be able to integrate and evaluate the ethical implications of their actions and choices, reflecting on their personal values and professional responsibilities.	

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

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

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO8	PO9	PO 10	PO 11	PO 12
PSG11021	Human Values and Professional Ethics	3										3	

BIT14114	Professional Development Training -II (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	Completion of PDT-I course				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G)

1. Resume Building & Cover Letter Writing.
2. Interview Skills.
3. Aptitude and Technical Skills.
4. Group Discussion and Communication Skills.
5. Personal Branding and Online Presence.
6. Professional Skills.
7. Industry Insights and Company Presentations.
8. Career Guidance for competitive entrance exams and Job Search Strategies
9. Mock Tests and Assessments.

Course learning outcomes:

CO1: Students will be able to **create** professional resumes and cover letters tailored to specific job applications, demonstrating effective resume-building techniques.

CO2: Students will **analyze** various interview scenarios to identify key strategies for successfully navigating different types of interview questions and formats.

CO3: Students will **apply** their aptitude and technical skills to solve real-world problems through mock tests and assessments, showcasing their problem-solving abilities.

CO4: Students will **evaluate** their personal branding and online presence, making necessary adjustments to enhance their professional image on platforms like LinkedIn.

CO5: Students will **demonstrate** effective communication skills in group discussions, presentations, and professional interactions, ensuring clear and confident expression of ideas.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	**50**	**50**

CO\PO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12
CO 1	1	0	0	0	0	0	0	3	0	0	0	0
CO 2	0	1	0	0	0	0	0	2	0	0	0	0
CO 3	0	0	3	0	3	3	0	0	0	0	0	0
CO 4	0	0	0	0	0	0	0	0	0	0	0	2
CO 5	0	2	0	0	0	0	0	0	0	0	0	0

SEMESTER V

BIT11072	Molecular Biology	L	T	P	C
Version 1.0	Contact Hours: 60	3	1	0	4
Pre-requisites/Exposure	10+2 Science				
Co-requisites	-				

Course Objectives

1. To conceptualize the characteristics of central dogma.
2. To conceptualize about the pattern of gene expression, regulation and mutation.
3. To acquire the knowledge about restriction and modification system and cloning vectors of recombinant DNA technology.
4. To acquire the knowledge about amplification and analysis of gene in *in vivo* and *in vitro* system.
5. To gain the knowledge about genetically modified organisms, biosafety rules and ethics.

Course Outcomes

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

CO1: **Describe** the fundamental processes of DNA replication, transcription, and translation, and their mechanisms in prokaryotes and eukaryotes.

CO2: **Explain** the molecular mechanisms of gene regulation, including both prokaryotic operons and eukaryotic regulatory elements.

CO3: **Analyze** various DNA repair mechanisms and their implications for genomic stability and human diseases.

CO4: **Illustrate** post-transcriptional modifications and their impact on gene expression, including capping, splicing, polyadenylation, and RNA editing.

CO5: **Evaluate and assess** the role of molecular biology techniques in biotechnology applications, including the use of genomic and proteomic tools for research and industry.

Catalog Description

Molecular biology is the branch of biology that concerns the molecular basis of biological activity in and between cells, including molecular synthesis, modification, mechanisms and interactions. The central dogma of molecular biology describes the process in which DNA is transcribed into RNA then translated into protein. William Astbury described molecular biology in 1961 in Nature, as:
...not so much a technique as an approach, an approach from the viewpoint of the so-called

basic sciences with the leading idea of searching below the large-scale manifestations of classical biology for the corresponding molecular plan. It is concerned particularly with the forms of biological molecules and is predominantly three-dimensional and structural – which does not mean, however, that it is merely a refinement of morphology. It must at the same time inquire into genesis and function. Some clinical research and medical therapies arising from molecular biology are covered under gene therapy whereas the use of molecular biology or molecular cell biology in medicine is now referred to as molecular medicine. Molecular biology also plays important role in understanding formations, actions, and regulations of various parts of cells which can be used to efficiently target new drugs, diagnose disease, and understand the physiology of the cell. Recombinant DNA (rDNA) molecules are DNA molecules formed by laboratory methods of genetic recombination (such as molecular cloning) to bring together genetic material from multiple sources, creating sequences that would not otherwise be found in the genome. Recombinant DNA is the general name for a piece of DNA that has been created by combining at least two fragments from two different sources. Recombinant DNA is possible because DNA molecules from all organisms share the same chemical structure, and differ only in the nucleotide sequence within that identical overall structure. Recombinant DNA molecules are sometimes called chimeric DNA, because they can be made of material from two different species, like the mythical chimera. R-DNA technology uses palindromic sequences and leads to the production of sticky and blunt ends.The DNA sequences used in the construction of recombinant DNA molecules can originate from any species. For example, plant DNA may be joined to bacterial DNA, or human DNA may be joined with fungal DNA. In addition, DNA sequences that do not occur anywhere in nature may be created by the chemical synthesis of DNA, and incorporated into recombinant molecules. Using recombinant DNA technology and synthetic DNA, literally any DNA sequence may be created and introduced into any of a very wide range of living organisms. Proteins that can result from the expression of recombinant DNA within living cells are termed recombinant proteins. When recombinant DNA encoding a protein is introduced into a host organism, the recombinant protein is not necessarily produced. Expression of foreign proteins requires the use of specialized expression vectors and often necessitates significant restructuring by foreign coding sequences. Recombinant DNA differs from genetic recombination in that the former results from artificial methods in the test tube, while the latter is a normal biological process that results in the remixing of existing DNA sequences in essentially all organisms. However, the goal of this paper to analyse the artificially created recombinant DNA and expression of their genes.

Course Content

UNIT I REPLICATION AND REPAIR (Contact Hours – 12)

Replication in prokaryotes and eukaryotes: Mechanism, Model: Replication-theta model, strand displacement model and rolling circle model, structure and function of different Enzymes in DNA replication. Initiation, Elongation & Termination of replication; Proof reading activity, 5’ to 3’ exonuclease activity, Telomeric DNA replication and Plasmid. Inhibitors of DNA replication; RNA replication. DNA Repair in Prokaryotes and Eukaryotes: Nucleotide excision repair, base excision repair, mismatch repair, photo-reactivation repair, recombination repair and SOS repair. Repair defects and human diseases

UNIT II TRANSCRIPTION AND POST TRANSCRIPTIONAL MODIFICATIONS (Contact Hours – 12)

Components of transcriptional machinery in prokaryotes and eukaryotes: Structure of mRNA,

promoter, RNA polymerases and transcription factors, terminators. Process of transcription in prokaryotes and eukaryotes: Initiation, Elongation & Termination of transcription (Rho dependent and independent). Post transcriptional processing of RNA: capping, splicing (different types), polyadenylation and RNA editing. mRNA stability. Inhibitors of transcription. Reverse transcription. Ribozyme.

UNIT III TRANSLATION AND POST TRANSLATIONAL PROCESSING (Contact Hours – 12)

Components translational machinery in prokaryotes and eukaryotes: structure and function of ORF, tRNA, rRNA, aminoacyl synthetases, Ribosomes, RBS). Process of Translation in prokaryote and eukaryote: Initiation, Elongation & Termination. Concept of genetic code and Wobble hypothesis. Post translational modifications of protein, Protein folding, Protein targeting and degradation, Inhibitors of translation. Principles protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast, and nucleus.

UNIT IV GENE REGULATION (Contact Hours – 12)

Molecular structure of genes and its nomenclature. Principle of gene regulation: negative and positive regulation, inducer, repressor, co-repressor, activators, co-activators, silencers, insulators, enhancers, DNA binding protein-protein interacting domain of gene regulatory protein. Gene regulation in prokaryote: concept of operon model, (lac, trp and ara operon), Phage regulatory strategy and antitermination in lambda phage. Gene regulation in eukaryotes: DNA looping model, hormonal control of gene expression (steroid and non steroid), regulations at level of translation, riboswitch, gene silencing. Regulatory proteins (Transcription factors)- DNA-binding motif of regulatory proteins. Role of zinc fingers, leucine zippers, helix-turn-helix.

UNIT V APPLICATIONS (Contact Hours – 12)

Importance of genome projects, human genome project, Sequence component of eukaryotic genome, satellite, microsatellite and minisatellite DNA; physical mapping by building clone contigs, genomic libraries, YAC, BAC libraries. General organization of human genome. An overview of gene expression in human cells, genetic markers, principles and strategies in identifying disease genes, application of sequence information for identification of defective genes.

Reference Books

1. From Genes to Genomes by Jeremy W. Dale and Malcolm von Schantz, 2002, John Text books:
2. Molecular Biology of the Gene – by Watson
3. Gene IX by B. Lewin.
4. Essentials of molecular Biology, by Malacinski and Freifelder Jones and Bartlelt Publishers.
5. Molecular and Cellular Biology- by Stefen Wolfe
6. Genomes, by T. A. Brown, John Wiley and Sons PTE Ltd.
7. Cell and molecular Biology, Concepts and experiments by Gerald Karp, John Wiley and Sons.
8. The Cell - A molecular approach, by Gm Cooper Asm Press.Principles of Gene Manipulation, An Introduction to Genetic Engineering Old R.W.Primrose SB, - Blackwell Scientific Publications.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	**50**	**50**

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Describe** the fundamental processes of DNA replication, transcription, and translation, and their mechanisms in prokaryotes and eukaryotes.	**PO1, PO2, PO3,PO4,PO5, PO6, PO7, PO8, PO9, PO11**
CO2	**Explain** the molecular mechanisms of gene regulation, including both prokaryotic operons and eukaryotic regulatory elements.	**PO1, PO2, PO3,PO4,PO5, PO6, PO7, PO8, PO9, PO11**
CO3	**Analyze** various DNA repair mechanisms and their implications for genomic stability and human diseases.	**PO1, PO2, PO3,PO4,PO5, PO6, PO7, PO8, PO9, PO11**
CO4	**Illustrate** post-transcriptional modifications and their impact on gene expression, including capping, splicing, polyadenylation, and RNA editing.	**PO1, PO2, PO3,PO4,PO5, PO6, PO7, PO8, PO9, PO11**
CO5	**Evaluate and assess** the role of molecular biology techniques in biotechnology applications, including the use of genomic and proteomic tools for research and industry.	**PO1, PO2, PO3,PO4,PO5, PO6, PO7, PO8, PO9, PO11**

		Academic Excellence	Critical Thinking	Skills	Modern Tools and Techniques Usage	Problem Solving	Analysis	Proper Solutions	Professional	Collaboration	Sustainability	Ethics
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
BIT11072	Molecular Biology											

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11074	**Bioinformatics**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	PLUS TWO LEVEL SCIENCE				
Co-requisites	--				

Course Objectives

1. To provide those students with apt the knowledge to bioinformatics
2. It will also provide in depth knowledge of the general database, and biological databases.
3. Elaborating the alignment techniques
4. Explore the knowledge of the applications of bioinformatics

Course Outcomes

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

CO 1. Remembering: Students will be able to recall the basics of bioinformatics databases, including their types, functions, and importance in biological research.
CO 2. Understanding: Students will be able to explain the principles behind the design and implementation of bioinformatics databases, as well as the process of data retrieval and analysis.
CO 3. Applying: Students will be able to utilize various bioinformatics database tools to access, retrieve, and analyze biological data for research purposes.
CO 4. Analyzing: Students will be able to compare and contrast different bioinformatics databases and tools, evaluating their strengths, limitations, and potential applications in research.
CO 5. Evaluating: Students will be able to integrate and assess the quality and reliability of data obtained from bioinformatics databases, assessing its relevance and significance in addressing specific research questions.

Catalog Description

The core-course of 'Bioinformatics' will help to understand the introductory level knowledge to bioinformatics tools, biological database, sequence alignments. This course is an beginning to the bioinformatics, the application of different bioinformatics methods to biological data analysis, and some current research activities in the field of bioinformatics. Furthermore, the possible applications of bioinformatics would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Bioinformatics [BIT11074]

Unit I **(Contact Hours – 12)**

Introduction & NCBI:

Internet basics; Connecting to internet; Email; FTP; www; NCBI; BIOSEQ's, BIOSEQ sets, SEQ-ANNOT, SEQ-DESCR.

Unit II **(Contact Hours – 12)**

Biological databases:

Biological databases; primary sequence databases; Composite sequence databases; Secondary databases; composite protein pattern databases; structure classification databases; Genome Information Resources; DNA sequence databases; specialized genomic resources.

Unit III **(Contact Hours – 12)**

Alignment techniques:

Pairwise Alignment Technique; Database searching; algorithms & programs; comparing two sequences; identity & similarity; global & local alignments; pairwise database searching; Multiple sequence Alignment; computational Complexity; Manual methods; Simultaneous methods; Progressive methods; Databases of multiple alignment; Secondary database searching; Analysis packages.

Unit IV **(Contact Hours – 12)**

Protein analysis:

Protein identity based on composition, Motifs & patterns; secondary structure prediction; specialized secondary structures; tertiary structures; Overview of artificial intelligence, machine-learning, and deep learning.

Unit V **(Contact Hours – 12)**

Introduction to perl:

Using PERL to facilitate biological analysis; Strings, numbers, variables; Basic input and output; File handles; Conditional Blocks and loops; Pattern matching; Arrays-Hashes..

SUGGESTED BOOKS:

1 Andreas D Baxevanis and B F Francis," Bioinformatics- A practical guide to analysis of Genes & Proteins", John Wiley, 2002.

2 T K Attwood and D J Parry-Smith," Introduction to Bioinformatics", Pearson Education, 1st edition, 2005.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remembering: Students will be able to recall the basics of bioinformatics databases, including their types, functions, and importance in biological research.	**PO1, PO2**
CO2	Understanding: Students will be able to explain the principles behind the design and implementation of bioinformatics databases, as well as the process of data retrieval and analysis.	**PO1, PO2,PO3**
CO3	Applying: Students will be able to utilize various bioinformatics database tools to access, retrieve, and analyze biological data for research purposes.	**PO1, PO2, PO3**

CO4	Analyzing: Students will be able to compare and contrast different bioinformatics databases and tools, evaluating their strengths, limitations, and potential applications in research.	**PO1, PO2, PO5, PO6**
CO5	Evaluating: Students will be able to integrate and assess the quality and reliability of data obtained from bioinformatics databases, assessing its relevance and significance in addressing specific research questions.	**PO1, PO2, PO3, PO5, PO8**

		Academic excellence	Critical thinking	Skill	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11 074	**Bioinform atics** (THEOR Y)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

BIT11107	**BIOETHICS, BIOSAFETY & IPR (THEORY)**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology and concept of innovation.				
Co-requisites	--				

Course Objectives

1. To provide the students with understanding of components and process of obtaining protection using IPR.
2. It will also discuss various aspects of bioethics
3. To study the scope of entrepreneurship development using biotechnology and imbibe skills.

Course Outcomes

On completion of this course,
CO1. **Define** the concept of Intellectual Property Rights (IPR) and its significance in the field of biotechnology.
CO2. **Interpret** the provisions of various agreements and treaties governing IPR in the context of biotechnology.
CO3. **Apply** the effectiveness of safety protocols and regulations in ensuring responsible conduct in biotechnology research.
CO4. **Evaluate** and propose bioethical, biosafety and IPR guidelines for research and bio-entrepreneurship activities in the biotechnology sector.
CO5. **Integrate and assess** the ethical dilemmas faced by biotechnologists in balancing innovation and ethical considerations.

Catalog Description

The core-course of bioethics, IPR and biological patent is a core course that discusses various concepts of IPR along with its background, history and method of obtaining them. This is a fundamental course that would help students to be aware of the legal protection of innovation and innovative products. Several bio-ethical concepts are also discussed to provide critical appraisal on various biological processes. The scope of entrepreneurship utilizing biotechnological ideas are also dealt in this course.

Course Content

BIOETHICS, BIOSAFETY & IPR (BIT11107)

Unit I. Intellectual Property Right (IPR)
1. Concept and provisions of IPR Lecture hours 15
Patents, Trademarks, Copyright, Conditional information, Breeder's right. Patent; importance, types, scope, criteria, applying for a patent. Protection of Biotechnological inventions. Patent infringement- meaning, scope, litigation, case studies and examples
2. Agreements and Treaties History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT

Unit II. Safety in Biotechnology Lecture hours 10
Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines , Overview of Biotechnology Regulations and relevant International Agreements including Cartegana Protocol.

Unit III. Bioethics Lecture hours 8
Biotechnology information, communication and public perception, Future prospects of consumers and social acceptance .Case studies

Unit IV. Bio-entrepreneurship Lecture hours 12

Support mechanism for entrepreneurship in India; Leadership skills; Managerial skills; Team building; team work;. Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks. Information technology for business administration, E-business setup and management.

Suggested Books:

1. The Ethics of Biotechnology by Jonathan Morris, 2005
2. Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology by Barry R. Schaller, 2007
3. Nexus of Law and Biology: New Ethical Challenges by Barbara Ann Hocking, 2009
4. Intellectual Property and Biotechnology: Biological Inventions by Matthew Rimmer, 2008
5. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology by Padma Nambisan, 2017
6. Biotechnology Entrepreneurship by Craig Shimasaki, 2014

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Define** the concept of Intellectual Property Rights (IPR) and its significance in the field of biotechnology.	**PO1, PO2, PO3, PO4, PO5, PO6, PO11**
CO2	**Interpret** the provisions of various agreements and treaties governing IPR in the context of biotechnology.	**PO1, PO2, PO3, PO11**
CO3	**Apply** the effectiveness of safety protocols and regulations in ensuring responsible conduct in biotechnology research.	**PO1, PO2, PO3, PO4,**

		PO5, PO6, PO7, PO11
CO4	**Evaluate** and propose bioethical, biosafety and IPR guidelines for research and bio-entrepreneurship activities in the biotechnology sector.	**PO2, PO3, PO7, PO8, PO9, PO10, PO12**
CO5	**Integrate and assess** the ethical dilemmas faced by biotechnologists in balancing innovation and ethical considerations.	

		Academic Excellence	Critical Thinking	Skills	Modern Tools and Technique usage	Problem Solving	Analysis	Proper Solution	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11107	**BIOETHICS, BIOSAFETY & IPR**												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	3	3	3	3	3	2
CO2	3	3	3	3	2	3	2	2	2	2	3	2
CO3	3	3	2	3	3	3	3	3	2	2	3	3
CO4	3	2	2	3	3	3	3	3	3	3	3	3
CO5	3	2	2	2	3	3	3	3	3	3	3	3
Average	3	2.6	2.4	2.8	2.6	3	2.8	2.8	2.6	2.6	3	2.6

Course Title	Professional elective I	L	T	P	C
Course Code BIT11075	Genomics, Proteomics & Metabolomics	2	1	0	3
Contact Hours	45				
Pre-requisites/Exposure	Basic knowledge of Biochemistry				

Course Objectives

5. The course aims to explain the students the fundamental concepts of technologies relevant to Genomics and Proteomics, their applications and illustrate skills to apply the knowledge to solve problems.
6. At the end of the course students should be able to explain fundamental methodologies of genomic and proteomic and they would be able to propose suitable methods for analysis of given sample with respect to purpose of study.

Course Outcomes

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

CO1. Remembering:
- List the major applications of genomics, proteomics, and metabolomics in biological research

CO2. Understanding:
- Compare and contrast the methodologies used in genomics, proteomics, and metabolomics

CO3. Applying:
- Design experiments to investigate specific biological questions using genomics, proteomics, and metabolomics techniques

CO4. Analyzing:
- Analyze genomic, proteomic, and metabolomic datasets to identify patterns and trends

CO5. Evaluating:
- Integrate and develop strategies for improving the accuracy and reliability of genomic, proteomic, and metabolomic data

Course Description

Genomics & Proteomics deals with the rapidly evolving scientific area that introduces students into genomes and proteomes of different organisms and shows how to apply the information to solve critical problems genes, proteins, genomes and proteomes. This course provides a extensive overview of the goals, methods, and applications for genomics and proteomics in the life sciences field.

