BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

INSTITUTE VISION

To become a Globally Recognized Academic Institution in consonance with the social, economic, and ecological environment, striving continuously for excellence in education, research, and technological service to the National needs.

INSTITUTE MISSION

- To educate students at Undergraduate, Postgraduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and r esearch projects.
- To develop effective teaching learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education, and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

DEPARTMENT VISION

The Department of Bioengineering has a vision to impart international standard quality education in the field of Biotechnology and Bioengineering.

DEPARTMENT MISSION

- To create state-of-the-art infrastructure for Research and Training in Biotechnology and Bioengineering.
- To provide globally acceptable technical education in Bioscience, Biotechnology and Bioengineering.
- To nurture graduates for innovation and creativity in the field of Bioscience, Biotechnology and Bioengineering have ethical and social concern.
- To promote collaboration with Academia, Industries and Research Organizations at National and International level.
- To contribute to socio-economic development through education and bioentrepreneurship.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To produce graduates in Biotechnology with strong technical competence in Bioscience, technology, engineering and management.
2. To develop teamwork and awareness amongst students towards the importance of multidisciplinary approach for problem solving skills in Biotechnology.
3. To develop trained human resources in Biotechnology to promote quality education and to initiate lifelong learning process for productive career
4. To generate potential knowledge pools with interpersonal and collaborative skills to identify, assess and formulate problems and execute the solution in closely related biological industries.

PROGRAMME OUTCOMES (POs)

1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these in multidisciplinary environments.

11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1: Students will be able to apply the knowledge acquired during the program for identification of problems and designing their solutions in the area of life, biomaterials and bioprocesses.

2: After completion of the program students will acquire competence in handling biotechnology related projects.

3: Students will develop skills to carry out research in different areas of Bioengineering & Biotechnology.

Mapping of Pos and PSOs with PEOs

	PEO1	PEO2	PEO3	PEO4
PO1	1	2	3	2
PO2	2	1	2	3
PO3	2	2	2	3
PO4	2	3	2	2
PO5	3	2	1	2
PO6	2	2	2	3
PO7	1	1	3	1
PO8	1	2	2	3
PO9	2	2	2	3
PO10	2	2	2	3
PO11	2	3	2	3
PSO1	2	2	3	2
PSO2	2	3	3	2
PSO3	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEW COURSE STRUCTURE – To be effective from academic session 2024-25
Based on NEP-2020 model
Recommended scheme of study *(For Non-Circuit Branches)*

Sr. No.	Course Level	Semester of Study (Recommended)	Course Code	Subjects	Mode of delivery & credits *L-Lecture; T-Tutorial; P-Practical*			Total Credits *C-Credits*
					L (*Periods/ week*)	**T** *(Periods/ week)*	**P** *(Periods/ week)*	**C**
I.1	**FIRST**	**FS**	MA24101	Mathematics - I	3	1	0	**4**
I.2			PH24101	Physics	3	1	0	**4**
I.3			BE24101	Biological Science for Engineers	2	0	0	**2**
I.4		**GE**	CS24101	Programming for Problem Solving	3	1	0	**4**
I.5			EE24101	Basics of Electrical Engineering	2	1	0	**3**
I.6		**MC**	**BE24001**	**Foundation to Engineering Mathematics***	3	0	0	**0**
		LABORATORIES						
I.7		**FS**	PH24102	Physics Lab	0	0	2	**1**
I.8		**GE**	CS24102	Programming for Problem Solving Lab	0	0	2	**1**
I.9			EE24102	Electrical Engg. Lab.	0	0	2	**1**
I.10		**HSS**	HU24131	Communication Skills - I	0	0	3	**1.5**
I.11		**MC**	MC24101/102/103/104/105	Choice of NCC/NSS/ PT & Games/ Creative Arts (CA)/Entrepreneurship	0	0	2	**1**
					TOTAL (Theory+ Labs)			**22.5**
	***Mandatory Course for students admitted through NEET**							
II.1	**SECOND**	**FS**	MA24103	Mathematics - II	3	1	0	**4**
II.2			CH24101	Chemistry	3	1	0	**4**
II.3			CE24101	Environmental Science	2	0	0	**2**
II.4		**GE**	ME24101	Basics of Mechanical Engineering	2	1	0	**3**
II.5			EC24101	Basic Electronics	2	1	0	**3**
		LABORATORIES						
II.6		**FS**	CH24102	Chemistry Lab	0	0	2	**1**
II.7		**GE**	EC24102	Electronics Lab	0	0	2	**1**
II.8			ME24102	Engineering Graphics	0	0	4	**2**

II.9			PE24102	Workshop Practice	0	0	2	**1**
II.10		**MC**	MC24106/107/108/109/110	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)/Entrepreneurship	0	0	2	**1**
							TOTAL (Theory+ Labs)	**22**
							TOTAL for 1st Year	**44.5**
Sr. No.	**THIRD**			**THEORY**				
III.1		**FS**	MA24201	Numerical Methods	2	0	0	**2**
III.2		**HSS**	MT24131	UHV2: Understanding Harmony	3	0	0	**3**
III.3		**PC**	**BE24241**	**Cellular Dynamics and Molecular Biology**	3	0	0	**3**
III.4			**BE24242**	**Microbiology**	3	0	0	**3**
III.5			**BE24243**	**Biochemistry**	2	0	0	**2**
III.6			**BE24244**	**Basics of Bioinformatics**	3	0	0	**3**
III.7			**BE24245**	**Chemical Process Calculations**	3	1	0	**4**
				LABORATORIES				
III.8		**PC**	**BE24246**	**Cell Biology Lab**	0	0	2	**1**
III.9			**BE24247**	**Biochemistry Lab**	0	0	2	**1**
III.10			**BE24248**	**Bioinformatics Lab**	0	0	2	**1**
III.11		**FS**	MA24202	Numerical Methods Lab	0	0	2	**1**
III.12		**MC**	MC24201/202/203/204/205	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)/Entrepreneurship	0	0	2	**1**
							TOTAL	**25**
	FOURTH			**THEORY**				
IV.1		**PC**	**BE24249**	**Biology of Immune System**	2	0	0	**2**
IV.2			**BE24250**	**Fluid Mechanics & Heat Transfer**	3	0	0	**3**
IV.3			**BE24251**	**Thermodynamics of Chemical & Biological Systems**	3	0	0	**3**
IV.4		**PE**		**Programme Elective -I**	3	0	0	**3**
IV.5				**Programme Elective -II**	3	0	0	**3**
IV.6		**OE**	XX24XXX/ MO24201	Open Elective-I/ MOOC-I	3	0	0	**3**
IV.7			HU24211	Indian Knowledge System	2	0	0	0
				LABORATORIES				
IV.8			**BE24252**	**Microbiology Lab**	**0**	**0**	**2**	**1**
IV.9			**BE24253**	**Immunology Lab**	**0**	**0**	**2**	**1**