Course Content

Genomics, Proteomics & Metabolomics (BIT11075)

UNIT I **(10 hrs)**

Introduction to Genomics: DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Oxford Nanopore next generation sequencing, and computational tools for sequencing projects: Genome sequence assembly software.

UNIT II **(8 hrs)**

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III **(20 hrs)**

Introduction to protein structure & Proteomics: Chemical properties of proteins. Physical interactions that determine the property of proteins; short-range interactions; electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation. Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

UNIT IV **(7 hrs)**

Metabolomics: Metabolites - primary and secondary, Microbial secondary metabolites. Concept of Metabolomics: definition and importance; environmental metabolomics, exometabolomics, Metabonomics.

Books & Other Resources

Text Book(s)	
T1	Introduction to Genomics 2nd eds by Arthur M. Lesk. Oxford University Press, 2012.
T2	Introduction to Proteomics by Daniel. C. Liebler, Humana press, 2002
T3	The Handbook of Metabonomics and Metabolomics 1st eds by John C. Lindon
T4	Genomics and Proteomics: Principles

T = Text Book

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**

CO1	Remembering: - List the major applications of genomics, proteomics, and metabolomics in biological research	**PO1, PO2, PO5, PO6**
CO2	Understanding: - Compare and contrast the methodologies used in genomics, proteomics, and metabolomics	**PO1, PO2, PO4, PO7**
CO3	Applying: - Design experiments to investigate specific biological questions using genomics, proteomics, and metabolomics techniques	**PO2, PO3, PO4, PO5, PO6, PO7, PO9**
CO4	Analyzing: - Analyze genomic, proteomic, and metabolomic datasets to identify patterns and trends	**PO3, PO4, PO5, PO6, PO8, PO10**
CO5	Evaluating: - Integrate and develop strategies for improving the accuracy and reliability of genomic, proteomic, and metabolomic data	**PO3, PO4, PO8, PO9, PO11, PO12**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11075	Genomics, Proteomics & Metabolomics (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	1	-	1	-	-	-
CO2	3	3	2	3	3	3	3	-	1	-	-	-
CO3	3	3	3	3	3	3	3	-	1	-	-	-
CO4	3	3	3	3	3	3	3	-	1	-	-	-

CO5	3	3	3	3	2	3	3	-	1	-	-	-
Average	3	3	2.8	3	2.8	3	2.8	-	1	-	-	-

Course Title	**Professional elective I**	**L**	**T**	**P**	**C**
Course Code BIT11076	**Recombinant DNA Technology**	**2**	**1**	**0**	**3**
Contact Hours	**45**				
Pre-requisites/Exposure	**12th level Science**				

Course Objectives

1. To provide basic concepts of Recombinant DNA Technology.
2. To provide basic understanding of the molecular biology and gene manipulation techniques.
3. Elaborating genetic engineering strategies in plants, gene editing concepts in human.

Course Outcomes

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

No.	**Course Outcomes**
CO1	Students can **explain** the structure and function of cloning vectors.
CO2	Students can **demonstrate** various PCR techniques.
CO3	Students can **illustrate** the gene cloning process, summarise library preparation, blotting techniques.
CO4	Students can **compare** and contrast between cloning and expression vectors.
CO5	Students can **integrate and assess** specific gene cloning/manipulation technique to be executed in various types of cells.

CO = Course Outcomes

Catalog Description:
In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for the study of DNA and proteins. In the laboratory students will apply theory and practical skills from this and previous courses to perform standard molecular biology techniques for the isolation, manipulation and analysis of DNA as well as the expression and purification of protein. Students will be assisted in career development through instruction and practice in resume-writing and interview skills, and will be exposed to different biotechnology job possibilities via a number of special interest seminars and/or company tours.

Course Content

Recombinant DNA Technology (BIT11076)

UNIT I **(15 hrs)**

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT II **(10 hrs)**

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription, Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT III **(10 hrs)**

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT IV **(10 hrs)**

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Books & Other Resources

Text Book(s)	
T 1	**Text Book:** 1. From genes to genomes concepts and applications of DNA technology by Jere my W dale and Malcolm von Scrantz, 2011 2. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard Glick 2009
T 2	**Reference Book:** 1. Genomes 3 by T.A. Brown, 2006 2. Principles of Gene Manipulation and Genomics by Sandy Primrose and Twyman, 2006

T = Text Book; R = Reference Book

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students can **explain** the structure and function of cloning vectors.	**PO1, PO2**
CO2	Students can **demonstrate** various PCR techniques.	**PO1, PO2,PO3**
CO3	Students can **illustrate** the gene cloning process, summarise library preparation, blotting techniques.	**PO1, PO2, PO3, PO4**
CO4	Students can **compare** and contrast between cloning and expression vectors.	**PO1, PO2, PO5, PO6, PO8, PO12**
CO5	Students can **integrate and assess** specific gene cloning/manipulation technique to be executed in various types of cells.	**PO1, PO2, PO3, PO5, PO7, PO8, PO11**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11076	Recombinant DNA Technology (PE-THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

BIT11079	**Professional elective II Nanobiotechnology** (THEORY)	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	Basic biochemistry and bio-analytical tools				
Co-requisites	--				

Course Objectives:

- To **understand** the fundamental principles of nanoscience and classify nanomaterials
- To **apply** various methods for synthesis of nanomaterials
- To **analyse** synthesized nanomaterials
- To **understand** the design of naturally occurring nanosystems
- To **integrate and assess** the concepts of nanotechnology for different biological applications

Course Outcomes

On completion of this course,

CO1	Knowledge: Define nanobiotechnology and explain its significance in various fields such as medicine, agriculture, and energy. Recognize the fundamental principles of nanotechnology and understand how they are applied in nanobiotechnology
CO2	Comprehension: Explain the potential benefits and risks associated with the use of nanomaterials in biological systems
CO3	Application: Apply the principles of nanobiotechnology to design and develop innovative solutions for drug delivery, diagnostic imaging, and tissue engineering
CO4	Analysis: Analyze current research trends and technologies in nanobiotechnology, and assess their impact on healthcare, environment, and industry
CO5	Evaluation: Evaluate and assess of nanobiotechnology-based solutions in addressing specific challenges in healthcare, agriculture, and environmental sustainability

Course Description:

This course will cover the biotechnology and biomedicine applications of nanotechnology world. The methods used for nanotechnology and nanofabrication, medical and biotechnological applications, future of nanobiotechnology, and its use in diagnostics, nanofabrication, and nanostructures such as gold, silver and carbon nanotubes will be covered in addition to molecular production methods, nano-molecular interactions, molecular transport, self-assembly process, hybrid species through addition of nanomaterials to biological

molecules, Development of nano-scale nanobots and quandom dots based nanosensors, is another upcoming important areas of biological science with an application in many fields of medicinal science.

Course Content:

Nanobiotechnology (BIT11079)

UNIT I: 10 Lecture hours

Introduction: Interconversion of units, concept of surface area to volume ratio and aspect ratio. Difference between surface area to volume ratio of bulk materials and nanomaterials (sphere, hollow sphere, rods, hollow rods, cubes and hollow cubes) and related numerical problems. Classification of nanomaterials: 0D, 1D, 2D and 3D. Different classes of nanomaterials: Quantum dots, Quantum wires, Carbon nanotubes, Bucky balls, Fullerenes.

UNIT II 15 Lecture hours

Synthesis: Top-Down fabrication methods –Types of Top-Down fabrication methods: mechanosynthesis, thermal, high energy, lithography-concepts with examples only).
Bottom-Up fabrication methods-Types of Bottom-Up fabrication methods: chemical and biological methods of nanomaterial synthesis-concepts with examples only.
Concept of reducing and capping agents, introduction to biomolecules as reducing and capping agents.

UNIT III 5 Lecture hours

Characterization techniques- X-ray diffraction (XRD) technique, Dynamic light scattering, Applications of XRD, Introduction to Optical microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, UV visible spectroscopy, Infrared Spectroscopy and Fourier Transform Infrared Spectroscopy.

UNIT IV 10 Lecture hours

Biological nanosystems: Naturally found nanoparticles: viruses, exosomes, magnetosomes, lipoproteins, ferritin; Molecular motors: natural molecular motors like myosin, kinesin, dynein, flagella, ATP synthase, helicases, topoisomerases etc. Ion channels as molecular switches,.

UNIT V 10 Lecture hours

Biological applications: Nanostructures for drug delivery: Concepts, targeting, routes of delivery & advantages; Nanostructures for diagnostics & biosensors; Nanoparticles for diagnostics and imaging; nanomedicine; nanostructures for tissue engineering; nanoparticles for photodynamic/ photothermal therapy; nanobiosensors; DNA based nano devices.

Suggested Books

1. Bionanotechnology by David S. Goodsell, 2004, Wiley Publications.
2. Nanobiotechnology: Concepts, Applications and Perspectives by Christof M. Niemeyer, Chad A. Mirkin. ISBN: 978-3-527-30658-9. Wiley VCH, 2004.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term

Weightage (%)	**50**	**50**

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO-1	Knowledge: Define nanobiotechnology and explain its significance in various fields such as medicine, agriculture, and energy. Recognize the fundamental principles of nanotechnology	**PO1, PO2**
CO-2	Comprehension: Explain the potential benefits and risks associated with the use of nanomaterials in biological systems	**PO1, PO3, PO4**
CO-3	Application: Apply the principles of nanobiotechnology to design and develop innovative solutions for drug delivery, diagnostic imaging, and tissue engineering	**PO3, PO4, PO5**
CO-4	Analysis: Analyze current research trends and technologies in nanobiotechnology, and assess their impact on healthcare, environment, and industry	**PO1, PO4, PO6**
CO-5	Evaluation: Evaluate and assess the effectiveness and efficiency of nanobiotechnology-based solutions in addressing specific challenges in healthcare, agriculture, and environmental sustainability	**PO2, PO3, PO5, PO8**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques	Problem Solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11 079	**Nanobiotech nology** (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11111	Profesional elective II Bioenergy for Sustainable Development	L	T	P	C
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	Preliminary knowledge about bioprocess engineering and environmental science from previous semesters				
Co-requisites	--				

Course Objectives

1. Students will be able to understand the effect of exploitation of different forms of energy and energy conservation.
2. Students will be able to understand the significance of energy conservation.
3. Students will be able to learn about the use of fuels and energy sources of biological origin and use bioreactors for that.
4. Students will understand the role of microorganisms in energy generation that can be utilized in large scale for human consumption.

Course Outcomes

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

1. Recognize the importance of bioenergy for sustainable development.
2. Interpret the role of biofuel in achieving energy security and environmental sustainability.
3. Implement sustainable practices in bioenergy production to minimize environmental impact.
4. Assess the challenges and opportunities in scaling up bioenergy technologies for widespread adoption.
5. Integrate and design strategies to optimize bioenergy systems for maximum impact on sustainable development goals.

Catalog Description

The professional elective course of 'energy engineering and biofuels' enables the students to understand and interpret the knowledge obtained for identification, isolation, preservation of different types of microorganisms of that can be cultured to generate renewable energy in large scale so that the exhaustion of conventional energy sources can be prevented. They will be able to design protocol for producing biotechnologically important production using different bioreactors and culture techniques that can be used as source of energy and fuels. Additionally, the students will also come to know about the detail procedures of industrial production of essential commodities with help of microorganisms and the advancement of enzyme technology. The concept gained by this course is also useful in application of biotechnology in extraction of coal and other fuels in an eco-friendly manner with reduced pollution on an industrial scale. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Bioenergy for Sustainable Development (BIT11111)

Unit 1 **[Lesson hours: 10]**

Energy: Renewable & non-renewable resources - Water, Minerals, & Energy; Use & overexploitation; Classification & Sources of Energy; Problems relating demand & supply of various energy sources; Coal, Petroleum etc.

Unit 2 **[Lesson hours: 10]**

Conventional & non-conventional energy: Conventional fuels; firewood, plant & animal wastes; coal, gas, animal oils & their environmental impact; Modern fuels - methanogenic bacteria & biogas; microbial hydrogen production; conversion of sugars to ethanol, the gasohol experiment; solar energy converters; photosynthetic pigments, plant based petroleum industry, cellulose degradation for combustible fuels & their environmental impacts.

Unit 3 **[Lesson hours: 10]**

Biogas plant & its design: KVIC plants, process kinetics, digester design, sludge treatment, energy from wastes, development in energy routes, energy engineering, biorefinery, and sustainable approaches.

Unit 4 **[Lesson hours: 10]**

Clean coal technology: Biotechnology & Microbiology of Coal Degradation; Aerobic & Anaerobic pathway of coal degradation; Characterization & identification of bioconversion substrates & products; Biosolubilization & bioliquefaction of coal; Biodesulfurisation of coal & oil; Mechanisms of coal biosolubilization; Enzymes that depolymerise coal; Recent Advances in Bioprocessing of coal.

Unit 5 **[Lesson hours: 5]**

Green technology – microbial fuel cell: From Microbes to Megawatts; Microbial Fuel Cells; Types of Biological fuel cells; Applications of Biological Fuel cells;

Text Books

1. Bioenergy and Biofuels by Ozcan Konur, 2017 by CRC Press. ISBN 9781138032811

2. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms,14th edition, Pearson-Bejamin Cummings

3. Prescott & Dunn's Industrial Microbiology by G Reed, 2004

Reference Books

1. Biofuels and Bioenergy: Processes and Technologies by Sunggyu Lee and Y.T. Shah. 2012 by CRC Press, ISBN 9781420089554.

2. Biotechnology. U Satyanarayan

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recognize the importance of bioenergy for sustainable development.	**PO1, PO2**
CO2	Interpret the role of biofuel in achieving energy security and environmental sustainability.	**PO1, PO2, PO3**
CO3	Implement sustainable practices in bioenergy production to minimize environmental impact.	**PO3, PO4, PO6**
CO4	Assess the challenges and opportunities in scaling up bioenergy technologies for widespread adoption.	**PO4, PO5, PO6, PO8**
CO5	Integrate and design strategies to optimize bioenergy systems for maximum impact on sustainable development goals.	

		Academic excellence	Critical thinking	Skill Development	Modern tools and technique usage	Problem Solving	Analysis	Proper Solutions	Professional Development	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT1111	Bioenergy for Sustainable Development (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

Course Title	**Molecular Biology Lab**	**L**	**T**	**P**	**C**
Course Code	**BIT12081**	**0**	**0**	**4**	**2**
Contact Hours	**45**				
Pre-requisites/Exposure	**10+2 level Biology**				

Course Objectives

1. To provide basic concepts of buffer preparation to be used for different practical.
2. To provide advanced concepts and theories of Molecular biology techniques.
3. Elaborating new advanced techniques related to isolation and quantification of Nucleic acids from various sources.

Course Outcomes

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

No.	Course Outcomes
CO1	**Perform** standard molecular biology techniques such as DNA extraction, PCR, gel electrophoresis, and sequencing, demonstrating hands-on proficiency in laboratory procedures.
CO2	**Analyze** experimental data to interpret results from molecular biology experiments, including quantification of nucleic acids and proteins.
CO3	**Apply** techniques for gene cloning, expression analysis, and mutation detection to real-world biological problems, showcasing practical skills in molecular manipulation.
CO4	**Demonstrate** the use of laboratory equipment and software for molecular biology applications, including spectrophotometers, thermal cyclers, and data analysis tools.

CO5	**Evaluate and assess** experimental protocols and troubleshoot technical issues in molecular biology experiments, ensuring accuracy and reliability of results.

CO = Course Outcomes

Catalog Description:
In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for the study of DNA. In the laboratory students will apply theory and practical skills from this and previous courses to perform standard molecular biology techniques for the isolation, manipulation and analysis of DNA and also the basic techniques of DNA cloning. The students will gain an in depth understanding of different modern molecular biology techniques in order to design an analytical work-flow to acquire data and achieve the research objectives of their project.

Course Content

Molecular Biology Lab (BIT12081)

Topic	Contact hours
Preparation of Agarose gel.	3hrs
Isolation of Genomic DNA from blood, plant cell and bacteria (any one). Estimation of DNA content in the given sample.	4 hrs
Isolation of Plasmid DNA.	4 hrs
Gel electrophoresis of DNA.	3 hrs
Demonstration of Polymerase Chain Reaction; (A). Setting up PCR reaction; (B). Analysis of amplified product	6hrs
Digestion of DNA and clean-up of DNA for ligation; (B). Setting up DNA ligation; (C). Preparation of culture media, pouring Plates and streaking of *E.coli*; (D). Evaluation of transformants and preparation of glycerol stocks; (E). Demonstration of electroporation	6 hrs
Induced mutation by: (a) Chemical (b) Ultraviolet light.	4 hrs
Restriction digestion of DNA.	4 hrs
Ligation of digested of DNA.	4 hrs
Polyacrylamide gel electrophoresis	4 hrs
Phage Titration.	4 hrs
Demonstration of DNA sequencing; (A). Setting up sequencing reactions; (B). Casting sequencing gel; (C). Gel electrophoresis & autoradiography. (D). Reading sequencing from X-ray film	3 hrs

Books & Other Resources

Text Book(s)

T1	**Text Book:** 1. From genes to genomes concepts and applications of DNA technology by Jeremy W dale and Malcolm von Scrantz, 2011 2. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard Glick 2009
T2	**Reference Book:** 1. Genomes 3 by T.A. Brown, 2006 2. Principles of Gene Manipulation and Genomics by Sandy Primrose and Twyman, 2006

T = Text Book; R = Reference Book

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Perform** standard molecular biology techniques such as DNA extraction, PCR, gel electrophoresis, and sequencing, demonstrating hands-on proficiency in laboratory procedures.	**PO1, PO2**
CO2	**Analyze** experimental data to interpret results from molecular biology experiments, including quantification of nucleic acids and proteins.	**PO1, PO2,PO3**
CO3	**Apply** techniques for gene cloning, expression analysis, and mutation detection to real-world biological problems, showcasing practical skills in molecular manipulation.	**PO1, PO2, PO3, PO4**
CO4	**Demonstrate** the use of laboratory equipment and software for molecular biology applications, including spectrophotometers, thermal cyclers, and data analysis tools.	**PO1, PO2, PO5, PO6, PO7, PO8**
CO5	**Evaluate and assess** experimental protocols and troubleshoot technical issues in molecular biology experiments, ensuring accuracy and reliability of results.	**PO1, PO2, PO3, PO5, PO8, PO12**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Data Analysis	Proper solution	Professional Development	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT12081	Molecular Biology Lab (Practical)												

1=weakly mapped,

2= moderately mapped,

3=strongly mapped

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT12083	**Bioinformatics Lab**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	0	0	4	2
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	--				

Course Objectives

1. To provide students with hands-on activities designed to encourage interest in the field of bioinformatics, as well as promote greater understanding of the concepts presented in lecture.

2. Students will need to become proficient with terms, techniques, and applications.

Course Outcomes

On completion of this course,

CO 1. Remembering:
- Recall the fundamental concepts of bioinformatics
- Memorize essential biological databases and tools used in bioinformatics
- Identify common bioinformatics analysis techniques

CO 2. Understanding:
- Interpret and explain the principles behind bioinformatics tools and algorithms
- Understand the significance of bioinformatics in genomics, proteomics, and other biological fields
- Comprehend the ethical and legal issues related to bioinformatics research

CO 3. Applying:
- Utilize bioinformatics software and databases to analyze biological data
- Apply statistical methods to interpret bioinformatics results
- Implement various bioinformatics protocols in laboratory experiments

CO 4. Analyzing:
- Evaluate the quality of bioinformatics data and results
- Compare and contrast different bioinformatics tools for specific research questions
- Analyze complex biological problems using bioinformatics approaches

CO 5. Evaluating:
- Critically assess the validity and reliability of bioinformatics analyses
- Judge the appropriateness of bioinformatics tools for specific research tasks
- Formulate recommendations for improving bioinformatics analyses based on evaluation.

Catalog Description

Bioinformatics Lab (Practical) is the overall learning and application of the knowledge of using different modern tools and techniques in the field of bioinformatics. This course covers laboratory techniques describes different modern practical methods related to Bioinformatics such as retrieval of genes, sequence alignment of DNA and proteins, predict protein secondary and tertiary structure of protein. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Bioinformatics Lab (PRAC TICAL) [BIT12083]

1 Knowledge about nucleotide Databases. **(Contact Hours – 6)**

2 Knowledge about Protein databases. **(Contact Hours – 5)**
3 Literature survey through Pubmed. **(Contact Hours – 4)**
4 Local similarity search. **(Contact Hours – 5)**
5 Global similarity search. **(Contact Hours – 5)**
6 Gene prediction and translation. **(Contact Hours – 5)**
7 Protein sequence analysis. **(Contact Hours – 5)**
8 Protein secondary structure prediction. **(Contact Hours – 5)**
9 Homology Modelling. **(Contact Hours – 5)**

SUGGESTED BOOKS:

1. Ghosh Z. and Bibekanand M, Bioinformatics: Principles and Applications. OxfordUniversity Press. (2008)
2. Pevsner J, Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell. (2009)
3. Campbell A. M., Heyer L. J. Discovering Genomics, Proteomics and Bioinformatics. IIEdition. Benjamin Cummings. (2006)
4. Andreas D Baxevanis and B F Francis," Bioinformatics- A practical guide to analysis of Genes & Proteins", John Wiley, 2002.
5. T K Attwood and D J Parry-Smith," Introduction to Bioinformatics", Pearson Education, 1st edition, 2005.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remembering: - Recall the fundamental concepts of bioinformatics - Memorize essential biological databases and tools used in bioinformatics - Identify common bioinformatics analysis techniques	**PO1, PO2, PO3**
CO2	Understanding: - Interpret and explain the principles behind bioinformatics tools and algorithms - Understand the significance of bioinformatics in genomics, proteomics, and other biological fields - Comprehend the ethical and legal issues related to bioinformatics research	**PO1,po4, PO10, PO11**
CO3	Applying: - Utilize bioinformatics software and databases to analyze biological data - Apply statistical methods to interpret bioinformatics results - Implement various bioinformatics protocols in laboratory	**PO1, PO2, PO3, PO4, PO8**

	experiments	
CO4	Analyzing: - Evaluate the quality of bioinformatics data and results - Compare and contrast different bioinformatics tools for specific research questions - Analyze complex biological problems using bioinformatics approaches	**PO1, PO3. PO6, PO9**
CO5	Evaluating: - Critically integrate and assess the validity and reliability of bioinformatics analyses - Judge the appropriateness of bioinformatics tools for specific research tasks - Formulate recommendations for improving bioinformatics analyses based on evaluation.	**PO1, PO4, PO8, PO12**

		Academic excellence	Critical thinking	Skill	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT1283	**Bioinformatics Lab**												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	3	-	-	3
CO2	-	3	3	1	3	3	3	3	3	-	-	3
CO3	-	3	3	1	3	3	3	3	3	-	-	3
CO4	-	3	3	1	3	3	3	3	3	-	-	3
CO5	-	3	3	1	3	3	3	3	3	-	-	3
Avg	-	3	3	1	3	3	3	3	3	-	-	3

Course Title	Professional elective I Lab Genomics, Proteomics & Metabolomics Lab	L	T	P	C
Course Code	BIT12077	0	0	4	2
Contact Hours	60				
Pre-requisites/Exposure	Basic knowledge of Biochemistry Lab				

Course Objectives

1. To provide students with hands-on activities designed to encourage interest in the field of genomics & proteomics, as well as promote greater understanding of the concepts presented in lecture.
2. Students will become proficient with terms, techniques, and applications in genomics & proteomics.

Course Outcomes

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

CO1. **demonstrate** concepts of genomics & proteomics with easy-to-run experiments.
CO2. **explain** basic laboratory instruments and understand principles underlying measurements using those instruments for experiments in genomics & proteomics.
CO3. **develop** skills to identify and analyze various genomes and proteomes, and as well to carryout functional comparison.
CO4. **construct** experiments to isolate and manipulate nucleic acids and proteins.
CO5. **demonstrate and assess** use of various techniques for purification of proteins, nucleic acids, etc.

Course Description

Genomics is the study of entire genomes, including the complete set of genes, their nucleotide sequence and organization, and their interactions within a species and with other species. The advances in genomics have been made possible by DNA sequencing technology. Proteomics is the large-scale study of proteins. Proteins are vital parts of living organisms, with many functions. The proteome is the entire set of proteins that is produced or modified by an organism or system. Proteomics has enabled the identification of ever increasing numbers of protein. The student will perform various experiments involving genomes and proteomes in the laboratory course to better understand how biomacromolecules works within cell.

Course Content

Genomics, Proteomics & Metabolomics Lab (BIT12077) [5 hrs each experiment]

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database

5. Softwares for Protein localization.
6. Agarose gel electrophoresis.
7. Native PAGE
8. SDS-PAGE
9. Genome comparison in bacteria, Proteome comparison in bacteria

Reference Books

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
2. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Demonstrate** concepts of genomics & proteomics with easy-to-run experiments.	**PO1, PO2, PO3**
CO2	**Explain** basic laboratory instruments and understand principles underlying measurements using those instruments for experiments in genomics & proteomics.	**PO1, PO3, PO4, PO5, PO6**
CO3	**Develop** skills to identify and analyze various genomes and proteomes, and as well to carryout functional comparison.	**PO1, PO2, PO3, PO5, PO6, PO7, PO8**
CO4	**Construct** experiments to isolate and manipulate nucleic acids and proteins.	**PO1, PO4, PO5. PO6, PO7, PO8, PO9, PO11**
CO5	**Demonstrate and assess** the use of various techniques for purification of proteins, nucleic acids, etc.	**PO1, PO3, PO4, PO8, PO10**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT12 077	Genomics, Proteomics & Metabolomics Lab												-

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

Course Title	Professional elective I Lab Recombinant DNA Technology Lab	L	T	P	C
Course Code	BIT12078	0	0	4	2
Contact Hours	15 weeks × 3 hr = 45 hr				
Pre-requisites/Exposure	12th level English				

Course Objectives

1. To provide basic concepts of Nucleic acid isolation.
2. To provide basic understanding of Nucleic acid quantification.
3. Elaborating molecular cloning strategies.

Course Outcomes

On completion of this course

No.	Course Outcomes
CO1	Students can gather **rxplaination** about how to isolate DNA from various sources.
CO2	Students can **demonstrate** the process of RNA isolation.
CO3	Students can **illustrate** the gene cloning and bacterial transformation process
CO4	Students can **compare** and contrast between various blotting techniques.
CO5	Students can perform PCR and **interpret** the data.

CO = Course Outcomes

Catalog Description:
In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for the study of DNA and proteins. In the laboratory students will apply theory and practical skills from this and previous courses to perform standard molecular biology techniques for the isolation, manipulation and analysis of DNA as well as the expression and purification of protein. Students will be assisted in career development through instruction and practice in resume-writing and interview skills, and will be exposed to different biotechnology job possibilities via a number of special interest seminars and/or company tours.

Course Content

Recombinant DNA Technology Lab (BIT12078)

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*.
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation

5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR.

Books & Other Resources

Text Book(s)	
T1	**Text Book:** 1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K. 2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA. 3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington 4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
T2	**Reference Book:** 1. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

T = Text Book; R = Reference Book

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam
Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students can gather **rxplaination** about how to isolate DNA from various sources.	**PO1, PO2, PO4**
CO2	Students can **demonstrate** the process of RNA isolation.	**PO1, PO2, PO3, PO4**
CO3	Students can **illustrate** the gene cloning and bacterial transformation process	**PO1, PO2, PO3, PO5**
CO4	Students can **compare** and contrast between various blotting techniques.	**PO1, PO2, PO4, PO5, PO6, PO7**
CO5	Students can perform PCR and **interpret** the data.	**PO1, PO2, PO3, PO5, PO7, PO10**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT12 078	Recombinant DNA Technology Lab												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

BIT14115	Professional Development Training -III (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	Completion of PDT-II course				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G

1. Interview Skills.
2. Aptitude and Technical Skills.
3. Group Discussion and Communication Skills.
4. Personal Branding and Online Presence.
5. Professional Skills.
6. Industry Insights and Company Presentations.
7. Career Guidance for competitive entrance exams and Job Search Strategies
8. Mock Tests and Assessments.

Course learning outcomes:

CO1: Students will be able to **create** professional resumes and cover letters tailored to specific job applications, demonstrating effective resume-building techniques.

CO2: Students will **analyze** various interview scenarios to identify key strategies for successfully navigating different types of interview questions and formats.

CO3: Students will **apply** their aptitude and technical skills to solve real-world problems through mock tests and assessments, showcasing their problem-solving abilities.

CO4: Students will **evaluate** their personal branding and online presence, making necessary adjustments to enhance their professional image on platforms like LinkedIn.

CO5: Students will **demonstrate** effective communication skills in group discussions, presentations, and professional interactions, ensuring clear and confident expression of ideas.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	**50**	**50**

CO\PO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12
CO 1	1	0	0	0	0	0	0	3	0	0	0	0
CO 2	0	1	0	0	0	0	0	2	0	0	0	0
CO 3	0	0	3	0	3	3	0	0	0	0	0	0
CO 4	0	0	0	0	0	0	0	0	0	0	0	2
CO 5	0	2	0	0	0	0	0	0	0	0	0	0

SEMESTER VI

BIT11085	Immunotechnology	L	T	P	C
Version 1.0	Contact Hours - 45	2	1	0	3
Pre-requisites/Exposure	Intermediate level science				
Co-requisites	--				

Course Objectives:

1. To provide basic understanding of our immune system and its medical implication.
2. To provide basic understanding B-cell, T-cell, antibody structure and their interaction with antigen.
3. To provide basic understanding of the activation, mechanism and regulation of the immune system and Host pathogen interaction.

Course Outcomes

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

CO1. **Define** the basic concepts of immunology including the immune system, antigen-antibody interactions, and the role of innate and adaptive immunity
CO2. **Describe** the mechanisms of immune responses at the molecular level, including the functions of cytokines, complement system, and major histocompatibility complex
CO3. **Analyze** the experimental techniques used to study the fundamental principles of immunology, such as ELISA, flow cytometry, and Western blotting
CO4. **Evaluate** the significance of immunotechnology in various fields such as diagnostics, therapeutics, and biotechnology
CO5. **Integrate and develop** critical skills to do experiments and interpret data related to immunology and make connections to real-world applications

Catalog Description:

Immunology and Medical Biotechnology course will provide an through understanding of the principles and mechanisms of the immune system and immune responses in the context of infection, malignancy and immunological disorders. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

IMMUNOTECHNOLOGY (BIT11085)

Unit I **9 Lecture Hours**

The immune system:
Innate & adaptive immunity, comparative immunity; cells & organs; Antigens.

Unit II **15 Lecture Hours**

Immunoglobulin structure & functions:

Basic structures of Immunoglobulins; Ig classes & biological activities; Antigenic determinants on Ig, B Cell receptor, Monoclonal, polyclonal antibodies; cytokines; complement system, MHC Antigen processing and presentations.

Unit III **7 Lecture Hours**

Leukocyte migration & inflammation; hypersensitive reactions; immune response to

infections and diseases;

Unit IV **5 Lecture Hours**

Immune response to infectious and non-infectious diseases; Monoclonal antibodies; vaccines

UnitV **9 Lecture Hours**

Antigen – antibody interactions:
Antibody Affinity & activity; Precipitation reactions; agglutination reactions; Radio immunoassay; ELISA; Western blotting; Immunoprecipitation, Immunofluroscence, immunoelectron microscopes; flow cytometry

Reference Books:

1. Kuby Immunology by Richard A. Golds by Tharmas J. kindt fourth edition 2000 and Barbara Osborne. W.H.freeman and company.
2. Fundamental Immunology 7th Edition by William E. Paul. Publisher: LWW-2012

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Define** the basic concepts of immunology including the immune system, antigen-antibody interactions, and the role of innate and adaptive immunity	**PO1, PO2, PO5, PO6,**
CO2	Describe the mechanisms of immune responses at the molecular level, including the functions of cytokines, complement system, and major histocompatibility complex	**PO1, PO2, PO5, PO6, PO3**
CO3	Analyze the experimental techniques used to study the fundamental principles of immunology, such as ELISA, flow cytometry, and Western blotting	**PO1, PO2, PO3, PO4, PO5, PO6, PO7**
CO4	Evaluate the significance of immunology in various fields such as diagnostics, therapeutics, and biotechnology	**PO1, PO2, PO4, PO5, PO6, PO7**

CO5	Integrate and develop critical skills to do experiments and interpret data related to immunology and make connections to real-world applications	**PO1, PO8, PO9, PO10, PO11, PO12**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11085	Immunotechnology (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	3	3	3	3	2	2
CO2	3	3	2	3	2	3	2	2	2	2	2	2
CO3	3	3	2	3	3	3	3	3	2	2	2	3
CO4	3	2	2	3	3	3	3	3	3	3	2	3
CO5	3	2	2	2	3	3	3	3	3	3	3	3
Average	3	2.6	2.2	2.8	2.6	3	2.8	2.8	2.6	2.6	2.2	2.6

Course Title	Plant & Agricultural Biotechnology	L	T	P	C
Course Code	BIT11128	2	1	0	3
Contact Hours	45				
Pre-requisites/Exposure	12th level Science				

Course Objectives

1. To provide advanced concepts of Plant and Agricultural Biotechnology.
2. Elaborating genetic engineering gene editing in human, overexpression of recombinant proteins, cutting-edge sequencing technologies and their applicationsin plant and agriculture field.

Course Outcomes

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

No.	Course Outcomes
CO1	Students will be able to **summarize** different aspects of plant growth and development.
CO2	Students will be able to **interpret** the various Plant Biotechnology techniques and their application.
CO3	Students will be able to to **demonstrate** Plant Tissue Culture Techniques.
CO4	Students will be able to illustrate **Plant Genetic Engineering**
CO5	Students will be able to **integrate and assess** the concepts of Intellectual Property Rights and Biosafety in Plant Biotechnology

CO = Course Outcomes

Catalog Description:

In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for the study of the different techniques of gene transfer and target proteins expression control. In the laboratory students will apply theory and practical skills from this and previous courses to perform standard molecular biology techniques for the isolation, manipulation and analysis of DNA as well as the expression and purification of protein mainly in plant system to improve the growth and productivity of crops. Students will be assisted in career development through instruction and practice in resume-writing and interview skills, and will be exposed to different biotechnology job possibilities via a number of special interest seminars and/or company tours. The students will gain an in depth

understanding of this important techniques in order to design an analytical work-flow to acquire data and achieve the research objectives of their project.

Course Content

Plant & Agricultural Biotechnology (BIT11128)

Unit I. Different aspects of plant growth and development (9 Lectures)

- Introduction to different parts of a typical angiosperm plant
- Important biosynthesis pathways responsible for plant growth and development.
- Plant growth regulators and their roles.
- Plant secondary metabolism.

Unit II. Introduction to Plant Biotechnology (9 Lectures)

- Introduction to plant biology and its significance in biotechnology
- Historical development and milestones in plant biotechnology
- Applications of plant biotechnology in agriculture, horticulture, and medicine
- Ethical and social considerations in plant biotechnology

Unit III. Plant Tissue Culture Techniques (9 Lectures)

- In vitro plant propagation: micropropagation and somatic embryogenesis
- Callus culture and organogenesis
- Suspension culture and cell culture techniques
- Synthetic seed production
- Cryopreservation of plant cells and tissues

Unit IV. Plant Genetic Engineering (9 Lectures)

- Genetic transformation methods in plants
- Types of genes needs for plant transformation
- Agrobacterium-mediated gene transfer
- Physical methods of transformation
- Transcriptomics, proteomics, and metabolomics in plants

Unit V. Intellectual Property Rights and Biosafety in Plant Biotechnology (9 Lectures)

- Patenting and intellectual property issues in plant biotechnology
- Biosafety regulations and risk assessment in GM crops
- Coexistence of GM and non-GM crops

- Public perception and communication of plant biotechnology

Books & Other Resources

Suggested Books:

1. Plant Biotechnology: The Genetic Manipulation Of Plants by Adrian Slater, 2003
2. Biotechnology in Agriculture by Swaminathan, 2009
3. Plant Biotechnology by William G. Hopkins, 2006
4. Plants, Biotechnology and Agriculture (Modular Texts) by Denis Murphy, 2011.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students will be able to **summarize different aspects of plant growth and development.**	**PO1, PO2**
CO2	Students will be able to **interpret** the various Plant Biotechnology techniques and their application.	**PO1, PO2,PO3**
CO3	Students will be able to **demonstrate** Plant Tissue Culture Techniques.	**PO1, PO2, PO3, PO4**
CO4	Students will be able to illustrate **Plant Genetic Engineering.**	**PO1, PO2, PO5, PO6, PO7, PO8**
CO5	Students will be able to **integrate and assess** the concepts of Intellectual Property Rights and Biosafety in Plant Biotechnology	**PO1, PO2, PO3, PO5, PO8, PO12**

		Fundamental Knowledge	Critical thinking	Skill Development	Modern tools and techniques	Research	Problem Solving	Data Analysis	Professional Development	Collaboration	Life Long Learning	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11128	Plant & Agricultural Biotechnology												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11087	**Animal Biotechnology**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	--				

Course Objectives

1. To provide students with apt introductory level knowledge to animal biotechnology.

2. It will also provide in depth knowledge of Animal Cell Culture and foreign gene expression.
3. Elaborating the Characteristics of cells in culture and IVF
4. Explore the knowledge of Gene transfer, Gene therapy &Transgenics

Course Outcomes

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

CO1. Knowledge:
- Define the basic principles of animal cell culture and its applications in biotechnology.

CO2. Comprehension:
- Compare and contrast different methods of animal cell culture and their respective advantages and limitations.

CO3. Application:
Formulate an IVF protocol for enhancing reproductive success in animals.

CO4. Analysis:
- Evaluate the advantages and disadvantages of different gene transfer techniques in terms of efficiency and safety.

CO5. Evaluation:
Integrate and assess the ethical considerations and societal implications of using transgenic animals in biotechnological research and applications.

Catalog Description

The core-course of 'Animal Biotechnology' will help to understand the introductory level knowledge to animal biotechnology, and its importance. This course includes comprehensive approach such as Gene transfer, Gene therapy &Transgenics. Furthermore, the ethical issues in animal biotechnology would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

ANIMAL BIOTECHNOLOGY (BIT11087)

Unit I. Basic Animal Cell Culture:

Equipments & materials for animal cell culture technology; Primary cell culture, Establishment of cell line, Maintenance and Preservation of cell line; Culture medium; natural media, synthetic media, sera. Introduction to balanced salt solutions & simple growth medium. Brief discussion on the chemical, physical & metabolic functions of different constituents of culture medium; role of carbon dioxide, and supplements.

Unit II. Advanced culture techniques:

Various systems of tissue culture and their distinguishing features- advantages & limitations.

Co-culturing, Protocols for 3D culturing of cells, Basics of tissue engineering-scaffolds and matrices.

Unit III. Gene transfer and Gene therapy:
Methods of gene transfer- Physical, Chemical, and Biological; Principles of Ex vivo and In vivo gene therapy, Applications of cell fusion- Hybridoma Technology.

Unit IV. Assisted Reproductive Technology:
Artificial insemination and germ cell manipulation, In Vitro fertilization and Embryo transfer Technology; Ethical issues.

Unit V. Transgenic Animals:
Concepts of Transgenic Animals; Strategies for the production of transgenic animals and their importance in Biotechnology; Production of Vaccines in animal Cells.

Textbook:
1.. Animal Biotechnology by M.M. Ranga, 2007
2. Textbook of Animal Biotechnology by Carlos Wyatt, 2016
3. Introduction to Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney Sixth Edition. Publisher, John Wiley & Sons, 2011.