IV.10		PC	BE24254	**Computational Biology Lab**	**0**	**0**	**2**	**1**
IV.11			BE24255	**Fluid Mechanics & Heat Transfer Lab**	0	0	2	**1**
IV.12		MC	MC24206 /207/208/209 /210	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)/Entrepreneurship	0	0	2	**1**
							TOTAL	**22**
							TOTAL for 2nd Year	**47**
	FIFTH			**THEORY**				
V.1		PC	**BE24341**	**Bio-analytical Techniques**	3	0	0	**3**
V.2			**BE24342**	**Functional Genomics, rDNA Technology and Genome Editing**	3	0	0	**3**
V.3			**BE24343**	**Mass Transfer Operations**	3	0	0	**3**
V.4			**BE24344**	**Reaction Engineering**	3	1	0	**4**
V.5		**PE**		**Programme Elective -III**	3	0	0	**3**
V.6		**OE**	XX24XX/ MO24301	Open Elective-II/ MOOC-II	3	0	0	**3**
		LABORATORIES						
V.7		**HSS**	HU24133	Communication Skills - II	0	0	3	**1.5**
V.8			**BE24300**	**Project-I**				**2**
V.9		PC	**BE24345**	**Molecular Biology & rDNA Technology Lab**	0	0	2	**1**
V.10			**BE24346**	**Bio-analytical Lab.**	0	0	2	**1**
V.11			**BE24347**	**Mass Transfer Operation Lab**	0	0	2	**1**
							TOTAL	**25.5**
	SIXTH	**THEORY**						
VI.1		PC	**BE24357**	**Bioprocess Engineering**	3	0	0	**3**
VI.2			**BE24358**	**Bioseparation Engineering**	3	0	0	**3**
VI.3			**BE24359**	**Plant & Agriculture Biotechnology**	3	0	0	**3**
VI.4		PE		**Programme Elective -IV**	3	0	0	**3**
VI.5				**Programme Elective -V**	3	0	0	**3**
VI.6		**OE**	MO24303	Open Elective-III/ MOOC-III	3	0	0	**3**
		LABORATORIES						
VI.7			**BE24361**	**Bioprocess Engineering Lab**	0	0	2	**1**

		PC	BE24362	**Bioseparation Engineering Lab**	0	0	2	**1**
VI.9			BE24363	**Plant Cell Technology Lab**	0	0	2	**1**
VI.10			BE24350	**Project-II**				**2**
							TOTAL	**23**
							TOTAL for 3rd Year	**48.5**

	SEVENTH	**THEORY**						
VII.1		PC	**BE24441**	**Bioreactor Design & Analysis**	3	0	0	**3**
VII.2			**BE24442**	**Integrative Nanobiotechnology**	3	0	0	**3**
VII.3		**PE**		**Programme Elective-VI**	3	0	0	**3**
VII.4		**HSS**	MT24204	Constitution of India	2	0	0	**0**
VII.5		**OE**	XX24XXX / MO24401	Open Elective-IV/ MOOC	3	0	0	**3**
		LABORATORIES						
VII.6		**PC**	**BE24443**	**Bioreactor Design Lab**	0	0	2	**1**
VII.7			**BE24444**	**Integrative Nanobiotechnology Lab**	0	0	2	**1**
VII.8		**MC**	MC24400	Summer Training				**4**
VII.9			**BE24400**	**Project-III**				**3**
							TOTAL	**21**
VIII.1	**EIGTH**	**PC**	**BE24450/ BE24490**	**Project-IV / Industry Internship**				**6**
VII.12		**PC**	**BE24498**	**Comprehensive Viva**				**1**
							TOTAL	**7**
							TOTAL for 4th Year	**28**
							GRAND TOTAL	**168**

Vocational Course for B. Tech (Biotechnology)

Vocational Course	**Course Code**	**Subjects**	L	T	P	**C**
VC	**BE24163**	**Vocational Course-I (Clinical Electrophysiology)**	1	0	4	**3**
VC	**BE24164**	**Vocational Course-II (Instrumental Methods of Analysis)**	1	0	4	**3**

VC	**BE24263**	**Vocational Course-III (Spawn and Mushroom Technology)**	1	0	4	**3**
VC	**BE24264**	**Vocational Course-IV (Fundamentals of Nanoscale Technology)**	1	0	4	**3**

*Requirement of Programme Elective courses (Theory/ Lab): 18 credit or above

Programme Elective Courses for B. Tech (Biotechnology)

Sem		CODE	SUBJECT	L	T	P	C
4th	**PE 1**	BE24256	Cheminformatics	3	0	0	**3**
		BE24257	Enzyme Technology	3	0	0	**3**
	PE 2	BE24258	Natural Product Biotechnology	3	0	0	**3**
		BE24259	Biofuels and Biorefineries	3	0	0	**3**
5th	**PE 3**	BE24348	Stem cell and Tissue Engineering	3	0	0	**3**
		BE24349	Pharmaceutical Biotechnology	3	0	0	**3**
6th	**PE 4**	BE24364	Fermentation Engineering	3	0	0	**3**
		BE24365	Biomaterials	3	0	0	**3**
	PE5	BE24366	Food Science and Technology	3	0	0	**3**
		BE24367	Cellular and Applied Electrophysiology	3	0	0	**3**
7th	**PE6**	BE24445	Metabolic Engineering	3	0	0	**3**
		BE24446	Bioinformatics Algorithms	3	0	0	**3**
		BE24447	Process Biotechnology	3	0	0	**3**

Open Elective Courses for B. Tech (Biotechnology)

4th	**OE 1**	BE24261	Fundamentals of Bioinformatics	3	0	0	**3**
		BE24262	Techniques in Pharmaceutical Biotechnology	3	0	0	**3**
5th	**OE 2**	BE24353	Fundamentals of Bioelectronic Devices	3	0	0	**3**
		BE24354	Biotreatment of Municipal and Industrial	3	0	0	**3**
6th	**OE 3**	BE24370	Fundamentals of Bioinformatics Algorithms	3	0	0	**3**
		BE24371	Comprehensive Nanomaterials	3	0	0	**3**
7th	**OE 4**	BE24451	Bioenergy and Biofuels	3	0	0	**3**
		BE24452	Molecular Modelling and Drug Designing	3	0	0	**3**

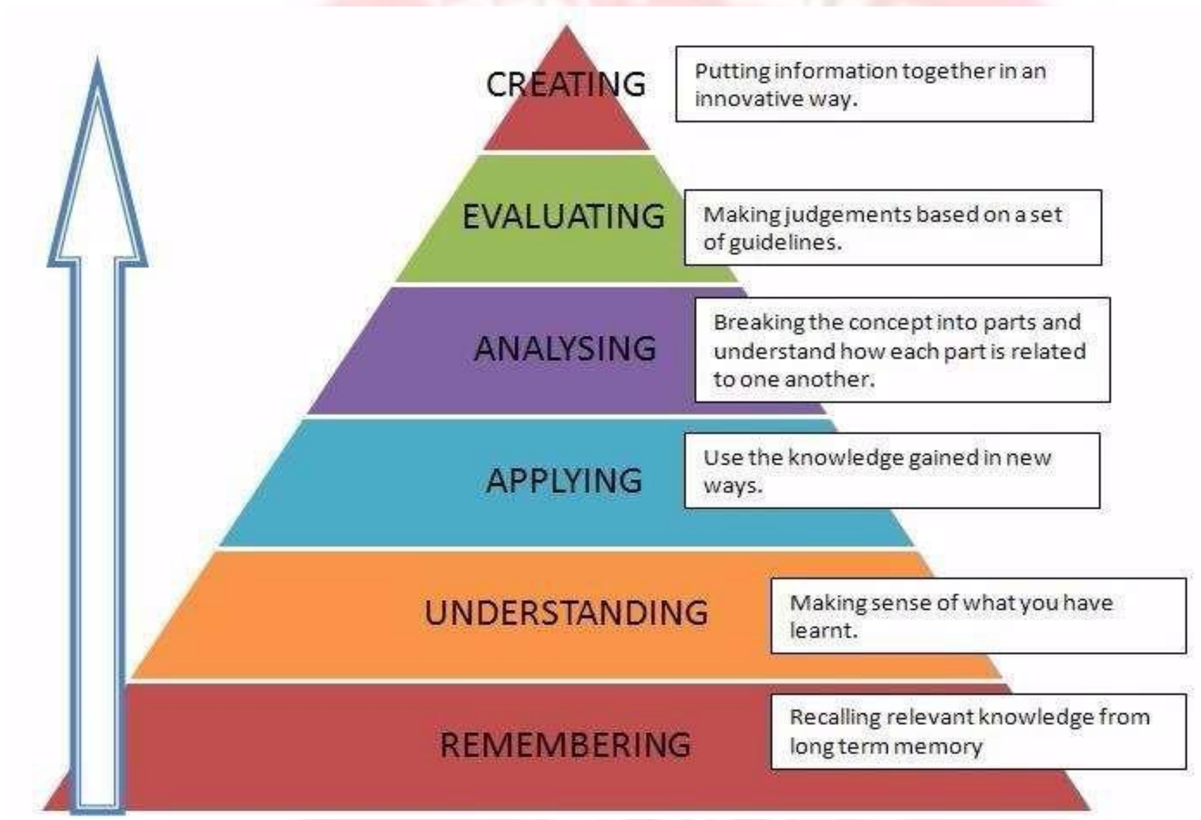
In-depth Specialization in Computational Biotechnology with B. Tech (Biotechnology)							
Sl. No	**Semester of Study (Recommended)**	**Course Code (*TBD*)**	**Subjects**	**Mode of delivery & credits**			**Total Credits**
				L (*Periods /Week*)	**T *(Periods/ Week)***	**P *(Periods/ week)***	**C**
1	5TH	BE24351	Molecular Simulation of Biomolecules	3	1	0	4
2		BE24352	Perl & Bioperl Programming	3	1	0	4
3	6TH	BE24368	Biosequence Analysis and Programming Lab	1	0	2	2
4		BE24369	Advanced Algorithmic Techniques & Communication	3	1	0	4
5	7TH	BE24448	Systems Biology	3	1	0	4
6		BE24449	Advanced Biocomputing Lab	1	0	2	2
TOTAL							**20**

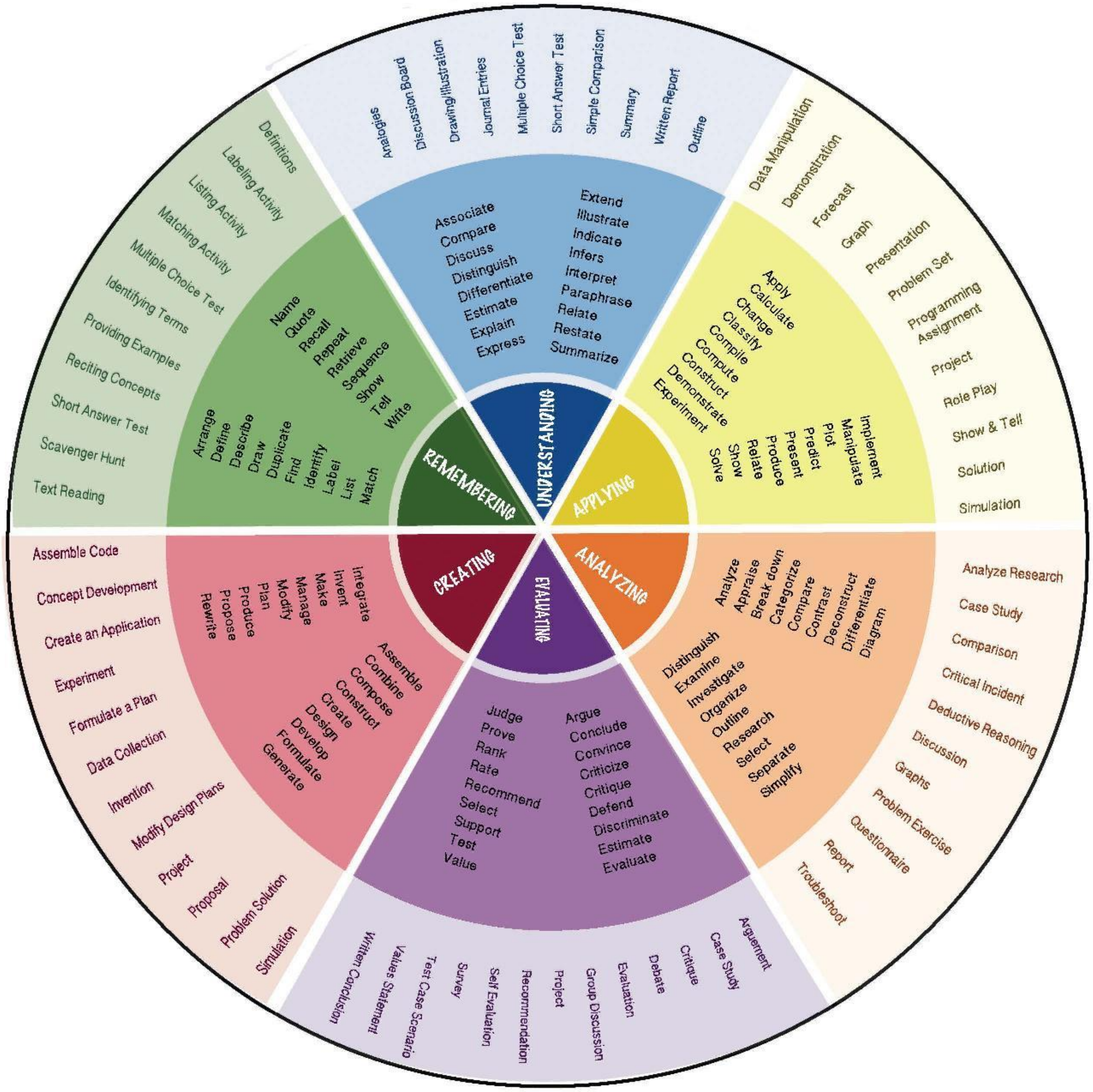
BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI Minor in Biotechnology offered for B. Tech Programme (for other than B.T Biotechnology students) To be effective from academic session 2024-25							
Sl. No.	**Semester of Study (Recomended)**	**Course Code**	**Subjects**	**Mode of delivery & credits** *L-Lecture; T-Tutorial; P-Practicals*			**Total Credits** **C- Credits**
				L	**T**	**P**	**C**
THEORY							
1	5th	BE24355	Cellular and Molecular Dynamics	3	1	0	4
2		BE24356	Biochemistry & Microbiology	3	1	0	4
TOTAL							**8**
3	6th	BE24372	Introductory Pharmaceutical Biotechnology	3	1	0	4
4		BE24373	Basic Biotechnology Lab	1	0	2	2
TOTAL							**6**
5	7th	BE24453	Fundamentals of Process Biotechnology	3	1	0	4
6		BE24454	Process Biotechnology Lab	1	0	2	2
TOTAL							**6**
GRAND TOTAL							**20**