Reference books:
1. An Introduction to Genetic Engineering by Desmond S.T. Nicholl, 2002
2. Genetic Engineering by WAGmob, 2013
3. Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies by Richard Twine, 2010.
4. Molecular Biotechnology by Glick, 2010
5. Stem Cells: A Short Course by Rob Burgess, 2015

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes

CO 1	Knowledge: - Define the basic principles of animal cell culture and its applications in biotechnology.	**PO1, PO2**
CO 2	Comprehension: - Compare and contrast different methods of animal cell culture and their respective advantages and limitations.	**PO1, PO2,PO3**
CO 3	Application: Formulate an IVF protocol for enhancing reproductive success in animals.	**PO1, PO2, PO3**
CO 4	Analysis: - Evaluate the advantages and disadvantages of different gene transfer techniques in terms of efficiency and safety.	**PO1, PO2, PO5, PO6**
CO 5	Evaluation: Integrate and assess the ethical considerations and societal implications of using transgenic animals in biotechnological research and applications.	**PO1, PO2, PO3, PO5, PO8**

		Academic excellence	Critical thinking	Skill	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11087	**Animal Biotechnology** (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT11091	Professional elective III Medical Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 45	2	1	0	3
Pre-requisites/Exposure	PLUS TWO LEVEL SCIENCE				
Co-requisites	--				

Course Objectives

- To provide those students with apt the knowledge to Medical Biotechnology
- It will also provide in depth knowledge of the Immunodiagnostics & therapy
- Elaborating the clinical research
- Explore the knowledge of the medical biotechnology

Course Outcomes

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

CO1. Students will be able to **explain** basic of medical biotechnology and its techniques.
CO2. Students will be able to **demonstrate** the immunodiagnostics & therapy.
CO3. Students will be able to **illustrate** the knowledge of use of enzymes in clinical diagnosis & kit development
CO4. Students will be able to **explain** clinical research
CO5. Students will be able to **integrate and assess** the applications of medical biotechnology and current research activities in the field of medical biotechnology

Catalog Description

The core-course of 'medical biotechnology' will help to understand the introductory level knowledge to medical biotechnology, different kind of diagnostics and therapeutics. This course is a beginning to the medical biotechnology, the application of medical biotechnology, and some current research activities in the field of medical biotechnology. Furthermore, the clinical research in the field of medical biotechnology would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Medical Biotechnology [BIT11091]

Unit I **(Contact Hours – 9)**

Immunodiagnostics & therapy:

Hybridoma technology; Antibody markers, CD Markers, FACS, HLA typing; Bioassays. Therapeutic Antibodies; types of ELISA, problems & prospects from mouse. Vaccine - types; Vaccine technology, DNA vaccine, Vaccines for AIDS & cancer; DNA & RNA based diagnostics & therapy; PCR, PCR/OLA procedures, RFLP, SSCP; Microarrays, FISH, In-situ hybridization; Genotyping; Case studies related to bacterial, viral & parasitic infections.

Unit II **(Contact Hours – 9)**

Applications:

Gene Therapy; Antisense RNA therapy, Ribozyme therapy; status, problems & prospects; Use

of proteomics in protein based biomarkers in disease diagnosis (eg. cancer); development & future prospects.

Unit III **(Contact Hours – 9)**

Use of enzymes in clinical diagnosis & kit development:

Principle of diagnostic enzymology, determination and use of enzyme; enzyme activities for clinical diagnosis; Liver, cardiac & Kidney enzymes, Digestive enzymes, Miscellaneous enzymes & their general function tests; Biosensors - types & applications of biosensor.

Unit IV **(Contact Hours – 9)**

Clinical Research:

Milestones of regulations; FDA, US, Indian clinical research; global scenario of clinical research; Designing clinical trials; principles, scheme for conducting clinical trials; planning defining, objectives, variables, study populations, testable hypothesis, prediction of errors & bioselection of appropriate study design, Execution steps.

Unit V **(Contact Hours – 9)**

Ethical Issues in clinical research; codes, declaration & guidelines; Informed concent, special issues, Roles & responsibilities of IRBS, issues with ethics review; ICH-GCP - History of ICH, Objectives, ICH structure, Guidelines & Future of ICH.

SUGGESTED BOOKS:

1. Griffiths et al, Modern genetic analysis, 2nd Edition, Freeman, 2002.
2. Alberts et al, Molecular Biology of The Cell, 2nd Edition , Garland 2007
3. Kuby J. (1997), Immunology, 3rd Edition, W.H. Freeman & Co., New York
4. Gupta P.K. (2003), Biotechnology and Genomics, Rastogi Publications Meerut

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students will be able to **explain** basic of medical biotechnology and its techniques.	**PO1, PO2**
CO2	Students will be able to **demonstrate** the immunodiagnostics & therapy.	**PO1, PO2,PO3**
CO3	Students will be able to **illustrate** the knowledge of use of enzymes in clinical diagnosis & kit development	**PO1, PO2, PO3**
CO4	Students will be able to **explain** clinical research	**PO1, PO2, PO5, PO6**

CO5	Students will be able to **integrate and assess** the ethics in medical biotechnology and clinical research	**PO1, PO2, PO3, PO5, PO8**

		Academic excellence	Critical thinking	Skill	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11091	**Medical Biotechnology (THEORY)**												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

BIT11101	PE-IIII Advances in Crop Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 45	2	1	0	3
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	--				

Course Description:

This course aims to provide students with an understanding of the principles, techniques, and applications of biotechnology in the context of crop improvement and agricultural practices. The course will cover various aspects of crop biotechnology, including genetic engineering, tissue culture, plant breeding, and molecular marker-assisted selection. Students will also learn about the ethical, social, and environmental considerations associated with crop biotechnology.

Course Objectives

- To introduce the principles and concepts of crop biotechnology.
- To develop an understanding of genetic engineering techniques used in crop improvement.
- To familiarize students with plant tissue culture and its applications in crop production.
- To provide knowledge of molecular marker-assisted selection and its role in crop breeding.
- To discuss the ethical, social, and environmental implications of crop biotechnology.

Course Outcomes

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

No. **Course Outcomes**

CO1. Remembering:
- Identify key terms and concepts related to crop biotechnology.

CO2. Understanding:
-Explain the concepts of gene editing, transgenic crops, and marker-assisted selection in crop biotechnology.

CO3. Applying:
-Apply the various techniques of plant tissue culture to propagate and genetically modify crops for improved traits.

CO4. Analysing:

Interpret the significance of molecular markers in crop improvement programs.

CO5. Evaluating:

Design and implement innovative strategies for integrating biotechnology with smart crop management for improved agricultural production outcomes

Catalog Description:

In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for the study of the different techniques of gene transfer and target proteins expression control. In the laboratory students will apply theory and practical skills from this and previous courses to perform standard molecular biology techniques for the isolation, manipulation and analysis of DNA as well as the expression and purification of protein mainly in plant system to improve the growth and productivity of crops. Students will be assisted in career development through instruction and practice in resume-writing and interview skills, and will be exposed to different biotechnology job possibilities via a number of special interest seminars and/or company tours. The students will gain an in depth understanding of these important techniques in order to design an analytical work-flow to acquire data and achieve the research objectives of their project.

Course Content

Advances in Crop Biotechnology (BIT11101)

Unit 1 Introduction to Crop Biotechnology [Lesson hours: 10]

- Overview of biotechnology in crop improvement
- Historical developments in crop biotechnology
- Role of crop biotechnology in sustainable agriculture
- Social and economic impacts of crop biotechnology
- Environmental risk assessment and biosafety regulations.

Unit 2 Genetic Engineering in Crop Improvement [Lesson hours: 13]

- Techniques for gene transfer in plants using chloroplast engineering
- Genetic engineering for stress tolerance in crops
- Genetically modified organisms (GMOs) and their applications in crops
- Ethical issues related to genetically modified crops.

Unit 3 Plant Tissue Culture for crop improvement [Lesson hours: 12]

- Introduction to plant tissue culture techniques
- Micropropagation and its applications in crop production
- Various techniques of tissue culture use for crop improvement (haploid culture, triploid culture, protoplast culture)
- Plant bioreactors for value added crop production.

Unit 4 Molecular Plant Breeding and Marker-Assisted Selection [Lesson hours: 10]

- Basics of Molecular Plant Breeding
- Genomic Selection and Breeding
- Applications of molecular marker-assisted selection in crop breeding
- Marker-assisted selection for disease resistance and abiotic stress tolerance
- CRISPR-Cas9 and other genome editing techniques in plants

Unit 5 Smart crop management [Lesson hours: 10]

- Understanding IoT and its applications in crop improvement.

- Using Biosensors in crop improvement program
- Futuristic crop improvement using soilless agriculture (Hydroponics, Aquaponics and Aeroponics) techniques.
- Autonomous vehicles and drones for crop monitoring and spraying
- Integrated Pest Management (IPM) principles in smart agriculture.

Books & Other Resources

1) Plant Biotechnology by Adrian Slater, Nigel W. Scott, and Mark R. Fowler
2) Introduction to Plant Biotechnology by H. S. Chawla
3) Principles of Plant Genetics and Breeding by George Acquaah
4) Crop Improvement: Challenges and Prospects by Pawan Kumar Jaiwal and Rana Pratap Singh

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**CO1. Remembering:** - Identify key terms and concepts related to crop biotechnology.	**PO1, PO2**
CO2	**CO2. Understanding:** -Explain the concepts of gene editing, transgenic crops, and marker-assisted selection in crop biotechnology.	**PO1, PO2,PO3**
CO3	**CO3. Applying**: -Apply the various techniques of plant tissue culture to propagate and genetically modify crops for improved traits.	**PO1, PO2, PO3, PO4**
CO4	**CO4. Analysing**: Interpret the significance of molecular markers in crop improvement programs.	**PO1, PO2, PO5, PO6, PO7, PO8**
CO5	**CO5. Evaluating:** Design and implement innovative strategies for integrating biotechnology with smart crop management for improved agricultural production outcomes.	**PO1, PO2, PO3, PO5, PO8, PO12**

		Academic excellence	Critical Thinking	Skills	Modern Tools and Techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11 101	**Advances in Crop Biotechnology**												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

BIT11093	Open elective I Advances in Microbial Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 45	2	1	0	3
Pre-requisites/Exposure	10+2 Science				
Co-requisites	--				

Course Objectives

1. To provide advanced concepts of microorganisms association with biotechnology.
2. Elaborating genetic engineering gene editing in microorganisms to enable a better response for a particular work like waste treatment agricultural aspects or in human health.

Course Outcomes

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

No.	Course Outcomes
CO1	Remembering: Recall key concepts and principles in microbial biotechnology, including the role of microorganisms in various industrial processes.
CO2	Understanding: Demonstrate comprehension of advanced techniques used in microbial biotechnology, such as genetic engineering and metabolic engineering.
CO3	Applying: Apply knowledge of microbial biotechnology to solve complex problems in industries like pharmaceuticals, agriculture, and environmental remediation.
CO4	Analyzing: Evaluate research articles and case studies in microbial biotechnology to identify trends, challenges, and potential innovations in the field.
CO5	Evaluating: Integrate and assess the ethical implications and societal impacts of advances in microbial biotechnology, including concerns related to biosecurity and bioterrorism.

Catalog Description:
In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for implementing changes in microorganisms to make them more useful in different ways. Students will be assisted in career development through instruction and practice in resume-writing and interview skills, and will be exposed to different biotechnology job possibilities via a number of special interest seminars and/or company tours. The students will gain an in depth understanding of these important techniques in order to design an analytical work-flow to acquire data and achieve the research objectives of their

project.

Course Content

ADVANCES IN MICROBIAL BIOTECHNOLOGY (BIT11093)

Unit 1 **[Lesson hours: 8]**

Microbial biotechnology, scope and techniques, Bioprospecting of microbial diversity, Isolation and preservation of industrially important microorganisms. Genomics, Transcriptomics, Proteomics Metabolomics, metagenomics and Systems Biology .

Unit 2 **[Lesson hours: 10]**

Production of proteins and enzymes in bacteria yeast and fungus, recombinant and synthetic vaccines. Microbial polysaccharides and polyesters Microbes as biocontrol agents microbial insecticides (Baculoviruses,entomopathogenic fungi, Bacillus thurinigiensis Bacillus sphaericus Bacillus popilae, Microbe derived inhibitors.

Unit 3 **[Lesson hours: 10]**

Microbial biomass production, utilization of plant biomass by microorganisms (lignocellulose biodegradation), ethanol production, amino acids, antibiotics .Biotransformation of steroid and non steroid compounds, metabolic engineering.

Unit 4 **[Lesson hours: 10]**

Biology of nitrogen fixation, preparation of different, Types of inoculants (nitrogen fixers phosphate solubilizers, plant growth promoting rhizobacteria, PGPR, composting.

Unit-5 **[Lesson hours: 7]**

Introduction to the use of microbes in environmental applications, Bioremediation, bioaugemntation, Bioemulsifiers, biosurfactants, MEOR, Leaching of ores. Microbial fuels (Methane, Hydrogen).

Books & Other Resources

1. Plant Biotechnology: The Genetic Manipulation Of Plants by Adrian Slater, 2003
2. Biotechnology in Agriculture by Swaminathan, 2009
3. Plant Biotechnology by William G. Hopkins, 2006
4. Plants, Biotechnology and Agriculture (Modular Texts) by Denis Murphy, 2011

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remembering: Recall key concepts and principles in microbial biotechnology, including the role of microorganisms in various industrial processes.	**PO1, PO2**
CO2	Understanding: Demonstrate comprehension of advanced techniques used in microbial biotechnology, such as genetic engineering and metabolic engineering.	**PO1, PO2,PO3**

CO3	Applying: Apply knowledge of microbial biotechnology to solve complex problems in industries like pharmaceuticals, agriculture, and environmental remediation.	**PO1, PO2, PO3, PO4**
CO4	Analyzing: Evaluate research articles and case studies in microbial biotechnology to identify trends, challenges, and potential innovations in the field.	**PO1, PO2, PO5, PO6, PO7, PO8**
CO5	Evaluating: Integrate and assess the ethical implications and societal impacts of advances in microbial biotechnology, including concerns related to biosecurity and bioterrorism.	**PO1, PO2, PO3, PO5, PO8, PO12**

		Fundamental Knowledge	Critical thinking	Skill Development	Modern tools and techniques	Research	Problem Solving	Data Analysis	Professional Development	Collaboration	Life Long Learning	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11093	**Advances in Microbial Biotechno Logy**												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

BIT11102	**Protein Engineering** (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	Basic biochemistry and Bioinformatics				
Co-requisites	--				

Course Objectives:

1. To enable students with rational and combinatorial methods of protein engineering.
2. To train students for critical analysis of data and conclude it from primary literature.
3. To understand the basic and applied techniques associated with protein structure observation and engineering.
4. To enable the students for converse at an advanced level about current key topics in the field of protein engineering

Course outcome:

The students will be able

CO1. To **demonstrate** in detail basic concepts of protein engineering and able to explain application based knowledge

CO2. To **discuss** different pathways responsible for protein stability, folding and degradation

CO3. To **analyze** the principle and application of different techniques used for elucidation of protein structures.

CO4. To learn and **utilize** different computational methods important to study the protein structures.

CO5. To **assess** and **evaluate** the output data of various computational analysis protein structures, Protein-protein docking and Protein folding.

Course Description:

This course will cover a current understanding about the application of protein science and engineering techniques in Pharmaceutical, Biotechnology and Food-tech industries. The course objective is to give the students the in-depth understanding and skills necessary for analysing the protein structures and correlate them with their function to establish the structure-function relationship of molecule with a huge application in novel drug designing and development. The another important objective of this course to trained students about the different computational methods regarding molecular docking and molecular modelling of protein molecules along with analysis of output data. Students will also learn the concepts and strategies of Directed laboratory evolution and rational protein designing to understand the protein's structure-function correlation and for therapeutic applications

Course Content:

Protein Engineering (BIT11102)

UNIT I **20 Lecture hours**

Protein engineering: Introduction to steps of Protein design & Engineering; protein splicing & its application; Solid-phase peptide synthesis; Production of Novel Proteins; Random & site-directed mutagenesis; Expressing Recombinant Proteins; classification of Proteins structures; Crystallography & X-Ray Diffraction; Spectroscopy - UV-VIS, NMR & Fluorescence Spectroscopy & Calorimetric Methods; Industrial applications of Protein Engineering; Design of polymeric biomaterials; nicotinic acetylcholine receptors as a model for a super family of ligand; gated ion channel proteins.

UNIT II **25 Lecture hours**

Protein stability & folding: Overview of protein structure; higher level structure, Protein stability; Mechanism of protein folding (types, level, thermodynamics, Anfinsen's dogma, Levinthol paradox and kinetics); Ramchandran plot; Folding Rate; Molten globule; Techniques for studying of protein folding; NMR, CD spectroscopy; Proteolysis, Optical tweezers; Computational method; Location & functions of Molecular chaperones, chaperonin & co-chaperons, HSP chaperone system in *E. coli* and Human; Proteasomes & proteosome mediated protein degradation; Protein folding errors; Alzheimer's, prions & Mad Cow (BSE, CJD); Cystic Fibrosis & cancer. Polyketides & non-ribosomal peptides; Combinational manipulation of polyketides & non-ribosomal peptides; application of protein folding to design new drug.

Suggested Books

1. Protein Engineering Methods and Protocols by Bornscheuer, Uwe T., Höhne, Matthias (Eds.) Springer 2018.
2. Protein Engineering Handbook by Prof. Dr. Stefan LutzProf. Dr. Uwe T. Bornscheuer. Copyright © 2009 Wiley-VCH Verlag GmbH & Co. KGaA
3. Protein Engineering and Design by Sheldon J. Park, Jennifer R. Cochran. CRC press, Taylor & francis – 2009.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO-1	Students will be able to **demonstrate** in detail basic concepts of protein engineering and able to explain application based knowledge	**PO1, PO2**
CO-2	Students will be able to **discuss** different pathways responsible for protein stability, folding and degradation.	**PO1, PO3, PO4**
CO-3	Students will be able to **analyze** the principle and application of different techniques used for elucidation of protein structures.	**PO3, PO4, PO5**

CO-4	Students will be able to learn and **utilize** different computational methods important to study the protein structures.	**PO1, PO4, PO6**
CO-5	Students will be able to **assess and evaluate** the output data of various computational analysis protein structures, Protein-protein docking and Protein folding.	**PO2, PO3, PO5, PO8**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques	Problem Solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT1102	**Protein Engineering** (THEORY)												

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

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

BIT12088	IMMUNOTECHNOLOGY LAB (PRACTICAL)	L	T	P	C
Version 1.0	**Contact Hours - 45**	0	0	4	2
Pre-requisites/Exposure	Intermediate level science				
Co-requisites	--				

Course Objectives

1. to demonstrate and interpret different antigen-antibody interactions.
2. to acquaint with various components of the immune system and apply this knowledge in immunodiagnostics.
3. to apply various immunological techniques for clinical and research purpose.
4. to do quantitative/qualitative measurement of antigen/ antibody in different samples.
5. to analyze and assess antigen-antibody interaction

Course Outcomes

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

CO1. **Appraise** different antigen-antibody interactions.
CO2. **identify** different components of immune system in human system
CO3. **utilize** different immunological techniques for research and clinical purposes.
CO4. **Determine** and compare amount of antigen/antibody present in different samples
CO5. Analyse and **assess** antigen-antibody interaction

Catalog Description

The student will be able to use the knowledge obtained to perform and analyze different types of antigen-antibody interaction. Identification of different components of the immune system is possible with the concept obtained. Students will gain the ability to apply different immunological techniques for research and clinical purposes. All the experiments will be based on hands-on training in laboratory setup along with discussions of basic theories and advanced topics for practical implementation of knowledge. Classes will be conducted by hands-on lab training and/or audio-visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

IMMUNOTECHNOLOGY LAB (BIT12088)

Unit I **12 Lecture Hours**

1. Staining of Blood film; To study morphological & staining characteristics of different lymphocytes-neutrophils, monocytes, eosinophils, & basophils.