BLOOM'S TAXONOMY FOR CURRICULUM DESIGN AND ASSESSMENT:

Preamble

The design of curriculum and assessment is based on Bloom's Taxonomy. A comprehensive guideline for using Bloom's Taxonomy is given below for reference





Bloom's Taxonomy is used to formulate questions. It facilitates the formulation of action verbs in connection with the various tiers of thinking to achieve a balance between basic retrieval and more complex abilities. Questions at the Remember level, e.g., may use verbs to define or list, questions at the Understand level may use verbs to explain or summarize, at the Apply level use or demonstrate, at the Analyze level differentiate or compare, at the Evaluate level justify or critique, and then at the Create level design or formulate.

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

FIRST YEAR (SEMESTER-I)

COURSE INFORMATION SHEET

Course Code: MA24101
Course Title: Mathematics-I
Pre-requisite(s): -
Co- requisite(s): --
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B.Tech.
Semester / Level: I/1
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	infinite sequences and series
2.	theory of matrices including elementary transformations, rank and its application in consistency of system of linear equations, eigenvalues, eigenvectors etc.
3.	multivariable functions, partial differentiation, properties and applications of partial derivatives.
4.	integrals of multivariable functions viz. double and triple integrals with their applications
5.	properties like gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions

COURSE OUTCOMES (COs)

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

CO1	decide the behavior of sequences and series using appropriate tests.
CO2	handle problems related to the theory of matrices including elementary transformations, rank and its application in consistency of system of linear equations, eigenvalues, eigenvectors etc.
CO3	get an understanding of partial derivatives and their applications in finding maxima - minima problems.
CO4	apply the principles of integrals (multivariable functions viz. double and triple integrals) to solve a variety of practical problems in engineering and sciences.
CO5	get an understanding of gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions and demonstrate a depth of understanding in advanced mathematical topics, enhance and develop the ability of using the language of mathematics in engineering.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
MODULE – I: Sequences and Series Sequences, Convergence of Sequence. Series, Convergence of Series, Tests for Convergence: Comparison tests, Cauchy's Integral test, Ratio test, Cauchy's root test, Raabe's test, Gauss test, Alternating series, Leibnitz test, Absolute and Conditional Convergence.	**9**
MODULE – II: Matrices Rank of a Matrix, elementary transformations. Vectors, Linear Independence and Dependence of Vectors. Consistency of system of linear equations. Eigenvalues, Eigenvectors, Cayley - Hamilton theorem.	**9**
III: Advance Differential Calculus Function of several variables, Partial derivatives, Euler's theorem for homogeneous functions, Total derivatives, Chain rules, Jacobians and its properties, Taylor series for function of two variables, Maxima – Minima.	**9**
MODULE – IV: Advance Integral Calculus Double integrals, double integrals in polar coordinates, Change of order of integration, Triple Integrals, cylindrical and spherical coordinate systems, transformation of coordinates, Applications of double and triple integrals in areas and volumes.	**9**
MODULE – V: Vector Calculus Scalar and vector point functions, gradient, directional derivative, divergence, curl. Line Integral, Work done, Conservative field, Green's theorem in a plane, Surface and volume integrals, Gauss – divergence theorem, Stoke 's theorem.	**9**

TEXTBOOKS:

- M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Educations, 2008E.
- H. Anton, I. Brivens and S. Davis, Calculus, 10th Edition, John Wiley and sons, Singapore Pte. Ltd., 2013.
- Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint,2010.

REFERENCE BOOKS:

- M. J. Strauss, G. L. Bradley And K. J. Smith, Calculus, 3rd Ed, Dorling. Kindersley (India) Pvt. Ltd. (P Ed), Delhi, 2007.
- David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Ed. Asia, Indian Reprint, 2007.
- Robert Wrede & Murray R. Spiegel, Advanced Calculus, 3rd Ed., Schaum's outline series, McGraw-Hill Companies, Inc.,2010.
- D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) --

POS MET THROUGH GAPS IN THE SYLLABUS --

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN ---

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN --

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Laboratory experiments/teaching aids
CD5	Industrial/guest lectures
CD6	Industrial visits/in-plant training
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	0	0	0	0	1	2	**1**	**2**	**3**
CO2	3	3	2	2	2	0	0	0	0	1	2	**1**	**1**	**1**
CO3	3	3	2	2	1	0	0	0	0	1	2	**1**	**2**	**1**
CO4	3	3	3	3	2	1	0	0	0	1	2	**2**	**2**	**2**
CO5	3	3	2	3	2	1	1	1	1	2	2	**1**	**2**	**1**

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: PH24101
Course Title: Physics
Pre-requisite(s): Intermediate Physics and Intermediate Mathematics
Co- requisite(s): Mathematics I
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B.Tech.
Semester / Level: I
Branch: All
Name of Teacher:

COURSE OBJECTIVES (numbers may vary depending on the course)

This course envisions to impart to students:

2.	The principles of physical optics and basic concept of fiber optics.
3.	Fundamental laws of electromagnetism leading to Maxwell's equations.
4.	The posulates of special theory of relativity, Lorenz transformation equation and their consequences: Einstein energy mass relation and relativistic energy-momentum relation
5.	The limitations of classical physics and basic concepts such as wave-particle duality, and working of quantum mechanics with the help of particles in a box problem
6.	Concepts of stimulated emission and working principle of laser with examples, concepts of nuclear physics and plasma physics

COURSE OUTCOMES (COs) (3 COs to 6 COs depending upon the course)

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

CO1	analyse the intensity variation of light due to polarization, interference and diffraction.
CO2	formulate and solve the problems on electromagnetism
CO3	explain and apply concepts of special theory of relativity and its consequences
CO4	Apply the concepts of quantum mechanics such as wave-particle duality and obtain the solution of simple quantum mechanical problems.
CO5	explain working principle of lasers and to summarize its applications, describe basic concepts of nuclear and plasma physics

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: **Physical Optics:** Polarization, Malus' Law, Brewster's Law, Double Refraction, Interference in thin parallel films, Interference in wedge-shaped layers, Newton's rings, Fraunhofer diffraction by single slit and double slit. Elementary ideas of fibre optics and application of fibre optic cables	**8**
Module – II: **Electromagnetic Theory:** Gradient, Divergence and Curl, Statement of Gauss theorem & Stokes theorem, Gauss's law, Applications, Concept of electric potential, Relationship between E and V, Polarization of dielectrics and dielctric constant, Boundary conditions for E & D, Gauss's law in magnetostatics, Ampere's circuital law, Boundary conditions for B & H, Equation of continuity, Displacement current, Maxwell's equations.	**8**
Module – III: **Special Theory of Relativity:** Introduction, Inertial frame of reference, Galilean transformations, Postulates, Lorentz transformations and its conclusions, Length contraction, time dilation, velocity addition, Mass change, Einstein's mass energy relation.	6
Module – IV: **Quantum Mechanics:** Planck's theory of black-body radiation, Compton effect, Wave-particle duality, De Broglie waves, Davisson and Germer's experiment, Uncertainty principle, Brief idea of Wave Packet, Wave Function and its physical interpretation, Schrodinger equation in one-dimension, free particle, particle in an infinite square well	9
Module – V **Modern Physics:** Laser-Spontaneous and stimulated emission, Einstein's A and B coefficients, Population inversion, Light amplification, Basic laser action, Ruby and He-Ne lasers, Properties and applications of laser radiation, Nuclear Physics: Binding Energy Curve, Nuclear Force, Liquid drop model, Introduction to Shell model, Applications of Nuclear Physics, Concept of Plasma Physics and its applications.	9

TEXTBOOKS:

1. A. Ghatak, Optics, 4th Edition, Tata Mcgraw Hill, 2009
2. Mathew N.O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2001
3. Arthur Beiser, Concept of Modern Physics, 6th edition, Tata McGraw- Hill, 2009
4. F. F. Chen, Introduction to Plasma Physics and controlled Fusion, Springer, Edition 2016.

REFERENCE BOOKS:

- Fundamentals of Physics, Halliday, Walker and Resnick

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment/Quiz	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

7. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	2	0	1	1	0	0	1	0	0	2	2	2	2
CO2	2	2	0	1	1	0	0	1	0	0	2	1	2	1
CO3	2	1	0	1	1	0	0	1	0	0	2	0	1	2
CO4	2	1	0	1	1	0	0	1	0	0	2	1	2	2
CO5	2	1	0	1	1	0	0	1	0	0	2	1	2	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: **BE24101**
Course Title: **Biological Science for Engineers**
Pre-requisite(s): -
Co- requisite(s): -
Credits: **2 (L:2 T: 0 P: 0)**
Class schedule per week: **2**
Class: **B. Tech**
Semester / Level: **FIRST**
Branch: **Biotechnology**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand fundamental concepts of biology relevant to engineering.
2.	Explore the structure and function of biological molecules and cells.
3.	Learn about genetic principles and molecular biology techniques.
4.	Understand the applications of biological science in various engineering fields considering global challenges and ethical considerations.

COURSE OUTCOMES (COs)

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

CO1	Comprehend and apply the fundamental concepts of biological sciences in the context of engineering.
CO2	Analyze the structure and function of biological molecules and cells and their relevance to engineering solutions.
CO3	Demonstrate understanding of genetic principles and molecular biology techniques and their applications in engineering.
CO4	Apply knowledge of biological sciences to innovate and develop solutions in various engineering domains and critically evaluate the role of biological sciences in addressing global challenges, including ethical and safety considerations.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module I: Introduction to Biological Sciences Overview and importance of biology in engineering, Origin of Life, Cell Theory and Structure.	**6**
Module II: Molecular Biology and Genetics Central Dogma of Molecular Biology, DNA, RNA and Protein structure and function, Mendelian Genetics, rDNA Technology and Genome Editing.	**6**

Module III: Biochemistry Cell Metabolism, Enzymes and Catalysis, Cell Communication and Signalling.	**6**
Module IV: Applications of Biological Sciences in Engineering Biomaterials, Bioinformatics, Biosensors and Bioelectronics (Biological Sensors- Ear & Eye), Synthetic Biology, Nanobiotechnology.	**6**
Module V: Global Challenges and Ethical Considerations Convergence of AI and Biology, Climate change and food security, Biosafety and Biohazards, Ethical Considerations.	**6**

TEXTBOOKS:

1. Lehninger A, Principals of Biochemistry
2. Stryer L, Biochemistry
3. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.
4. Biology for Engineers" by Arthur T. Johnson

REFERENCE BOOKS:

1. Purves et al, Life: The Science of Biology
2. R. Dulbecco, The Design of Life.
3. Biological Science Edited by Soper, Cambridge low price edition.
4. Synthetic Biology: A Primer" by Paul S. Freemont and Richard I. Kitney
5. "Introduction to Bioinformatics" by Arthur Lesk Genomes" by T.A. Brown

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN
POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	√	√	√	√

Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT
1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1:	3	3	3	3	1	1	1	2	1	1	1	3	2	3
CO2:	3	3	3	3	1	1	1	2	1	1	1	3	3	3
CO3:	1	3	3	3		1	1	1		1	1	2	3	3
CO4:	2	2	2	2		2	2	2		1	1	3	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: CS24101
Course Title: Programming for Problem Solving
Pre-requisite(s): School-level mathematics and Science
Co- requisite(s):
Credits: L: 3 T: 1 P:0
Class schedule per week: 4
Class: UG
Semester / Level: II
Branch: ALL
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Develop Programming Skill.
2.	Understand the fundamental Concepts of Coding
3.	Learn how to Debug Programs
4.	Convert Problems to Programs

COURSE OUTCOMES (COs)