2. Total and differtial Leukocyte count

3. To understand stamp smear through permanent slides

Unit II **6 Lecture Hours**

4. Blood Grouping and determination of the Rh factor of given blood.

5. To perform serum separation

Unit III

6. To perform Radial Immunodiffusion assay **6 Lecture Hours**

Unit IV

7. To perform quantitative precipitation assay. **6 Lecture Hours**

Unit V

8. To perform dot-ELISA. **6 Lecture Hours**

Text Book(s)

1. Immunology Lab Manual by Wilmore Weberly, 2015
2. Immunology methods manual - The comprehensive source book by Lefkovits., 1996
3. Manual of clinical laboratory immunology by Rose NR, 2002
4. Laboratory Immunology by Bradshaw LJ.1997

Reference books

Owen, J.A.; Punt, J.; Kuby, J.; Stranford, S.A. Kuby immunology. W.H. Freeman: 2013.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Identify** different components of immune system in human system**.**	**PO2, PO3, PO5**
CO2	**Appraise** different antigen-antibody interactions.	**PO2, PO3, PO5**

CO3	**utilize** different immunological techniques for research and clinical purposes.	**PO2, PO4, PO5, PO7,PO8**
CO4	**Determine** and compare amount of antigen/antibody present in different samples	**PO2, PO5, PO6, PO8**
CO5	**Analyse** and **assess** antigen-antibody interaction	**PO2, PO4, PO5, PO8**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT12088	Immunotechnology lab (practical)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT12129	Plant & Animal Biotechnology Lab	L	T	P	C
Version 1.0	Contact Hours - 45	0	0	4	2
Pre-requisites/Exposure	10+2 SCIENCE				
Co-requisites	12th level English				

Course Objectives:

1. To provide students with hands-on activities designed to encourage interest in the field of Animal Biotechnology, as well as promote greater understanding of the concepts presented in lecture.
2. Students will be able to demonstrate and design with hands-on activities for applied plant tissue culture in laboratory;
3. Students will be able to implement acquired knowledge in commercial field in plant and Animal biotechnology.

Course Outcomes

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

CO1. Remembering:
Recall the steps involved in sterilization techniques for plant tissue culture, such as autoclaving, filtration, and chemical sterilization and contrast different types of media used in plant tissue culture, such as MS media, B5 media, and Woody Plant media, in terms of their composition and purpose.

CO2.
Understanding:
Understand the techniques of plant tissue culture experiments and troubleshoot any issues that may arise.

CO3. Applying:
- Demonstrate the proper techniques for culture maintenance and cryopreservation.

CO4. Analysing
Analyze and troubleshoot issues related to cell viability and growth in animal cell culture.

CO5. Evaluating:
Integrate and assess the quality and viability of tissue cultured plants after practice hardening and maintenance procedures.

Catalogue Description

Animal Biotehnology Practical (LAB) is all about animal cell culture procedure and application of in vitro cultures in research, drug discovery and other biotechnological fields. Students will learn about different animal cell structure and function, and how to maintain immortalized animal cell lines of various origins in *in vitro* conditions. This course covers laboratory techniques and biotechnological applications using animal cells. The very nature of Animal Biotechnology lab requires students to view different chromosomal structures and gene organization in different settings and to identify and describe them. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize

the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator. Plant Biotechnology Lab is a skill enhancement job-oriented course covers a vast range of technical tools for various tissue culture techniques and their applications by demonstration and hands on training. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms, such as analysis of video scenes and debates. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapers etc.

Course Content:	**45 hours**
I Organizing plant Tissue culture Laboratory	**5 hours**
II Preparation of Tissue Culture Media	**3 hours**
III Demonstration on various techniques of Plant tissue culture	**6 hours**
IV Isolation and Quantification of Plant DNA	**5 hours**
V Plant metabolomic study using bioinformatics tool	**4 hours**
VI Preparation of animal cell culture media & sterilization.	**6 hours**
VII MTT Assay.	**65hours**
VIII Live cell counting using hemocytometer	**5 hours**
IX Leukocyte/ Eukaryotic cell culture	**6 hours**

Text Books

1. Plant cell culture – A practical approach by Dixion RA. 1995
2. Trends in Insect Molecular Biology and Biotechnology by Chengliang Gong and Dhiraj Kumar. Publisher: Springer; 1st ed. 2018.
3. Animal Cell Culture and Technology (THE BASICS) by Michael Butler. Publisher: Taylor & Francis; 2nd – 2003.

Reference Books

1. Practical Botany, Volume II, S C Samanta
2. Animal cell culture by R. I. Freshney.
3. Animal Biotechnology by P. Ramadas.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remembering: Recall the steps involved in sterilization techniques for plant tissue culture, such as autoclaving, filtration, and chemical sterilization and contrast different types of media used in plant tissue culture, such as MS media, B5 media, and Woody Plant media, in terms of their composition and purpose.	**PO2, PO3, PO5**
CO2	Understanding: Understand the techniques of plant tissue culture experiments and troubleshoot any issues that may arise.	**PO2, PO3, PO5**
CO3	Applying: - Demonstrate the proper techniques for culture maintenance and cryopreservation.	**PO2, PO4, PO5, PO7,PO8**
CO4	Analysing Analyze and troubleshoot issues related to cell viability and growth in animal cell culture.	**PO2, PO5, PO6, PO8**
CO5	Evaluating: Integrate and assess the quality and viability of tissue cultured plants after practice hardening and maintenance procedures.	**PO2, PO4, PO5, PO8, PO10**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT12129	**Plant & Animal Biotechnology Lab**												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT15095	**Technical Seminar**	L	T	P	C
Version 1.0		0	0	2	2
Pre-requisites/Exposure	Knowledge about biotechnology and allied fields				
Co-requisites	-				

Course Objectives

1. Defining and outlining a research area with a clear question
2. Identifying the leading issues
3. Sourcing the relevant information
4. Assessing its reliability and legitimacy
5. Evaluating the evidence on all sides of a debate
6. Coming to a well-argued conclusion

Course Outcomes

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

CO1. Do critical review of literature and **design** and perform a new type of experiment.
CO2. **Summarize** the observation.
CO3. **Develop** the skill to make the data table.
CO4. **Conclude** the data
CO5. **Infer and assess** whether the data is really new or expected.

Catalog Description

Technical seminar allows students present their findings in response to a question or proposition that they choose themselves. The aim of the project is to test the independent research skills students have acquired during their time at university, with the assessment used to help determine their final grade. Although there is usually some guidance from your tutors, the dissertation project is largely independent.

Course Content

1. Reading of breakthrough and current research papers from high impact journals containing biotechnological/allied-field research work and also performance of laboratory- based research-oriented experiments/design/proposal.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Thesis	Presentation
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Do critical review of literature and **design** and perform a new type of experiment.	**PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO9, PO11**
CO2	**Summarize** the observation.	**PO1, PO2, PO5, PO6, PO7, PO8, PO10, PO11**
CO3	**Develop** the skill to make the data table.	**PO1, PO2, PO5, PO3, PO4, PO8, PO10**
CO4	**Conclude** the data	**PO4, PO6, PO8, PO10, PO11**
CO5	**Infer and assess** whether the data is really new or expected.	**PO1, PO2, PO4, PO6, PO8, PO9, PO10, PO11, PO12**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Data Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT15095	Technical Seminar	3	3		3	3	3		3		3	3	

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	2	-	-	-	2	-	3	1	3	3	3
CO2	-	2	-	-	-	2	-	3	1	3	3	3
CO3	-	2	-	-	-	2	-	3	1	3	3	3
CO4	-	2	-	-	-	2	-	3	1	3	3	3
CO5	-	2	-	-	-	2	-	3	1	3	3	3
Avg	-	2	-	-	-	2	-	3	1	3	3	3

BIT14116	Professional Development Training -IV (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	Completion of PDT-III course				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G)

1. Interview Skills.
2. Aptitude and Technical Skills.
3. Group Discussion and Communication Skills.
4. Personal Branding and Online Presence.
5. Professional Skills.
6. Industry Insights and Company Presentations.
7. Career Guidance for competitive entrance exams and Job Search Strategies
8. Mock Tests and Assessments.

Course learning outcomes:

CO1: Students will be able to **create** professional resumes and cover letters tailored to specific job applications, demonstrating effective resume-building techniques.

CO2: Students will **analyze** various interview scenarios to identify key strategies for successfully navigating different types of interview questions and formats.

CO3: Students will **apply** their aptitude and technical skills to solve real-world problems through mock tests and assessments, showcasing their problem-solving abilities.

CO4: Students will **evaluate** their personal branding and online presence, making necessary adjustments to enhance their professional image on platforms like LinkedIn.

CO5: Students will **demonstrate** effective communication skills in group discussions, presentations, and professional interactions, ensuring clear and confident expression of ideas.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	**50**	**50**

CO\PO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12
CO 1	1	0	0	0	0	0	0	3	0	0	0	0
CO 2	0	1	0	0	0	0	0	2	0	0	0	0
CO 3	0	0	3	0	3	3	0	0	0	0	0	0
CO 4	0	0	0	0	0	0	0	0	0	0	0	2
CO 5	0	2	0	0	0	0	0	0	0	0	0	0

SEMESTER VII

MGT11402	HSSM-V (Industrial Management)	L	T	P	C
Version 1.0	Contact Hours - 45	2	1	0	3
Pre-requisites/Exposure	BASIC SCIENCE				
Co-requisites	--				

Course Objective:

1. To enable students to understand operational complexities of a business.
2. To enable students to conceptualize the process, functions and theories of management.
3. To enable students to provide knowledge about quality control processes.
4. To enable students to conceptualize different strategies relating to people management

Course Outcome: At the end of the course, the student will be able to:

CO1 **Interpret** the concepts related to Industrial management.

CO2 **Identify** the intricacies of Management Principles and Functions.

CO3 **Define** and analyze the importance of Quality control procedures.

CO4 **Interpret** the concepts of Materials Management.

CO5 **Integrate and assess** the importance of Production Planning procedures and project management techniques.

Course Description:

The purpose of this course is to provide an understanding of the theories and principles of modern management and encourage the course participants to make an appreciation of these principles in relation to their own experiences and selected managerial case studies.
The aims of the course is to understand the basic principles of management, and the four major functions of managers e.g. planning, organizing, leading and controlling and how managers actually operate. Students will be required to think critically and strategically about management theories and issues which will enable them to develop their decision-making and analytical skills. They will be involved in application exercises and case studies which will assist them to develop graduate attributes.

Course Content:

Module 1: Introduction [10 Lecture Hours]

Industrial management - Introduction: Concept, Development, application and scope of Industrial Management. Productivity: Definition, measurement, productivity index, types of production system, Industrial Ownership.

Module 2: Basic Management Functions and Principles [10 Lecture Hours]

Management Function: Principles of Management – Time and motion study, work simplification – process charts and flow diagrams, Production Planning. Inventory Control: Inventory, Cost, Deterministic Models, and Introduction to supply chain management.

Module 3: Quality Assurance **[5 Lecture Hours]**
Quality Control: Process control, SQC, Control charts, Single, Double and Sequential Sampling, Introduction to TQM.

Module 4: Materials Management **[5 Lecture Hours]**
Fundamentals of Materials Management; Material cycle; Forecasting; Material Classification-need and usage, Single and Multidimensional classifications; Materials Codification-Usage, Codification types;

Module 5: Production Planning **[10 Lecture Hours]**
Production Planning and Materials Requirements, Materials Procurement; Tendering; Types of Tenders, Storage and warehousing concepts, Receipt, Warehouse type, Layout, issue of materials and Updation of records; Manpower and equipment;

Module 6: Project Management **[5 Lecture Hours]**
Project Management concept, Project Feasibility Studies, Project Identification, Market and Demand Analysis, Technical Analysis, Project Scheduling with PERT/CPM, Project Cost Estimate, Financial Appraisal of Single Project, Financial Appraisal of Multiple Projects, Project Cost Control (PERT/Cost).

Text Books:

1. Arnold, Chapman: Introduction to Materials Management: Pearson, 5th edition, 2008
2. Khanna, O. P., Industrial Engineering and Management, Dhanpat Rai Publications, ISBN-10: 818992835X; ISBN-13: 978-8189928353

Reference Books:

1) Gopal Krishnan & Sundarsan: Material Management: An Integrated Approach, Prentice Hall of India Private Limited, New Delhi, 2003
2) Industrial Engineering and Management by OP Khanna, DhanpatRai Publications, Delhi.
3) Industrial Management by VK Sharma, OP Harkut.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	30	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Interpret** the concepts related to Industrial management.	**PO1, PO6, PO9, PO12**
CO2	**Identify** the intricacies of Management Principles and Functions.	**PO2, PO4, PO5, PO6, PO7 PO9, PO12**

CO3	**Define** and analyze the importance of Quality control procedures.	**PO2, PO4, PO5, PO6, PO7, PO9, PO12**
CO4	**Interpret** the concepts of Materials Management.	**PO1, PO3, PO5, PO6, PO9, PO10, PO12**
CO5	**Integrate and assess** the importance of Production Planning procedures and project management techniques.	**PO7, PO5, PO6, PO9, PO10**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MGT11402	Industrial Management												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11109	Industrial Biotechnology	L	T	P	C
Version 1.0	Contact hours-45	2	0	0	2
Pre-requisites/Exposure	Physics, Chemistry, Biology and Math in Class 12				
Co-requisites	-				

Course Objectives

1. Industrial biotechnology involves the application of biotechnology for industrial purposes.
2. Applying the techniques of modern molecular biology, it improves efficiency and reduces the multifaceted environmental impacts of industrial processes.
3. It includes the practice of using cells such as microorganisms, or components of cells like enzymes, to generate products in sectors that are industrially useful.
4. To make the students industry ready and equip them with the advanced industrial techniques.
5. The students can study industry-specific, custom-designed program

Course Outcomes

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

CO1.Apply the principles and methods of fermentation processes for bioproducts production.

CO2. Select suitable microbial strains for production of primary and secondary metabolites.

CO3. Develop the process flows steps for efficient production of products.

CO4 Design of novel process trains for enhanced yield of bioproducts.

CO5 Integrate and assess different types of bioreactors for large scale production in Industry level

Catalogue Description

Industrial biotechnology, a major subcategory of biotechnology involves bio-based production of pharmaceuticals, enzymes, nutrients, eco-friendly polymers, biofuels etc. Recent advances in industrial biotechnology permits new applications for biomass waste for resource conservation, emissions reduction and circularity making it an environmentally and economically sustainable technology. With the exponential growth in this sector there is a high demand for skilled manpower for research and development, production, and sample testing facilities. The course aims to provide fundamental insights to exploit enzymes and microbes for the manufacturing of products which have a huge industrial significance. It uniquely blends the science and engineering with various biochemical processes to obtain products of diverse fields such as chemicals, food, bioenergy etc. The course introduces bioreactors, its types, operation methods and provides an experimental demonstration of the same. Strategies to obtain higher yields, design of the reactors and production of biofuels from microbes are thoroughly explained. Students of various disciplines such as biotechnology, chemical engineering, food engineering, and pharmaceutical industries can be benefitted from

the course as it discusses the existing bioprocess applications such as wine and cheese making, antibiotics and vaccines etc. The course majorly focusses on the applications and allows students to gain practical knowledge rather than mere theory. Major bottlenecks for the operation of biochemical industries will be discussed.

Course Content

INDUSTRIAL BIOTECHNOLOGY

Unit I:

Microbes and enzymes of industrial importance, Basic of fermentation technology, Biochemistry of fermentation, Traditional and Modern Biotechnology- A brief survey of organisms, processes, products, Different types of bioreactors and bioreactor design for industrial use, Bioreactor analysis, Microbial growth, substrate degradation and product formation kinetics, Instrumentation, Sterilization of air, media and reactor, Basic concepts of Upstream and Downstream processing in biotechnology industry, Process flow sheeting – block diagrams, pictorial representation.

UNIT II

Production of commercially important primary metabolites like organic acids, amino acids and alcohols, Production of Oxy Chemicals I: Tax and non-tax alcohol, Brewing industry, Production of Oxy Chemicals II: Wine making, Vinegar and citric acid production

UNIT III

Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

UNIT IV

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Bio preservatives, Biopolymers, Biodiesel, Biobutanol, Biomethane, Cheese, Beer, SCP & Mushroom culture, Bioremediation, Aerobic and Anaerobic wastewater treatment processes

UNIT V

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines, Bioprocess strategies in Plant Cell and Animal Cell culture.

Reference Books

1.Industrial Microbiology by Samuel Cate Prescott and Cecil Gordon Dunn

2.Biochemical Engineering Fundamentals by Bailey and Ollis

3.Bioprocess Engineering Principles by Doran

4.Bioprocess Engineering Basic Concepts by Shular and Kargi

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	30	50

5.Biochemical Engineering by Blanch and Clark

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Apply the principles and methods of fermentation processes for bioproducts production.	**PO1, PO2, PO7 PO8**
CO2	Select suitable microbial strains for production of primary and secondary metabolites.	**PO1, PO2, PO4,PO5 PO6,PO8**
CO3	Develop the process flows steps for efficient production of products.	**PO1, PO2, PO3,PO4,PO5 ,PO6, PO7,PO8**
CO4	Design of novel process trains for enhanced yield of bioproducts.	**PO1, PO2, PO4,PO5 PO6, PO8**
CO5	Integrate and assess different types of bioreactors for large scale production in Industry level	**PO1, PO2, PO3,PO4,PO5,PO6, PO7,PO8**

6.Biochemical Engineering by Aiba, Humphrey and Millis

7.A textbook of Industrial Microbiology by Wulf Crueger and Anneliese Cruegen

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

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

		Research and Analysis	Academic Excellence	Data mining	Skills	Modernization and tools usage	Developments of solutions	Diversity	Professional	Collaboration	Sustainable Learner	Ethics	Global Perspectives
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11109	Industrial Biotechnology												

BIT11096	PE-IV: Food Biotechnology	L	T	P	C
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	Basic Knowledge of Microbiology and Bioprocess Technology				
Co-requisites	--				

Course Objectives

1. The course will deliver basic knowledge on the principles of food fermentation and enzyme technology.
2. Specific processes related to food raw materials and food bioprocessing will be described.
3. Know the basic symptoms of a Food-borne infections and intoxication caused by microorganism and how their laboratory testing procedures along with preventive measures.
4. The course will describe benefits that food biotechnology can bring during food manufacturing.

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

CO1: **Explain** the principles of food preservation techniques.
CO2: **Understand** different applications of food production technology and associated safety standards.
CO3: **Interpret** the use of enzymes in food processing.
CO4: **Analyze** major food ingredients.
CO5: **Integrate and assess** different applications of food biotechnology.
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Catalog Description

Food Technology is a branch of science that deals with the techniques involved in production, processing, preservation, packaging, labelling, quality management, and distribution of food products. The field also involves techniques and processes that are used to transform raw materials into food. Dairy technology study involves processing, storage, packaging, distribution and transportation of dairy products by implying the science of bacteriology, nutrition and biochemistry.

Course Content

Food biotechnology (BIT11096)

UNIT I **(10 hours)**
Preservation Technology: Spoilage of food; Food poisoning; Microbiology of water, milk, meat, & vegetables; preservation of food by canning, dehydration, irradiation, & sterilization; Role of lactic acid in preservation in sauerkraut.

UNIT II **(10 hours)**

Food Production Technology: Fermented and semi-fermented food; Production of single cell protein; Yeast, mushroom; SCP for cattle feed. Genetically modified crop; safety aspects of genetically modified crops. Food Safety standard: Hazard Analysis and Critical Control Point (HACCP) Program – Good manufacturing Practices (GMP's) and microbiological standards.

UNIT III **(10 hours)**

Technology for Improved Process: Enzymes in bakery & cereal products; Enzymes in fruit juice production; Enzymes in fat & oil production. Enzymes in cheese making & beverage production; Utilization of food wastes.

UNIT IV **(10 hours)**

Analysis of major food ingredients: Analysis of preservative, natural & synthetic Food colour; Food flavor enhancing agents. Chemical safety measurement; Heavy metal, fungal toxins, bacterial toxins, herbicide, & Pesticide; detection & Quality control tests.

UNIT V **(10 hours)**

Applications of food biotechnology: Designing and development, micro encapsulation and packaging, scopes and challenge; Development and formulation of novel products such as probiotic foods. Nutrogenomics-concept, working, significance and relevance. Biosensors and novel tools and their application in food science & Technology.

Textbooks:

1. Microbiology by Pelczar, JR E.C.S Chan and noel R.Krieg. Fifth edition Tata Mc GrawHill -2006

2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS, Publishers and Distributors, Delhi, India.