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

CO1	Formulate Algorithms for arithmetic and logical problems.
CO2	Translate the algorithms to programs.
CO3	Test and execute the programs and correct syntax and logical errors.
CO4	Apply programmatic skills for solving scientific problems.
CO5	Decompose problems into functions and structured programming.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I Representation of an Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs: source code, variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.	**6**
Module – II Structure of a C program, variables and data types, Operators – precedence and associativity, Evaluating expressions, Basic I/O – use of printf, scanf, getchar etc. and format specifiers, Conditional Branching statements – If, If - else, If-else- if, switch case, Writing nested conditional statements.	**8**
Module – III Iterative programming structures – for loops, while loops, do while loops. Understanding break and continue and their usage. Writing Nested loops, Arrays –	**8**

creation and usage, Strings and string handling.	
Module – IV Functions (including using built in libraries), Parameter passing in functions, call by value, Recursion, as a different way of solving problems, Nested function calls. Understanding scope and lifetime of a variable.	**8**
Module – V Structures - Defining structures, Accessing structures elements, Creating an array of Structures, Nested structures. Some advanced concepts – typedef, enum, macros. An introduction to pointers – understanding, creating pointers and accessing variables using pointers. Passing arrays to functions: idea of call by reference, passing parameters to main.	**10**

TEXTBOOKS:

1. Let us C, Yashwant Kanetkar, 18th Edition, BPB Publications
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4. R.G.Dromey, How to Solve it by Computer, Pearson Education

REFERENCE BOOKS:

• Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

5. The syllabus focused on the concepts and basics of Program writing skills.
6. Industry often requires debugging of their existing programs/software compare to the new program, which is a knowledge beyond the basics, including real-world software (collection of programs) experience.
7. More memory management practices, file handling and library functions

POS MET THROUGH GAPS IN THE SYLLABUS: YES [PO1-PO5 & PO10-PO12]

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

File Handling with memory management, pre processor directives, Graphics, Data Arrangement, Task scheduling and assembly level programs.

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: YES [PO1-PO5]

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**
2. **Student Feedback on Faculty/Content Delivery**
3. **Student Feedback on Evaluation Procedures**

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars/ Quiz (s)
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Self-Learning, Group Study, Coding Contest

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**	**2**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**	**3**	**2**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**	**2**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**	**1**	**2**	**2**

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD3, CD5
CO3	CD3, CD5, CD7
CO4	CD2, CD3, CD4, CD6, CD7
CO5	CD1, CD3, CD5, CD7

COURSE INFORMATION SHEET

Course Code: EE24101
Course Title: Basics of Electrical Engineering
Pre-requisite(s):
Co- requisite(s): Basic Sciences
Credits: 3 L: 2 T: 1 P: 0
Class schedule per week: 03
Class: B.Tech.
Semester / Level: I (II)/01
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

•	realize the electrical signals, elements, and their properties.
•	understand the mathematical representation of AC, DC signals and theorems/laws for solving electrical circuits with variations of voltage and frequency.
•	perceive the 3-phase AC signal representation and 3-phase circuit analysis for balanced and unbalanced condition.
•	understand the characteristics of magnetic material and analysis of magnetic circuits.

COURSE OUTCOMES (COs)

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

CO1	explain the voltage, current signals and their characteristics in electrical circuit elements.
CO2	apply the theorems/laws for electrical circuit analysis.
CO3	solve the electrical circuits for variable voltage and frequency to observe the resonance, power and power factor in the electric circuit.
CO4	analyze the 1-phase and 3-phase AC balanced and unbalanced circuits
CO5	apply the concept of magnetic circuits for magnetic circuit analysis.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction:** Importance of Electrical Engineering in day-to-day life, Electrical elements, properties (linear, non-linear, unilateral, bilateral, lumped and distributed, etc.) and their classification, Ideal and Real Sources, Source Conversion, Star-Delta conversion, KCL and KVL, Mesh current and Nodal voltage method.	**8**
Module – II **D.C. Circuits**: Steady state analysis with independent and dependent sources; Series and Parallel circuits. **Circuit Theorems:** Superposition, Thevenin's, Norton's, and Maximum Power Transfer theorems for Independent and Dependent Sources applied to DC circuits.	**8**
Module – III **Single-phase AC Circuits:** Common signals and their waveforms, RMS and Average value. Form factor & Peak factor of a sinusoidal waveform. **Series Circuits:** Impedance of Series circuits. Phasor diagram. Active Power. Power factor. Power triangle. **Parallel Circuits:** Admittance method, Phasor diagram, Power and Power factor Power triangle, Series-parallel Circuit, Power factor improvement, Circuit Theorems applied to AC circuits. **Series and Parallel Resonance**: Resonance curve, Q–factor, Dynamic Impedance, and Bandwidth.	**12**
Module – IV **Three-Phase AC Circuits:** Importance and use of a 3-phase network, types of 3-phase connections- Star and Delta, Line and Phase relations for Star and Delta connection, Phasor diagrams, Power relations, analysis of balanced and unbalanced 3-phase circuits, Measurement of Power in 3-phase star and delta network.	**6**
Module – V **Magnetic Circuits:** Introduction, Series-parallel magnetic circuits, Analysis of Linear and Non-linear magnetic circuits, Energy storage, A.C. excitation, Eddy currents and Hysteresis losses. **Coupled Circuits:** Dot rule, Self and mutual inductances, Coefficient of coupling, working of transformer.	**6**

TEXTBOOKS:

- W. H. Hayt, Jr J. E. Kemmerly and S. M. Durbin, Engineering Circuit Analysis, 7th Edition TMH, 2010.
- Hughes, Electrical Technology, Revised by McKenzie Smith, Pearson.

- Fitzgerald and Higginbotham, Basic Electrical Engineering, McGraw Hill Inc, 1981

REFERENCE BOOKS:

- D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, 3rd Edition, TMH, New Delhi, 2009.
- Electrical Engineering Fundamental, Vincent Del Toro, Prentice Hall, New Delhi.
- Rajendra Prasad, Fundamentals of Electrical Engineering, 2nd Edition, PHI, New Delhi, 2011.
- Raymond A. DeCarlo, Prn-Min Lin, Linear Circuit Analysis Time Domain, Phasor and Laplace Transform Approaches, 2nd Edition, Oxford University, 2001
- Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, Basic Electrical Engineering, Tata McGraw Hill Publication, 2009.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

- Application of principles of magnetic circuits to electrical machines like transformers, generators and motors.
- Field applications of three phase equipment and circuits in power system.
- Applications of circuit theorems in electrical and electronics engineering

POS MET THROUGH GAPS IN THE SYLLABUS: 6, 4, 11

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Concepts of electric, magnetic and electromagnetic fields.
2. 3 - Φ power generation, transmission, and distribution.
3. Power factor improvement for three phase systems.
4. Utility of reactive power for creation of electric and magnetic fields.

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: 3, 4, 6.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Quiz (s)	10
Mid Semester Examination	25
End Semester Examination	50
Assignment	10
Teacher Assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5

Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

- **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Self- learning such as use of NPTEL materials and internets
CD8	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**1**	**3**	**2**	**3**	**1**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	**3**
CO2	**3**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**2**
CO3	**3**	**2**	**3**	**3**	**3**	**1**	**2**	**1**	**3**	**1**	**2**	**0**	**1**	**1**
CO4	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**1**	**2**	**0**	**1**	**2**
CO5	**3**	**2**	**1**	**1**	**3**	**1**	**2**	**1**	**3**	**1**	**2**	**0**	**1**	**2**

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD5
CO2	CD1, CD2, CD4, CD5, CD7
CO3	CD1, CD2, CD5, CD7, CD8
CO4	CD1, CD2, CD5, CD7, CD8
CO5	CD1, CD2, CD4, CD5, CD7, CD8

COURSE INFORMATION SHEET

Course Code: **BE24001**
Course Title: **Foundation to Engineering Mathematics**
Pre-requisite(s): - An adequate amount of knowledge in Mathematics, at 10th and 10+2 level.
Co- requisite(s): -
Credits: **2 (L:2 T:0 P: 0)**
Class schedule per week: **2**
Class: **B. Tech**
Semester / Level: **FIRST**
Branch: **Biotechnology**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Grab the knowledge theory of basic mathematical & statistical tools used in biological research/ biotechnology in industry and research lab
2.	Enable the students to understand the principle and application of Differential Calculus, Differential Equations and various Computational Techniques
3.	Learn various aspects to design, conduct, mathematical & statistical analysis new experiments, measurements and interpreting experimental data from biological system and addressing the challenges associated with the interaction between living systems and nonliving materials.

COURSE OUTCOMES (COs)

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

CO1	An ability to apply knowledge of mathematics and statistics to design and conduct experiments, as well as to analyze and interpret data for related to domain of biology.
CO2	An ability to design a system, component, or process to performing research in biological system and addressing the challenges
CO3	An ability to apply the knowledge of basic mathematical & statistical tools used in biological research/ biotechnology in industry and research lab.
CO4	An ability to understand the principle and application of Differential Calculus, Differential Equations and various Computational Techniques

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module I: Linear Algebra Complex numbers: modulus, Roots of complex numbers. Arithmetic Geometric and harmonic progressions, Exponential series. Set Theory, Matrices, Scalars, Vectors, Determinants, Eigen values & vectors, Solution of linear system of equations by matrix inversion method	**6**

Module II: Trigonometry & Co-ordinate Geometry Trigonometric functions and equations, sides of a triangle and T-ratios. Inverse trigonometric functions. Cartesian & Polar Co-ordinates, Distance between two points, Area of a triangle, Equation of a straight line, Angle between two lines. Distance of a point from a straight line. Equations of circle parabola, ellipse, and hyperbola. Scalar and vector product of two vectors	**6**
Module III: Differential Calculus Function, Limits and continuity, Differentiation of functions, Differentiation by substitution, Finding maxima and minima, Equation of tangent and normal lines to a curve	**6**
Module IV: Integral Calculus Integration as the inverse process of differentiation, Integration by the methods of substitution, by parts and by partial fractions, The definite integrals and their simple applications to areas	**6**
Module V: Differential Equations Differential equations (one dimensional and two dimensional) with solution	**6**

TEXTBOOKS:

5. Fundamentals of Mathematics by William M. Setek, Jr. and Michael A. Gallo, Prentice hall, ISBN-0-13-778341-8.
6. Basic Technical Mathematics with Calculus by Allyn J. Washington, Addison-Wesley Publishing Company.

REFERENCE BOOKS:

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT
1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1:	3	3	3	2	1	1	1	2	1	3	1	3	2	3
CO2:	3	2	3	3	1	1	1	2	1	1	1	3	3	3
CO3:	1	3	2	3		1	2	1	2	3	3	2	3	1
CO4:	2	2	3	2		2	3	2		1	1	3	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

<u>**COURSE INFORMATION SHEET**</u>

Course Code: PH24102
Course Title: Physics lab
Pre-requisite(s): Intermediate Physics
Co- requisite(s):
Credits: 1 L: 0 T: 0 P: 2
Class schedule per week: 2
Class: B.Tech.
Semester / Level: I
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	Understand the fundamentals of physical measurements and learn to account for inevitable errors in physical measurements.
2.	Understand and verify the basic principles of physics by hands-on experiments and making suitable measurements.
3.	Make electrical connections reliably to form functional circuits for measuring electrical quantities such as voltage, current, resistance, and resistivity
4.	Learn to set up different types of oscillating systems to study their characteristics, viz -a-viz resonant frequency, frequency response, phase relationship, bandwidth, and quality factor
5.	Develop an understanding of optical phenomena like dispersion, interference and diffraction and make measurements on the patterns produced to obtain physical quantities such as wavelength of light and refractive index of transparent materials.

COURSE OUTCOMES (COs)

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

CO1	Make reliable measurements and report results along with errors.
CO2	Wire simple electrical circuits for experimentally determining measurable electrical quantities.
CO3	Build electral and mechanical oscillating systems, characterize them, and make measurements over them.
CO4	Construct setups to produce interference and diffraction patterns and make measurements for determining physical quantities.

SYLLABUS (List of experiments)

- Error analysis in Physics Laboratory (CO: 1)
- To determine the frequency of AC mains with the help of a sonometer. (CO:1, 2, 3)
- To determine the resistance per unit length of a Carey Foster's bridge wire and resistivity of unknown wire. (CO:1, 2)
- Measurement of electrical equivalent of heat (CO:1, 2)
- To determine the wavelength of sodium lines by Newton's rings method (CO:1, 4)
- To determine the frequency of tuning fork using Melde's Experiment (CO:1,3)
- Measurement of voltage and frequency of a given signal using CRO (CO: 1,2, 3)
- To determine the emf of a cell using stretched wire potentiometer (CO:1, 2)
- Determination of refractive index of the material of a prism using spectrometer and sodium light (CO:1, 4)
- To study the frequency response of a series LCR circuit (CO:1, 2, 3)
- To study Lorentz force using Current balance (CO:1,2)
- To study electromagnetic induction and verification of Faraday's laws. (CO:1,2,3)
- To measure the wavelength of prominent spectral lines of mercury light by a plane transmission grating. (CO:1, 4)
- To determine the Planck's constant using photocell and optical wavelength filters. (CO:1, 2)

REFERENCE MATERIALS:

1. Lab manuals (available on department website)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

- **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	1	0	1	2	0	0	2	0	0	2	1	1	1
CO2	2	1	0	1	2	0	0	2	0	0	2	0	1	2
CO3	2	1	0	1	2	0	0	2	0	0	2	1	1	1
CO4	2	1	0	1	2	0	0	2	0	0	2	1	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: CS24102
Course Title: Programming for Problem Solving Laboratory
Pre-requisite(s):
Co- requisite(s): Programming for Problem Solving (CS24101)
Credits: L: T: P:
Class schedule per week:
Class:
Semester / Level: Ist, 1
Branch:All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students:

1.	The basics of computer programming.
2.	Ideas about converting problem statements to programs.
3.	Ideas about handling data at scale.
4.	Knowledge about accessing the memory of a computer using code.