3. G.F.G. Lopez & G.V.B. Canovas, Food Science and Food Biotechnology (2003), CRCPress, Florida, USA

4. Ranganna S, Handbook of Analysis and Quality Control for Fruits and Vegetable Products (1986), 2nd ed. TMH Education Pvt. Ltd.

5. GokogluN.Novel natural food preservatives and applications in seafood preservation: a review.(2019), Journal of Science Food and Agriculture, Voulme 99, Issue 5, Page number 2068-2077.

Reference books:

1. www.pubmed.org
http://www.mhhe.com/biosci/cellmicro/prescott/student/olcstudn.mhtml

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes

CO1	**Explain** the principles of food preservation techniques.	**PO1, PO2**
CO2	**Understand** different applications of food production technology and associated safety standards.	**PO1, PO2, PO3**
CO3	**Interpret** the use of enzymes in food processing.	**PO1, PO2, PO3**
CO4	**Analyze** major food ingredients.	**PO1, PO2, PO4, PO6**
CO5	**Integrate** and assess different applications of food biotechnology.	**PO1, PO2, PO3, PO5, PO8**

		Academic excellence	Critical Thinking	Skills	Modern Tools and Techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11096	Food Biotechnology (THEORY)	3	3							-	-	-	-

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11097	PE-IV: Environmental Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 45	2	1	0	3
Pre-requisites/Exposure	Class 12 Biology				
Co-requisites	--				

Course Objectives:

1. To provide students a better understanding for current applications of biotechnology to environmental quality evaluation, monitoring, and remediation of contaminated environments.
2. To provide students a foundation for subsequent discussions of microbial removal and degradation of organics, phytoremediation of soil and water contaminated with toxic metals and radionuclides, wetlands as treatment processes, biofilms/biofilters for vapor-phase wastes, and composting.

Course Outcomes

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

CO-1	Students will be able to **explain** about environmental pollution.
CO-2	Students will be able to **analyze** the problems associated with pollution and pollutants.
CO-3	Students will be able to **determine** quality of water and soil.
CO-4	Students will be able to compare and contrast between physical, chemical and biological treatment of water and can **summarize** the importance of microorganisms for treatment of water.
CO-5	Students will be able to **integrate and assess** different techniques of remediation.

Course Description:

The course is an introduction to Environmental Biotechnology and focuses on the utilization of microbial processes in waste and water treatment, and bioremediation. Topics included are microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology, approaches for studying microbial communities, and basic principles in bioremediation and biological water and waste treatment.

Course Content:

Unit I: Introduction to environmental pollutants [7 hours lecture]

Water, Soil and Air: their sources and effects. Removal of Specific Pollutants : Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal Accumulation, Biosorption & detoxification mechanisms.

Unit II: Microbiology and biochemistry of waste water treatment [6 hours lecture]

Biological Treatment of anaerobic and aerobic; methanogenesis, methanogenic, acetogenic, and fermentative bacteria- technical process and conditions; Use of Genetically Engineered

Organisms. emerging biotechnological processes in waste - water treatment; Applications include treatment of municipal and industrial wastewater

Unit III: Biodegradation of xenobiotic compounds [8 hours lecture]
Xenobiotic compounds: Aliphatic, Aromatics, Polyaromatic Hydrocarbons, Polycyclic aromatic compounds, Pesticides, Surfactants and microbial treatment of oil pollution.

Unit IV: Biotransformations and biocatalysts [12 hours lecture]
Basic organic reaction mechanism - Common prejudices against Enzymes.- Advantages & Disadvantages of Biocatalysts - Isolated Enzymes versus whole cell systems.- Mechanistic Aspects and Enzyme Sources.- Biocatalytic Application - Catalytic Antibodies; Stoichiometry, kinetics, and thermodynamics of microbial processes for the transformation of environmental contaminants.

Unit V: Biooxidation & microbial leaching [12 hours lecture]
Biooxidation – Direct and Indirect Mechanisms – Biooxidation Kinetics; Bacterial oxidation of Sphalerite, Chalcopyrite and Pyrite.; Extraction of metals from ores; Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal.

BOOKS	BOOK DETAILS
1	Environmental Microbiology, W.D. Grant & P.E. Long, Blakie, Glassgow and London.
2	Environmental Biotechnology by Bruce Rittmann and Perry McCarty.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO-1	Students will be able to **explain** about environmental pollution.	**PO1, PO2, PO10**
CO-2	Students will be able to **analyze** the problems associated with pollution and pollutants.	**PO1, PO3, PO4, PO10**
CO-3	Students will be able to **determine** quality of water and soil.	**PO3, PO4, PO5, PO10**
CO-4	Students will be able to **compare** and **contrast** between physical, chemical and biological treatment of water and can **summarize** the importance of microorganisms for treatment of water.	**PO1, PO4, PO6, PO10**

CO-5	Students will be able to **integrate and assess** different techniques of remediation.	**PO2, PO3, PO5, PO8 , PO10**

		Academic excellence	Critical Thinking	Skills	Modern Tools and Techniques	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11097	Environmental Biotechnology												

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

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11092	Professional Elective V STEM CELL BIOTECHNOLOGY (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	12th LEVEL SCIENCE				
Co-requisites	Biology				

Course Objectives

1. To enable Students, **Interpret** the basic components of stem cell research.

2. Students will apply their knowledge of stem cell technology in Interpreting Tissue engineering.

3. Students will be able to Interpret the molecular mechanism of pluripotency of stem cells.

Course Outcomes

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

CO1. Students will be able to **Interpret** and comprehend basic principle of stem cell research
CO2. Students will be able to **summarize** characteristics of Embryonic stem cells and functions
CO3. Students will be able to **develop** an integrated knowledge in Adult stem cells and their faiths
CO4. Students will be able to **demonstrate** the basic principle and applications of Stem cell in drug discovery and tissue engineering
CO5. Students will be able to **develop** an integrated knowledge in Genetic engineering and therapeutic application of stem cells

Catalog Description

Knowledge of "cell", the unit of life, is an integral part of any Biology related course. BTech Biotechnology offers this course to make the foundation of the course very strong. In this course, the focus will be on improving the Students knowledge in understanding the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles; Students will understand how these cellular components are used to generate and utilize energy in cells; Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation. Students will learn how to apply knowledge about the subject effectively through prescribed syllabus as well as through published research papers worldwide. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies.

We will combine traditional lectures with other active teaching methodologies, such as group discussions, cooperative group solving problems, analysis of video scenes and debates. Class participation is a fundamental aspect of this course. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs etc.

Course Content

STEM CELL BIOTECHNOLOGY (BIT11092)

Course Content:

1. **Animal Cell Culture: (10 hr)**
   Equipments & materials for animal cell culture technology. Various systems of tissue culture; their distinguishing features, advantages & limitations. Culture medium; natural media, synthetic media, sera. Introduction to balanced salt solutions & simple growth medium. Brief discussion on the chemical, physical & metabolic functions of different constituents of culture medium; role of carbon dioxide, & and supplements..
2. **Characteristics of cells in culture: (10 hr)**
   Contact inhibition, anchorage dependence, cell-cell communication; Cell senescence; cell & tissue response to trophic factors.
3. **IVF: (10 hr)**
   In vitro fertilization & embryo transfer technology; Ethical issues
4. **Gene transfer, Gene therapy & Transgenics: (15 hr)**
   Methods of gene transfer; Microinjection & viral mediated gene transfer techniques; Production of transgenic animals & molecular farming. Principles of Ex vivo and In vivo gene therapy; Stem cell and its application. Production of Vaccines in animal Cells. Production & Applications of monoclonal antibodies; Transgenic animals.

Text Book

1. Insect Biotechnology by Andreas Vilcinskas – 2010. Publisher - Springer Science & Business Media

Reference book:

1. Trends in Insect Molecular Biology and Biotechnology by Chengliang Gong and Dhiraj Kumar. Publisher: Springer; 1st ed. 2018.
2. Animal Cell Culture and Technology (THE BASICS) by Michael Butler. Publisher: Taylor & Francis; 2nd – 2003.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	20	30	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students will be able to **Interpret** and comprehend basic principle of stem cell research	**PO1, PO2**
CO2	Students will be able to **summarize** characteristics of Embryonic stem cells and functions	**PO1, PO2,PO3**
CO3	Students will be able to **develop** an integrated knowledge in Adult stem cells and their faiths	**PO1, PO2, PO3**
CO4	Students will be able to **demonstrate** the basic principle and applications of Stem cell in drug discovery and tissue engineering	**PO1, PO2, PO5, PO6**
CO5	Students will be able to **develop** an integrated knowledge in Genetic engineering and therapeutic application of stem cells	**PO1, PO2, PO3, PO5, PO8**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
BIT11092	Stem Cell Biotechnology (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11094	Professional Elective V Molecular Modeling and Drug Design (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	2	1	0	3
Pre-requisites/Exposure	Basic knowledge of Organic Chemistry and Protein Biochemistry & Bioinformatics				
Co-requisites	--				

Course Objectives:

1. The main focus of the course is the use of ligand based approaches to target proteins which are lacking highly resolved 3D crystal structures.
2. It will present drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening.
3. This course aims at application of modern in silico tools or information technology in different phases of drug discovery and design of new drug candidates by understanding the molecular basis of the interaction of small molecules with their targets.
4. The course will teach fundamental aspects about molecular modelling and modern drug discovery by rational drug designing methods like virtual screening of inhibitors using 3-D protein structures.

Course outcome:

The students will be able

CO1. To **Interpret** the various stages of drug discovery and analysis.
CO2. To **define** physicochemical Properties and the techniques involved in QSAR.
CO3. To learn and **utilize** various structure based drug design methods (Molecular docking, Denovo drug design)
CO4. To **examine** the role of drugs in metabolic pathways with their adverse and therapeutic values.
CO5. To **examine** the various techniques of Virtual Screening methods for novel drug discovery.

Course Description:

The subject is designed to impart knowledge about recent advances in the field of medicinal chemistry at the molecular level including different techniques for the rational drug design. At completion of this course it is expected that students will be able to apply various strategies important for designing and development of new drug like molecular modelling, docking and molecular dynamics simulation. The course is also going to teach different techniques for drug discovery, their role in medicinal chemistry research, different stages involved in drug discovery with an understanding of peptidomimetics and biological targets. This subject is

designed to impart the knowledge on preclinical evaluation of drugs and recent experimental techniques in the drug discovery and development. It will teach the students in developing drug safety data in Pre -clinical, Clinical phases of Drug development.

Course Content:

Molecular Modelling and Drug Design (BIT11094) (THEORY)

UNIT I **5 Lecture Hours**

Quantum mechanics and concepts in molecular modelling: Introduction to quantum mechanics; postulates; Schrodinger wave equation; Born-Oppenheimer approximation.

UNIT II **10 Lecture Hours**

Empirical force fields molecular mechanism: Stretching of Bond; Bending of Angle; Torsional terms; bonding motions; Electrostatic interactions; Van Der Waals interactions; Effective pair Potentials; Hydrogen Bonding; Simulation of liquid water. Derived & non-derived energy minimization method; simplex, sequential univariate method; steepest descent method; conjugate gradient method; Newton-Rapson method

UNIT III **5 Lecture Hours**

Computer simulation methods: Thermodynamic properties; Phase space; Practical aspects of computer simulation; Boundaries monitoring Equilibrium; Long range Process; Analyzing result of simulation & estimating errors.

UNIT IV **10 Lecture Hours**

Molecular dynamics simulation methods: Molecular Dynamics using simple modules; Molecular Dynamics with continuous potentials; Running Molecular Dynamics simulation; Time dependent properties; Constant dynamics; Molecular Dynamics at constant temp & pressure; Monte Carlo simulation methods; Analyzing the Results of a Simulation & Estimating Errors..

UNIT V **5 Lecture Hours**

Metropolis methods: Monte Carlo simulation of molecules & polymers; chemical potentials; Monte Carlo or Molecular Dynamics, Molecular modeling to discover & design new molecules.

UNIT VI **10 Lecture Hours**

Molecular modeling in drug discovery: Deriving & using 3D Pharma cores; Molecular docking; De novo ligand design; structure based drug design; pharmacophores; Simple Thermodynamic Properties & Phase Space.

SUGGESTED BOOKS:

1. Drug Design Strategies: Computational Techniques & Applications by Tim Clark, David E. Thurston and Lee Banting. Publisher: Royal Society of Chemistry, 2012 edition.
2. Computer-Aided Drug Discovery by Zhang Wei (Editor). Springer ISBN 978-1-4939-3521-5; 2016 edition.
3. *In Silico* Drug Discovery and Design: Theory, Methods, Challenges, and Applications

by Claudio N. Cavasotto (Editor). Publisher: CRC Press; 1st edition-2017.

4. Industrial Applications of Molecular Simulations by Marc Meunier (Editor). CRC press – 2011.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	20	30	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO-1	To **Interpret** the various stages of drug discovery and analysis.	**PO1, PO2**
CO-2	To **define** physicochemical Properties and the techniques involved in QSAR.	**PO1, PO2, PO5**
CO-3	To learn and **utilize** various structure based drug design methods (Molecular docking, De novo drug design)	**PO2, PO3, PO4**
CO-4	To **examine** the role of drugs in metabolic pathways with their adverse and therapeutic values.	**PO4, PO6**
CO-5	To **examine** the various techniques of Virtual Screening methods for novel drug discovery.	**PO1, PO3, PO5, PO7, PO8**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem Solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT11094	**Molecular Modelling and Drug Design** (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11100	**Agricultural Biotechnology (OPEN ELECTIVE II)**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	12^{th} with Biological Science as one of the subjects				
Co-requisites	English language skill				

Course Objectives:

- Understand the Fundamentals of Agriculture Biotechnology
- Gain Knowledge in Plant Genetics and Molecular Biology
- Explore Biotechnology and Crop Protection

Course Outcomes

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

CO1 Students will be able to summarize different aspects of Agriculture Biotechnology
CO2 Students will be able to interpret the various prospects of plant metabolic engineering and their application
CO3 Students will be able to demonstrate development of biotic and abiotic stress tolerance plants using biotechnological tools
CO4 Students will be able to illustrate various aspects of Animal Biotechnology
CO5 Students will be able to integrate and apply the knowledge in sustainable and precision Agriculture for food safety.

Catalogue Description

Agricultural Biotechnology is a challenging lecture course that covers a range of applied agriculture biotechnological techniques. The course takes a broader approach and covers many aspects of agro biotechnology like mushroom culture, bio fertilizer and bio pesticide development and basic agriculture soil science. Moreover, this course elaborately highlighted the commercial application of agriculture biotechnology which definitely helps the students for job searching. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms, such as analysis of video scenes and debates. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapers etc.

Course Content: (45 hours)

Unit I: Application of Agricultural Biotechnology (15 hours)

- Biotechnology in crop breeding and crop management
- Biotechnology in horticulture and forestry
- Biotechnology in animal agriculture
- Socioeconomic implications of agricultural biotechnology
- Biosafety regulations and risk assessment

Unit II: Plant Metabolic Engineering

(15 hours)

- Introduction to plant metabolic pathways
- Metabolic engineering strategies for increased crop yield and quality
- Production of secondary metabolites through genetic engineering
- Transcriptomics, proteomics, and metabolomics in plants
- Engineering plants for phytoremediation of pollutants
- Biofortification and enhanced nutritional content in crops

Unit III: Biotechnology for Abiotic and Biotic Stress Tolerance (7 hours)

- Herbicide and insect-resistant crops
- Plant responses to abiotic stresses (drought, salinity, temperature, etc.)
- Genetic engineering for stress tolerance in crops
- Marker-assisted selection (MAS) and genomic selection
- Biotechnology in crop breeding and crop management
- Plant-microbe interactions and their role in stress tolerance
- RNA interference (RNAi) technology for pest management in crops

Unit IV: Animal Improvement through Biotechnology (8 hours)

●Applications of marker-assisted selection in animal breeding
●Genomic selection methods for improving livestock traits
●Applications of marker-assisted selection in animal breeding
●Basics of genetic engineering and gene manipulation in animals
●Development of genetically modified animals with improved traits
●Biosafety regulations and risk assessment in animal biotechnology
●Food safety assessment of biotechnologically modified animal products

Unit V: Sustainable and precision Agriculture and global food security (8 hours)

● Understanding IoT and its applications in agricultural improvement.
●Using Biosensors in crop improvement program and adulteration monitoring
● Futuristic crop improvement using soilless agriculture (Hydroponics, Aquaponics and Aeroponics) techniques.
● Autonomous vehicles and drones for crop monitoring and spraying
●Integrated Pest Management (IPM) principles in smart agriculture.

Text Books

1. Textbook of Agricultural Biotechnology 3rd Edition by Andrew S Tanenbaum, Albert S Woodhull. Publisher: PHI Learning – 2006.
2. The Complete Technology Book on Biofertilizer and Organic Farming (2nd Revised Edition) – 2012 by NIIR Board Author

Reference Books

3. Plant Biotechnology and Agriculture: Prospects for the 21st Century by Arie Altman and Paul Hasegawa 1st Edition. Elsevier Academic Press 2011.
4. Textbook of Agricultural Biotechnology by A. Nag. PHI Learning Pvt. Ltd., 2008

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students will be able to **summarize** different aspects of Agriculture Biotechnology.	**PO1, PO2**
CO2	Students will be able to **interpret** the various prospects of plant metabolic engineering and their application.	**PO1, PO2, PO3**
CO3	Students will be able to **demonstrate** development of biotic and abiotic stress tolerance plants using biotechnological tools.	**PO1, PO2, PO3, PO4**
CO4	Students will be able to **illustrate** various aspects of Animal Biotechnology.	**PO1, PO2, PO5, PO6, PO7, PO8**
CO5	Students will be able to to integrate and apply the knowledge in sustainable and precision Agriculture for food safety.	**PO1, PO2, PO3, PO5, PO8, PO12**

		Academic excellence	Critical Thinking	Skills	Modern Tools and Techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12

BIT11100	Agricultural Biotechnology (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

BIT11103	**Gene expression (OPEN ELECTIVE II)**	L	T	P	C
Version 1.0	Contact Hours 45	3	0	0	3
Pre-requisites/Exposure	Class 12 level Biology knowledge				
Co-requisites	English language skill				

Course Objectives

1. To explain and categorize biosynthesis of RNA in prokaryotes and eukaryotes.
2. To discuss RNA splicing.
3. To demonstrate and illustrate Biosynthesis of proteins and mechanism of its degradation process.
4. To explain and categorize regulation of gene expression in prokaryotes and eukaryotes.

Course Outcomes

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

CO1 Student will be able to **explain** and categorize biosynthesis of RNA in prokaryotes and eukaryotes.

CO2 Student will be able to **discuss** RNA splicing.

CO3 Student will be able to **discuss** about Principles of molecular cell biology of cancer.

CO4 Student will be able to **demonstrate** and illustrate Biosynthesis of proteins and mechanism of its degradation process.

CO5 Student will be able to **integrate and assess** regulation of gene expression in prokaryotes and eukaryotes.

Catalog Description

To provide an understanding of i) the regulation of transcription in eukaryotic organisms; ii) post-transcriptional regulation; iii) the structure, formation and function of microRNAs; iv) how the process of translation is controlled.

Course Content

(45 hours)

1. Concept of gene regulation, regulation of phages, viruses, gene expression. (9 hours)
2. Central dogma & bacterial gene expression: Prokaryotic gene expression: chemical & physical structure of DNA, chemical & physical structure of proteins; Levels of structures in proteins, Ramachandran plot, Forces stabilizing the structure of proteins & DNA; (9 hours)
3. Prokaryotic gene expression includes catabolite repression, lac repressor, tryptophan operon, SOS response pathway, gene regulation by genetic recombination, and gene activation. (9 hours)
4. Gene expression control in Eukaryotes includes transcriptional regulation by chromatin, DNA binding proteins-activator, co-activator, positive and negative gene regulation using galactose metabolism in yeast, Posttranscriptional gene silencing by RNAi, and translational repression of eukaryotic mRNA. (9 hours)
5. Cell differentiation-developmental potential of stem cells. (9 hours)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Explain** and categorize biosynthesis of RNA in prokaryotes and eukaryotes.	**PO1, PO2**
CO2	**Discuss** RNA splicing	**PO1,PO2, PO3,**
CO3	**Discuss** about Principles of molecular cell biology of cancer.	**PO1, PO3, PO4, PO4**
CO4	**Demonstrate** and illustrate Biosynthesis of proteins and mechanism of its degradation process.	**PO6, PO7, PO10**
CO5	**Integrate and assess** regulation of gene expression in prokaryotes and eukaryotes	**PO8, PO9, PO11, PO10, PO12**

		Fundamental Knowledge	Critical Thinking	Skill Development	Modern tools and techniques	Research	Problem Solving	Data Analysis	Professional Development	Collaboration	Life Long Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11103	Gene expression												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

Course Title	Biocatalysis	L	T	P	C
Course Code	BIT11104	2	1	0	3
Contact Hours	45				
Pre-requisites/Exposure	10+2 SCI ENC E				

Course Objectives

1. To provide basic concepts of biocatalyst/enzymes.
2. To provide basic understanding on enzyme immobilization for various applications.
3. Elaborating the cutting-edge uses of modern biosensors.

Course Outcomes

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

No.	Course Outcomes
CO1	Students acquire knowledge and can **explain** the structure, functions and the mechanisms of action of enzymes.
CO2	Students can **demonstrate** various kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.
CO3	Students can **illustrate** the strategies of immobilization of enzymes.
CO4	The student will comprehend of industrial applications of enzymes and their future potential. Should **demonstrate** their shills in professional world to become a global citizen.
CO5	The student will **integrate** wide applications of biosensors and also can **assess** the mechanisms of enzyme regulations. Should realize research ethics.

CO = Course Outcomes

Catalog Description:
Upon completion of this module, the students are able to design strategies to purify enzymes. Further, the students can evaluate the purification based on yield, purification factor and electrophoretic methods. After this module the students can determine the enzyme activity of different enzymes using different methods (e.g. spectrometric, HPLC). Students have knowledge about different immobilization methods of enzymes after this module and can perform and evaluate covalent immobilization methods. Upon this module, the students can perform and evaluate biotransformation processes. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active

teaching methodologies, Class participation is a fundamental aspect of this course. Students will be encouraged to actively take part in all group activities and to give an oral group presentation on various topics of this course. Students will be expected to interact with media resources, such as, web sites, videos, research papers etc.

Course Content

Biocatalysis (BIT11104)

UNIT I **(15 hrs)**

Introduction: Classification, mechanism of enzyme action, active site determination, identification of binding and catalytic sites, specificity of enzyme action, activation energy and transition state theory, role of entropy in catalysis. Applications of enzymes.

UNIT II **(10 hrs)**

Kinetics: Kinetics of single substrate enzyme catalyzed reactions, Michaelis-Menten equation, turnover number, enzyme inhibition- competitive, non-competitive, and uncompetitive, allosteric enzymes and metabolic regulation.

UNIT III **(10 hrs)**

The technology of enzyme production: Types of reactors used for enzyme catalysis for free and immobilized enzymes, immobilized enzymes, preparation and properties.

UNIT IV **(10 hrs)**

Overview of applications of immobilized enzyme systems: Design of enzyme electrodes & their applications as biosensors; health care & environment; Design of Immobilized Enzyme Reactors; Packed-bed, Fluidized-bed Membrane reactors; Bioconversion calculations in free-enzyme CSTRs & immobilized enzyme reactors.

Books & Other Resources

Text Book(s)	
T1	Lehninger Principles of Biochemistry Edition 4, Nelson, David L. Cox, Michael M. Lehninger, Albert L. W H Freeman & Co.
T2	Enzymes And Enzyme Technology 1st Edition by Anil Kumar, Sarika Garg. ISBN-13: 978-1905740871.

T = Text Book; R = Reference Book

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students acquire knowledge and can **explain** the structure, functions and the mechanisms of action of enzymes.	**PO1, PO2**
CO2	Students can **demonstrate** various kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.	**PO1, PO2,PO3**
CO3	Students can **illustrate** the strategies of immobilization of enzymes.	**PO1, PO2, PO3, PO4**
CO4	The student will comprehend of industrial applications of enzymes and their future potential. Should **demonstrate** their shills in professional world to become a global citizen.	**PO1, PO2, PO5, PO6, PO8, PO12**
CO5	The student will **integrate** wide applications of biosensors and also can **assess** the mechanisms of enzyme regulations. Should realize research ethics.	**PO1, PO2, PO3, PO5, PO7, PO8, PO11**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT11104	**Biocatalysis** (THEORY)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT11108	**RESEARCH METHODOLOGY AND GLP (THEORY)**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	2	1	0	3
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology in industry and concept of basic and applied research.				
Co-requisites	--				

Course Objectives

2. To provide the students with understanding of research and its types along with identification of problem for conducting research.
3. It will also deal with the research methodology and work plan to be adopted for conducting research.
4. To study the scope of Good Laboratory Practice as an integral part of research and industrial laboratory.
5. To get introduced to various forms of quality management system (QMS) applied for biotechnological research as well as allied industries.

Course Outcomes

On completion of this course,

CO1. Students will be able to **identify** research problems, categorize various types of research and justify the feasibility and applicability of a research/invention/ innovation.

CO2. Students will be able to select and adopt the suitable methodology and **design** research plan.

CO3. Students will be able to **demonstrate** GLP in their laboratory, examine the process, identify hazard and propose measures for safety.

CO4. Students will be able to **illustrate** the process of QMS and determine the suitability for a industry/ sector and recommend actions.

Catalog Description

This course is designed to introduce the concept of research methodology to the students and provide them with understanding of research and its types along with identification of problem for conducting research. The concept of GLP will be dealt at par with international guidelines

that is followed in various industries. The course will also introduce various forms of quality management system (QMS) applied for biotechnological research as well as allied industries.

Course Content

RESEARCH METHODOLOGY AND GLP (BIT11108)

Unit I **Lecture Hours 2**

Introduction to research; Definitions and characteristics of research; Types of research; Main components of any research work.

Unit II **Lecture Hours 3**

Problem identification; Criteria for prioritizing problems for research.

UNIT III **Lecture Hours 5**

Analyzing the problem; Formulating the problem statement. Literature review: Uses of literature review; Definitions and Formulation of the research objectives**.**

UNIT IV **Lecture Hours 5**

Research methodologies: Study population; Variables; Sampling; Sample size determination; Plan for data collection; Methods of data collection; Plan for data processing and analysis; Ethical considerations**.**

UNIT: V **Lecture Hours 5**

Work Plan; Major components and outline of the different phases in a research process; Summary of the major components of a research proposal; Fieldwork; Writing a research report.

UNIT: VI **Lecture Hours 5**

Introduction to the WHO/TDR Handbook on GLP; Current Good Manufacturing Practices: Introduction, US Cgmp Part 210 and Part 211.EC Principles of GMP (Directive 91/356/EEC) Article 6 to Article 14 and WHO cGMP guidelines GAMP-5; Medical device and IVDs Global Harmonization Task Force(GHTF) Guidance docs.

UNIT: VII **Lecture Hours 5**

Introduction, USFDA GLP Regulations (Subpart A to Subpart K), Controlling the GLP inspection process, Documentation, Audit, goals of Laboratory Quality Audit, Audit tools, Future of GLP regulations, **relevant ISO and Quality Council of India(QCI) Standards,**

UNIT: VIII **Lecture Hours 5**

Good Automated Laboratory Practices:

Introduction to GALP, Principles of GALP, GALP Requirements, SOPs of GALP, Training Documentation,21 CFR Part 11, General check list of 21CFR Part 11, Software Evaluation checklist, relevant ISO and QCI Standards.

UNIT: IX **Lecture Hours 5**

Good Distribution Practices:

Introduction to GDP, Legal GDP requirements put worldwide, Principles,
Personnel, Documentation, Premises and Equipment, Deliveries to Customers, Returns, Self-Inspection, Provision of information, Stability testing principles, WHO GDP, USP GDP (Supply chain integrity), elevant CDSCO guidance and ISO standards

UNIT: X **Lecture Hours 5**

Quality management systems:

Concept of Quality, Total Quality Management, Quality by design, Six Sigma concept, Out of Specifications (OOS), Change control. Validation: Types of Validation, Types of

Qualification, Validation master plan (VMP), Analytical Method Validation. Validation of utilities, [Compressed air, steam, water systems, Heat Ventilation and Air conditioning (HVAC)]and Cleaning Validation. The International Conference on Harmonization (ICH) process, ICH guidelines to establish quality, safety and efficacy of drug substances and products, ISO 13485, Sch MIII and other relevant CDSCO regulatory guidance documents.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students will be able to **identify** research problems, categorize various types of research and justify the feasibility and applicability of a research/invention/ innovation.	**PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO10, PO12**
CO2	Students will be able to select and adopt the suitable methodology and **design** research plan.	**PO1, PO2, PO3, PO4, PO5, PO6,PO9**
CO3	Students will be able to **demonstrate** GLP in their laboratory, examine the process, identify hazard and propose measures for safety.	**PO1, PO2, PO3, PO4, PO5 PO6, PO7, PO8, PO11**
CO4	Students will be able to **illustrate** the process of QMS and determine the suitability for a industry/ sector and recommend actions.	**PO2, PO4, PO5, PO6, PO8, PO9, PO10, PO11, PO12**

		Academic Excellence	Critical Thinking	Skills	Modern Tools and Technique usage	Problem Solving	Analysis	Proper Solution	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
BIT1108	**RESEARCH METHODOLOGY AND GLP**												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT12098	**Food Biotechnology Lab**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	0	0	4	2
Pre-requisites/Exposure	Basic knowledge of Life science and Chemistry and Microbiology.				
Co-requisites	--				

Course Objectives

1. To understand the principles of modern techniques used in food analysis for quality assurance
2. To design labels for food products on the basis of food analysis
3. To develop analytical techniques for on-line monitoring of food quality during processing and storage
4. To ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements
5. To assess the environmental impact of products life from farm to fork.
6. To explain newer and relevant analytical techniques in food systems

Course Outcomes

Student will be able to

CO1: **Understand** the principles of redox chemical reactions to develop a protocol for analyzing specific food attributes.
CO2: **Identify** different chemical and biochemical analyses specific to food.
CO3: **Apply** protocols for different food formulations and analyze sensory data.
CO4: **Analyze** the effect of different process variables on specific attributes of fruits, vegetables, bakery, and dairy products.
CO5: **Intgrate** and assess the concepts of food quality and its role in the food industry.

Course Content

Food Biotechnology Lab (BIT12098)

1. Analysis of milk (liquid) & detection of adulterants in milk.
2. To check the efficiency of food preservatives.
3. Estimation of percentage of lactic acid (titrable acidity) in given milk and milk product sample using titration method.
4. To detect the number of bacteria in food sample by standard plate count (spc) method.
5. To make/bake bread using saccharomyces cerevisiae (baker's yeast).
6. Methods of screening of microorganisms with amylolytic and proteolytic activity.
7. Isolation of amino acid and proteins: cystine, egg albumin, globulin, milk casein.
8. Analysis of wheat flour and determination of damaged starch
9. Estimation of food bioactives (phenolics, pigments etc)

10. Sensory analysis of foods
11. Development of premixes and study of traditional food
12. Fruit and vegetable processing: dehydration and product development

Suggested Books:

1. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
2. Bioreactors in Biotechnology: A Practical Approach by A.H. Scragg, 1991

Reference Books

1. Chellapandi P. (2007). Laboratory Manual In Industrial Biotechnology. Pointer Publishers.
2. Food Microbiology by Soman J P First Edition, 2008
3. Practical in Microbiology by R C Dubey, D K Maheshwari, First Edition 2005

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Understand** the principles of redox chemical reactions to develop a protocol for analyzing specific food attributes.	**PO1, PO2, PO3, PO4**
CO2	**Identify** different chemical and biochemical analyses specific to food.	**PO1, PO2, PO3, PO4, PO5**
CO3	**Apply** protocols for different food formulations and analyze sensory data.	**PO1, PO2, PO3, PO4, PO6**
CO4	**Analyze** the effect of different process variables on specific attributes of fruits, vegetables, bakery, and dairy products.	**PO1, PO3, PO6, PO9**
CO5	**Intgrate** and assess the concepts of food quality and its role in the food industry.	**PO3, PO4, PO8, PO6**

		Academic excellence	Critical Thinking	Skills	Modern Tools and Techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
BIT1209 8	Food Biotechnology Lab (Practical)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

BIT12099	Environmental Biotechnology Lab	L	T	P	C
Version 1.0	**Contact Hours - 45**	0	0	4	2
Pre-requisites/Exposure	PLUS TWO LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. Students will learn to assess physical parameters that characterize the microorganisms obtained from natural resources like water, soil air etc.

2. Students will be able to identify, and estimate the microbial populations in different natural resources.

3. Students will be able to assess the potability of water samples.

4. Students will be able to comprehend microbial bioremediation.

Course Outcomes

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

CO1. to **assess** the microbial quality of water samples.
CO2. **determine** the biological oxygen demand and **judge** the potability of water samples.
CO3. **inspect** the different parameters of soil samples and identify, and estimate the soil microbial populations.
CO4. **identify** and categorize the microbes present in rhizospheres.
CO5. isolate and culture industrially important microbes from nature, and **develop** ideas to mimic the natural habitat for culturing different industriallyimportant environmentally sustainable microorganism.

Catalog Description

Environmental Biotechnology is a rapidly developing and increasingly important branch of science. It has implications for both the prevention and clean-up of pollution in domestic and industrial waste streams in waste water treatment plants. The student will be able to characterize the physical parameters defining the natural resources inhabited by microorganisms followed by estimation of type and quantity of microorganisms present there. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Environmental Biotechnology Lab (BIT12099)

4 Lecture Hours

1. Qualitative analysis of the soil from different locations for pH & different water-soluble cations & anions.

6 Lecture Hours

2. Quantitative estimation of oxidisable organic matter in soil, carbonate and bicarbonates by volumetry and calcium and magnesium by EDTA titration.

6 Lecture Hours

3. Hardness of water by EDTA titration.

6Lecture Hours

4. Study of pH and conductivity of tap water and polluted water.

6 Lecture Hours

5. Study of pH and conductivity of tap water and polluted water.

6 Lecture Hours

6. Methods of screening of microorganisms with amylolytic and proteolytic activity.

7 Lecture Hours

7. Analysis of organic compounds from soils.

Text Book(s)

T1. Pepper IL, Gerba CP, Gentry TJ (2014). Environmental Microbiology, 3rdedition, Academic Press

Reference books

R1. Atlas RM and Bartha R (2000). Microbial Ecology: Fundamentals & Applications. 4th edition, Benjamin Cummings

R2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms, 14th edition, Pearson

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	to **assess** the microbial quality of water samples.	**PO1, PO3, PO5**
CO2	**determine** the biological oxygen demand and **judge** the potability of water samples.	**PO3, PO4, PO5**
CO3	**inspect** the different parameters of soil samples and identify, and estimate the soil microbial populations.	**PO3, PO4, PO5**
CO4	**identify** and categorize the microbes present in rhizospheres.	**PO2, PO5, PO6**
CO5	isolate and culture industrially important microbes from nature, and **develop** ideas to mimic the natural habitat for culturing different industrially important environmentally sustainable microorganism.	**PO2, PO3, PO5**

		Academic excellence	Critical Thinking	Skills	Modern Tools and Techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT12099	Environmental Biotechnology Lab (Practical)												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

BIT14109	Minor Project	L	T	P	C
Version 1.0		0	0	8	4
Pre-requisites/Exposure	Knowledge about biotechnology and allied fields				
Co-requisites	-				

Course Objectives

7. Defining and outlining a research area with a clear question
8. Identifying the leading issues
9. Sourcing the relevant information
10. Assessing its reliability and legitimacy
11. Evaluating the evidence on all sides of a debate
12. Coming to a well-argued conclusion

Course Outcomes

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

CO1. **Design** and perform a new type of experiment.
CO2. **Summarize** the observation.
CO3. **Develop** the skill to make the data table.
CO4. **Conclude** the data
CO5. Integrate and assess whether the data is really new or expected.

Catalog Description

Technical seminar allows students present their findings in response to a question or proposition that they choose themselves. The aim of the project is to test the independent research skills students have acquired during their time at university, with the assessment used to help determine their final grade. Although there is usually some guidance from your tutors, the dissertation project is largely independent.

Course Content

1. Reading of very recent research papers from high impact journals containing biochemical/allied-field research work and also performance of laboratory based research oriented experiments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Thesis	Presentation
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students will be able to **design** and **perform** a new type of experiment.	**PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO9, PO11**
CO2	Students will be able to **summarize** the observation.	**PO1, PO2, PO5, PO6, PO7, PO8, PO10, PO11**
CO3	Students will **develop** the skill to make the data table.	**PO1, PO2, PO5, PO3, PO4, PO8, PO10, PO12**
CO4	Students will be able to **conclude** the data	**PO4, PO6, PO8, PO10, PO11, PO12**
CO5	Students will be able to i**ntegrate and assess** whether the data is really new or expected.	**PO1, PO2, PO4, PO6, PO8, PO9, PO10, PO11, PO12**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Data Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT14109	Minor Project												

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

BIT14110	Industrial training	L	T	P	C
Version 1.0	Contact Hours - 120	0	0	2	2
Pre-requisites/Exposure	Intermediate level Science				
Co-requisites	--				

Course Objectives:

1. Students will have the opportunity to put content from the classroom into practice consistent with the standards of the industry.
2. The primary goal of this course is to acquaint students with business or agency culture and to help them identify roles in that culture where scientific expertise in biotechnology is relevant.
3. Students will understand professional, ethical and social responsibilities and develop a respect for diversity and a knowledge of contemporary professional, societal and global issues of the need and an ability to engage in lifelong learning,

Course Outcomes

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

CO1. Introductory comprehension and **Interpreting** of the operations of a biotechnology industry/research lab, use of high-end instruments/software

CO2. **Demonstration** of professional behaviour including conscientious and meticulous performance and a collaborative work ethic

CO3. Ability to **distinguish** where knowledge and skills of the biotechnology can apply to industrial/research lab, with an increasing appreciation of the constraints and opportunities afforded by ethical business principles and practices

CO4. **Utilization** of technical information using written progress reports oral presentations related to observation, analysis and evaluation of results

CO5. **Develop** a respect for diversity and a knowledge of contemporary professional, societal and global issues of the need and an ability to engage in lifelong learning.

Catalog Description:

Students participate in research or applied biology outside this university. Students must contact and obtain approval of a supervising instructor at the off-campus location and the department internship coordinator in the term prior to registration. Students have the opportunity to put content from the classroom into practice consistent with the standards of the industry. Industry internships are a powerful way for students to experience biotechnology

first-hand and set them up for future employment. Industrial Training for 4-12 weeks will be taken at the end of 6th Semester, and will be evaluated in the 7th Semester.

Course Content:

Industrial training (BIT14110)

Student Notebook and Portfolio: A bound, paged notebook should serve as a reservoir of observations, results or conclusions about daily activities during the internship. Each date should be entered with a title of the activity in a form that can be listed in the table of contents, with appropriate page numbers. A brief concluding statement which suggests awareness of the purpose and important events or results acquired during the day should appear following any other observations or entries followed by the intern's signature. In addition, any interim projects or progress reports should be assembled or otherwise documented into a portfolio of products or findings arising from the internship.

Written Presentation: At the conclusion of the assignment student will be required to submit a formal written progress report a summary of the important findings; and a statement regarding the impact of these findings on future operations or directions relative to the problem under investigation.

Oral Presentation: Each student is required to make a formal oral presentation on the experience. The presentations will summarize the findings and the overall experience, especially reflecting on the experience relative to the course goal and learning objectives.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Report submission	Presentation
Weightage (%)	**50**	**50**

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

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Introductory comprehension and **Interpreting** of the operations of a biotechnology industry/research lab, use of high-end instruments/software	**PO1, PO2, PO3 PO4,**
CO2	**Demonstration** of professional behaviour including conscientious and meticulous performance and a collaborative work ethic	**PO1, PO2, PO3, PO7, PO8, PO9, PO10**
CO3	Ability to **distinguish** where knowledge and skills of the biotechnology can apply to industrial/research lab, with an increasing appreciation of the constraints and opportunities afforded by ethical business principles and practices	**PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8,PO9, PO11**

CO4	**Utilization** of technical information using written progress reports oral presentations related to observation, analysis and evaluation of results	**PO1, PO2, PO3, PO4, PO5, PO6, PO10**
CO5	**Integrate and assess** a respect for diversity and a knowledge of contemporary professional, societal and global issues of the need and an ability to engage in lifelong learning.	**PO1, PO2, PO7, PO8, PO10, PO11, PO12**

		Academic excellence	Critical thinking	Skills	Modern tools and techniques usage	Problem solving	Analysis	Proper solutions	Professional	Collaboration	Sustainability	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT14110	Industrial training												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

BIT14117	Professional Development Training -V (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	Completion of PDT-IV course				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G)

1. Interview Skills.
2. Aptitude and Technical Skills.
3. Group Discussion and Communication Skills.
4. Personal Branding and Online Presence.
5. Professional Skills.
6. Industry Insights and Company Presentations.
7. Career Guidance for competitive entrance exams and Job Search Strategies
8. Mock Tests and Assessments.

Course learning outcomes:

CO1: Students will be able to **create** professional resumes and cover letters tailored to specific job applications, demonstrating effective resume-building techniques.

CO2: Students will **analyze** various interview scenarios to identify key strategies for successfully navigating different types of interview questions and formats.

CO3: Students will **apply** their aptitude and technical skills to solve real-world problems through mock tests and assessments, showcasing their problem-solving abilities.

CO4: Students will **evaluate** their personal branding and online presence, making necessary adjustments to enhance their professional image on platforms like LinkedIn.

CO5: Students will **demonstrate** effective communication skills in group discussions, presentations, and professional interactions, ensuring clear and confident expression of ideas.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	**50**	**50**

CO\PO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12
CO 1	1	0	0	0	0	0	0	3	0	0	0	0
CO 2	0	1	0	0	0	0	0	2	0	0	0	0
CO 3	0	0	3	0	3	3	0	0	0	0	0	0
CO 4	0	0	0	0	0	0	0	0	0	0	0	2
CO 5	0	2	0	0	0	0	0	0	0	0	0	0

SEMESTER VIII

BIT14111	Major Project	L	T	P	C
Version 1.0		0	0	20	10
Pre-requisites/Exposure	Knowledge about biotechnology and allied fields				
Co-requisites	-				

Course Objectives

1. Defining and outlining a research area with a clear question
2. Identifying the leading issues
3. Sourcing the relevant information
4. Assessing its reliability and legitimacy
5. Evaluating the evidence on all sides of a debate
6. oming to a well-argued conclusion

Course Outcomes

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

CO1. **Design** and perform a new type of experiment.
CO2. **Evaluate** and Summarize the observation.
CO3. **Develop** the skill to make the data table.
CO4. **Conclude** the data
CO5. **Integrate and assess** whether the data is really new or expected.

Catalog Description

Dissertation allows students present their findings in response to a question or proposition that they choose themselves. The aim of the project is to test the independent research skills students have acquired during their time at university, with the assessment used to help determine their final grade. Although there is usually some guidance from your tutors, the dissertation project is largely independent.

Course Content

1. Reading of very recent research papers from high impact journals containing biochemical/allied-field research work and also performance of laboratory based research oriented experiments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Thesis	Presentation
Weightage (%)	50	50

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

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Students will be able to **design** and **perform** a new type of experiment.	**PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO9, PO11**
CO2	Students will be able to **evaluate** and summarize the observation.	**PO1, PO2, PO5, PO6, PO7, PO8, PO10, PO11**
CO3	Students will **develop** the skill to make the data table.	**PO1, PO2, PO5, PO3, PO4, PO8, PO10**
CO4	Students will be able to **conclude** the data	**PO4, PO6, PO8, PO10, PO11, PO12**
CO5	Students will be able to **integrate and assess** whether the data is really new or expected.	**PO1, PO2, PO4, PO6, PO8, PO9, PO10, PO11, PO12**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Data Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT14111	Major Project												

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

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

BIT15112	Comprehensive Viva-Voce	L	T	P	C
Version 1.0		0	0	0	4
Pre-requisites/Exposure	Knowledge of basic biotechnology at B.Tech level				
Co-requisites	-				

Course Objectives

1. Defining and outlining a research area with a clear question
2. Identifying the leading issues
3. Sourcing the relevant information
4. Evaluating the evidence on all sides of a debate
5. Coming to a well-argued conclusion

Course Outcomes

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

CO1. **Utilize** their knowledge during their interview for biotechnology related jobs.
CO2. **Utilize** their knowledge during their interview for biotechnology related research field.
CO3. **Develop** the skill to conclude a scientific fact.
CO4. **Discuss** about the biology data.
CO5. **Integrate** and c**reate** himself/herself as a good biotechnologist in society.

Catalog Description

The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Biotechnology acquired over 4 years of study in the undergraduate program

Course Content

1. Reading of Biotechnology Text books, very recent research papers from high impact journals containing biology research work and also performance of laboratory based research oriented experiments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Viva
Weightage (%)	100

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

Mapping between COs and Pos		
	Course Outcomes (COs)	Mapped Program Outcomes

CO1	Students will be able to **utilize** their knowledge during their interview for biotechnology related jobs.	**PO1, PO2, PO5, PO6, PO8**
CO2	Students will be able to **utilize** their knowledge during their interview for biotechnology related research field.	**PO1, PO4, PO5, PO6, PO7, PO10**
CO3	Students will **develop** the skill to conclude a scientific fact.	**PO1, PO2, PO3, PO6, PO7, PO10**
CO4	Students will be able to **discuss** about the biology data.	**PO1, PO2, PO4, PO5, PO8, PO10**
CO5	Students will be able to **integrate and create** himself/herself as a good biotechnologist in society.	**PO1, PO2, PO3, PO4, PO5, PO6,PO7, PO8, PO9, PO10, PO11, PO12**

		Academic excellence	Critical thinking	Skill Development	Modern tools and techniques	Problem Solving	Data Analysis	Proper solution	Professional Development	Collaboration	Sustainable Learning	Ethics	Global citizen
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT15112	Comprehensive Viva-Voce												

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

ADAMAS UNIVERSITY
SCHOOL OFLIFE SCIENCE & BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY
CO – PO MAPPING

Name of the Programme: B. Tech. Biotechnology

MTH11501	Engineering Mathematics- I											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	3	2	3	3	3	3	2	3	3	2
CO2	3	3	3	2	3	3	3	3	2	3	3	3
CO3	3	3	3	2	3	3	3	3	2	3	3	2
CO4	3	3	3	2	3	3	3	3	2	3	3	2
CO5	3	3	3	2	3	3	3	3	2	3	3	2
Avg	3	3	3	2	3	3	3	3	2	3	3	2.2
PHY13201	Applied Sciences											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-
GEE11001	Electrical and Electronics Technology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-
ENG11053	English Communication Theory											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-

CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11003	Life Sciences											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	1	1	1	1	1	1	1	3	1	1
CO2	3	1	3	3	1	1	1	1	1	3	1	1
CO3	1	1	3	3	3	1	1	1	1	3	1	1
CO4	3	1	1	3	1	3	1	1	1	3	1	1
CO5	1	3	3	1	3	1	1	3	1	3	1	1
Avg	2.2	1.8	2.2	2.2	1.8	1.4	1	1.4	1	3	1	1

DGS11002	Design Thinking & Prototyping											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	2	2	2	1	2	1	1	1	1	1	1
CO 2	3	3	2	2	2	2	1	1	1	1	1	1
CO 3	3	2	3	3	3	3	2	2	2	1	1	1
CO 4	2	3	2	2	3	3	2	1	1	1	1	1
CO 5	3	2	2	1	3	3	2	1	1	1	1	2
Average	2.8	2.4	2.2	2	2.4	2.6	1.6	1.2	1.2	1	1	1.2

GEE12002	Electrical and Elecronics Technology Lab											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

MEE12001	Engineering Workshop											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-

Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-
MTH11502	Engineering Mathematics II											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	3	1	3	3	3	3	-	3	-	2
CO2	3	3	3	1	3	3	3	3	-	3	-	2
CO3	3	3	3	1	3	3	3	3	-	3	-	2
CO4	3	3	3	1	3	3	3	3	-	3	-	2
CO5	3	3	3	1	3	3	3	3	-	3	-	2
Avg	3	3	3	1	3	3	3	3	-	3	-	2
EVS11112	Environmental Science											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	3	1	3	3	3	3	-	3	-	2
CO2	3	3	3	1	3	3	3	3	-	3	-	2
CO3	3	3	3	1	3	3	3	3	-	3	-	2
CO4	3	3	3	1	3	3	3	3	-	3	-	2
CO5	3	3	3	1	3	3	3	3	-	3	-	2
Avg	3	3	3	1	3	3	3	3	-	3	-	2
MEE11002	Engineering Mechanics											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-
CSE11001	Introduction to Programming											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-
CSE12002	Programming Lab											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**

CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-
CEE12001	Engineering Drawing and CAD											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-
CEE12001	Venture Ideation											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	1	3	-	-	-	-	3	-	3	-	3
CO2	3	1	3	-	-	-	-	3	-	3	-	3
CO3	3	1	3	-	-	-	-	3	-	3	-	3
CO4	3	1	3	-	-	-	-	3	-	3	-	3
CO5	3	1	3	-	-	-	-	3	-	3	-	3
Avg	3	1	3	-	-	-	-	3	-	3	-	3
GEE11012	Disruptive Technology Innovations											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	2	2	2	1	2	1	1	1	1	1	1
CO2	3	3	2	2	2	2	1	1	1	1	1	1
CO3	3	2	3	3	3	3	2	2	2	1	1	1
CO4	2	3	2	2	3	3	2	1	1	1	1	1
CO5	3	2	2	1	3	3	2	1	1	1	1	2
Avg	2.8	2.4	2.2	2	2.4	2.6	1.6	1.2	1.2	1	1	1.2
MTH11527	Probability Statistics and Numerical Methods											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	-	2	-	-	-	2	-	3	1	3	3	3

CO2	-	2	-	-	-	2	-	3	1	3	3	3
CO3	-	2	-	-	-	2	-	3	1	3	3	3
CO4	-	2	-	-	-	2	-	3	1	3	3	3
CO5	-	2	-	-	-	2	-	3	1	3	3	3
Avg	-	2	-	-	-	2	-	3	1	3	3	3
MTH12531	Numerical Methods Lab											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-
BIT11058	Biochemistry & Bioenergetics											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	3	2	1	-	-	-	-	-
CO2	3	3	2	3	3	3	2	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	2.8	2.8	2.8	2.4	-	-	-	-	-
BIT11059	Microbiology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-
BIT12060	Biochemistry Lab											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	1	-	1	-	-	-
CO2	3	3	2	3	3	3	2	-	2	-	-	-
CO3	3	3	3	3	3	3	3	-	2	-	-	-
CO4	3	3	3	3	3	3	3	-	2	-	-	-

CO5	3	3	3	3	2	3	3	-	2	-	-	-
Average	3	3	2.8	3	2.8	3	2.4	-	1.8	-	-	-
BIT12061	Microbiology Lab											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-
IDP14001	Inter-Disciplinary Project											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-
SOC14100	Community Service											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	-	3	3	1	3	3	3	3	3	-	-	3
CO2	-	3	3	1	3	3	3	3	3	-	-	3
CO3	-	3	3	1	3	3	3	3	3	-	-	3
CO4	-	3	3	1	3	3	3	3	3	-	-	3
CO5	-	3	3	1	3	3	3	3	3	-	-	3
Avg	-	3	3	1	3	3	3	3	3	-	-	3
BIT14113	Professional Development Training-I (Practical)											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	1	0	0	0	0	0	0	3	0	0	0	0
CO2	0	1	0	0	0	0	0	2	0	0	0	0
CO3	0	0	3	0	3	3	0	0	0	0	0	0
CO4	0	0	0	0	0	0	0	0	0	0	0	2
CO5	0	2	0	0	0	0	0	0	0	0	0	0

Avg	0.2	0.6	0.6	0	0.6	0.6	0	1	0	0	0	0.4

BIT11126	Cell biology and Genetics

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	1	3	1	3	1	1	1	1	1	1
CO2	3	3	3	1	1	3	1	1	3	1	1	1
CO3	3	3	1	1	3	1	1	3	1	1	1	1
CO4	3	3	1	1	3	3	1	1	1	1	1	1
CO5	3	1	1	1	1	1	1	1	1	1	3	3
Avg	3	2.6	1.4	1.4	1.8	2.2	1	1.4	1.4	1	1.4	1.4

BIT11065 Biophysical Techniques & Instrumentation

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
CO2	**3**	**3**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
CO3	**3**	**2**	**3**	**3**	**3**	**2**	-	-	-	-	-	-
CO4	**3**	**2**	**3**	**2**	**2**	**2**	-	-	-	-	-	-
CO5	**3**	**2**	**3**	**2**	**3**	**2**	-	-	-	-	-	-
Average	**3**	**2.2**	**2.4**	**2.6**	**2.8**	**2.4**	-	-	-	-	-	-

BIT11110 Bioprocess Technology

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**2**	**3**	**3**	**2**	-	-	-	-	-	-
CO2	**3**	**3**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
CO3	**3**	**2**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
CO4	**3**	**3**	**2**	**3**	**2**	**3**	-	-	-	-	-	-
CO5	**3**	**2**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
Average	**3**	**2.4**	**2**	**3**	**2.8**	**2.8**	-	-	-	-	-	-

BIT12127 Cell Biology & Genetics Lab

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-

Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT12069 Biophysical Techniques & Instrumentation Lab

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

BIT12070 Bioprocess & Fermentation Technology Lab

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
CO2	**3**	**3**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
CO3	**3**	**2**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
CO4	**3**	**3**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
CO5	**3**	**2**	**2**	**3**	**3**	**3**	-	-	-	-	-	-
Average	**3**	**2.4**	**2**	**3**	**3**	**3**	-	-	-	-	-	-

ECO11505 HSSM-IV (Economics for Engineers)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

PSG11021 Human Values and Professional Ethics

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-

CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

BIT14114	Professional Development Training-II

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	0	0	0	0	0	0	3	0	0	0	0
CO2	0	1	0	0	0	0	0	2	0	0	0	0
CO3	0	0	3	0	3	3	0	0	0	0	0	0
CO4	0	0	0	0	0	0	0	0	0	0	0	2
CO5	0	2	0	0	0	0	0	0	0	0	0	0
Average	0.2	0.6	0.6	0	0.6	0.6	0	1	0	0	0	0.4

BIT11072	Molecular Biology

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11074	Bioinformatics

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

BIT11107	Bioethics, Biosafety & IPR

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**

CO4	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Average	**3**	**2.6**	**2.4**	**2.8**	**2.6**	**3**	**2.8**	**2.8**	**2.6**	**2.6**	**3**	**2.6**
BIT11075	Genomics, Proteomics & Metabolomics (PE THEORY)											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**-**	**1**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**-**	**1**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**1**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**1**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**1**	**-**	**-**	**-**
Average	**3**	**3**	**2.8**	**3**	**2.8**	**3**	**2.8**	**-**	**1**	**-**	**-**	**-**
BIT11076	Recombin ant DNA Technolo gy (PE- THEORY)											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2
BIT11079	Nanobiotechnology (PE II THEORY)											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11111	Profesional elective II Bioenergy for Sustainable Development

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

BIT12081	Molecular Biology Lab (Practical)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT12083	Bioinformatics Lab

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	3	-	-	3
CO2	-	3	3	1	3	3	3	3	3	-	-	3
CO3	-	3	3	1	3	3	3	3	3	-	-	3
CO4	-	3	3	1	3	3	3	3	3	-	-	3
CO5	-	3	3	1	3	3	3	3	3	-	-	3
Avg	-	3	3	1	3	3	3	3	3	-	-	3

BIT12077	PE I Lab Genomics, Proteomic s & Metabolo mics Lab

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

BIT12078	PE I Lab Recombinant DNA Technology Lab											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-
BIT14115	Professional Development Training -III											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	0	0	0	0	0	0	3	0	0	0	0
CO2	0	1	0	0	0	0	0	2	0	0	0	0
CO3	0	0	3	0	3	3	0	0	0	0	0	0
CO4	0	0	0	0	0	0	0	0	0	0	0	2
CO5	0	2	0	0	0	0	0	0	0	0	0	0
Average	0.2	0.6	0.6	0	0.6	0.6	0	1	0	0	0	0.4
BIT11085	Immunotechnology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**
CO4	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**
CO5	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Average	**3**	**2.6**	**2.2**	**2.8**	**2.6**	**3**	**2.8**	**2.8**	**2.6**	**2.6**	**2.2**	**2.6**
BIT11128	Plant & Agricultural Biotechnology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11087	Animal Biotechnology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

BIT11091	PE III Theory Medical Biotechnology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

BIT11101	Advances in Crop Biotechnology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2

BIT11093	Open Elective I Advances in Microbial Biotechno Logy											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-

CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-
BIT11102	Protein Engineering											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Average	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-
BIT12088	Immunotechnology lab											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-
BIT12129	**Plant & Animal Biotechnology Lab**											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-
BIT15095	Technical Seminar											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	-	2	-	-	-	2	-	3	1	3	3	3
CO2	-	2	-	-	-	2	-	3	1	3	3	3
CO3	-	2	-	-	-	2	-	3	1	3	3	3
CO4	-	2	-	-	-	2	-	3	1	3	3	3
CO5	-	2	-	-	-	2	-	3	1	3	3	3
Avg	-	2	-	-	-	2	-	3	1	3	3	3

BIT14116	Professional Development Training-IV											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	0	0	0	0	0	0	3	0	0	0	0
CO2	0	1	0	0	0	0	0	2	0	0	0	0
CO3	0	0	3	0	3	3	0	0	0	0	0	0
CO4	0	0	0	0	0	0	0	0	0	0	0	2
CO5	0	2	0	0	0	0	0	0	0	0	0	0
Average	0.2	0.6	0.6	0	0.6	0.6	0	1	0	0	0	0.4
MGT11402	HSSM IV Industrial Management											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-
BIT11109	Industrial Biotechnology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-
BIT11096	PE-IV Food Biotechnology (THEORY)											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11097	PE-IV Environmental Biotechnology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-
BIT11092	PE-V Stem Cell Biotechnology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-
BIT11094	PE-V Molecular Modeling and Drug Design											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	3	3	-	-	-	-	-

BIT11100	OE-II Agricultural Biotechnology											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2

CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2
BIT11103	OE-II Gene expression											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
Avg	-	3	3	1	3	3	3	3	-	3	-	2
BIT11104	OE III Biocatalysis											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-
BIT11108	OE III RESEARCH METHODO LOGY AND GLP											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-
BIT12098	PE-IV Lab Food Biotechnology Lab											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-
BIT12099	PE-IV Lab Environmental Biotechnology Lab											

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

BIT14109	Minor Project

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

BIT14110	Industrial training

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-

BIT14117	Professional Development Training-V

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	0	0	0	0	0	-	3	-	-	-	0
CO2	0	1	0	0	0	0	-	2	-	-	-	0
CO3	0	0	3	0	3	3	-	0	-	-	-	0
CO4	0	0	0	0	0	0	-	0	-	-	-	2
CO5	0	2	0	0	0	0	-	0	-	-	-	0
Average	0.2	0.6	0.6	0	0.6	0.6	-	1	-	-	-	0.4

BIT14111	Major Project

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-

CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-
BIT15112	Comprehensive Viva-Voce											
CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	3	3	2.8	2.8	3	-	-	-	-	-
Mean of all POs course-wise	2.8	2.7	2.7	2.6	2.6	2.6	2.5	1.8	1.4	2.3	1.6	1.5

***While Averaging only the CO which represents particular PO has been considered**