COURSE OUTCOMES (COs)

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

CO1	Write basic programs using fundamental control structures.
CO2	Demonstrate the accessing of arrays.
CO3	Write simple functions to modularize programs.
CO4	Work with user defined data types.
CO5	Access memory using pointers and manipulate data using them.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Programming using basic control structures including sequential programs, selection logic including nested selection logic switch structures.	3
Module – II Write programs using basic iterative structures, nested iterations, programs using looping with selections, controlled loop exit, Manipulating n-dimensional arrays.	3
Module – III Modularize programs using functions, functions calling functions, elementary string handling programs, recursive programs.	3
Module – IV Programs using user defined data types, arrays of user defined data types, basic usage of pointers, functions and pointers.	3
Module – V Advanced usage of pointers, string handling using pointers, parameterizing main, manipulating arrays using pointers.	3

TEXTBOOKS:

1) Programming in C, Yashwant Kanetkar, BPB Publications.

REFERENCE BOOKS:

1) C Programming, Byron Gottfried, Addison Wesley Press

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1) Elementary file handling

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Laboratory Quiz	20

Laboratory Performance	30
Laboratory Viva	20
Continuous Evaluation	30

INDIRECT ASSESSMENT

8. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	1	2			3	1			1	1	1
CO2	3	3	2	1	2			3	1			0	0	1
CO3	3	3	2	1	2			3	1			1	2	2
CO4	3	3	2	1	2			3				2	2	2
CO5	3	2	2	1	2			1				1	1	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	
CO2	
CO3	
CO4	
CO5	

COURSE INFORMATION SHEET

Course code: EE 24102

Course Title: Electrical Engineering Laboratory

Pre-requisite(s): Physics, Fundamentals of Mathematics and Electrical Engineering.

Co- requisite(s):

Credits: 01 L: 0 T: 0 P: 2

Class schedule per week: 02

Class: B. Tech

Semester / Level: I (II)/1

Branch: EEE

Name of Teacher

Course Objectives

This course enables the students:

1.	To describe students' practical knowledge of active and passive elements and operation of measuring instruments
2.	To demonstrate electrical circuit fundamentals and their equivalent circuit models for both 1-φ and 3- φ circuits and use circuit theorems
3.	To establish voltage & current relationships with the help of phasors and correlate them to experimental results
4.	1. To conclude performance of 1 – Φ AC series circuits by resonance phenomena 2. To evaluate different power measurements for both 1-φ and 3- φ circuits

Course Outcomes

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

CO1	classify active and passive elements, explain working and use of electrical components, different types of measuring instruments;
CO2	illustrate fundamentals of operation of DC circuits, 1-φ and 3- φ circuits and also correlate the principles of DC, AC 1-φ and 3- φ circuits to rotating machines like Induction motor and D.C machine
CO3	measure voltage, current, power, for DC and AC circuits and also represent them in phasor notations;
CO4	analyze response of a circuit and calculate unknown circuit parameters;
CO5	recommend and justify power factor improvement methods in order to save electrical

LIST OF EXPERIMENTS ***(The experiment list may vary to accommodate recent development in the field)***

EXPERIMENT – 1

Name: - Measurement of low and high resistance of a DC shunt motor

Aim: - (i) To measure low resistance of armature winding of DC shunt motor.

(ii) To measure high resistance of field winding of DC shunt motor.

EXPERIMENT – 2

Name: - AC RLC series circuit

Aim: - To obtain current and voltage distribution in AC RLC series circuit and draw the phasor diagram of voltage distribution.

EXPERIMENT – 3

Name: - Single phase power factor measurement by three voltmeter method

Aim: - To obtain power and power factor of the single-phase load using three voltmeter method and draw the phasor diagram.

EXPERIMENT – 4

Name: - AC RLC parallel circuit

Aim: - To obtain current and voltage distribution in a AC RLC parallel circuit and draw the current phasor diagram.

EXPERIMENT – 5

Name: - Single phase power factor measurement by three Ammeter method

Aim: -To obtain power and power factor of single-phase load using three ammeter method and draw the phasor diagram.

EXPERIMENT – 6

Name: -Study of resonance in a RLC series circuit

Aim: - To obtain the resonance condition in AC RLC series circuit and draw the phasor diagram.

EXPERIMENT – 7

Name: -Three phase Delta connection

Aim: - To obtain the relation between line and phase quantities in a three-phase Delta connected load and obtain the phasor diagram.

EXPERIMENT – 8

Name: - Three phase Star connection

Aim: -To obtain the relation between line and phase quantities in a three-phase Star connected load and draw the phasor diagram.

EXPERIMENT – 9

Name: - Measurement of three phase power by two wattmeter method.

Aim: - To measure the power input to a three-phase induction motor by two-wattmeter method and draw the phasor diagram.

EXPERIMENT – 10

Name: - Verification of superposition and Thevenin's Theorems.

Aim: - (i) To verify Thevenin's Theorem for a given circuit.

(ii) To verify Superposition Theorem for a given circuit.

Gaps in the syllabus (to meet Industry/Profession requirements)

1. Application of principles of magnetic circuits to electrical machines like transformers, generators and motors.
2. Visualize Phase sequence.

POs met through Gaps in the Syllabus: 1, 2, 4, 6.

Topics beyond syllabus/Advanced topics/Design

1. Assignment: Simulation of electrical circuits with dependent/independent sources by various techniques (Mesh current/Node Voltage/Thevenin's theorem/Norton's theorem/Maximum power transfer theorem etc.) using MATLAB/PSIM/C++ software.
2. Active/reactive power calculation for 3 – Φ circuits

POs met through Topics beyond syllabus/Advanced topics/Design: 3, 4, 5, 6.

Mapping lab experiment with Course Outcomes

Experiment	Course Outcomes				
	CO1	CO2	CO3	CO4	CO5
1	3	3	1	1	
2	3	3	3	3	3
3	3	3	3	3	3
4	3	3	3	3	3
5	3	3	3	3	3
6	3	3	3	3	
7	3	3	3	1	
8	3	3	3	1	1
9	3	3	3	2	2
10	3	3	2	2	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	1	2	3	3	1	2	1	2	2
CO2	3	2	3	2	3	1	2	3	3	1	2	1	1	2
CO3	3	2	3	2	3	1	2	3	3	1	2	0	1	1
CO4	3	2	3	2	3	1	2	3	3	1	2	0	1	2
CO5	3	2	3	2	3	2	2	3	3	1	2	0	1	1

Course Delivery methods	
CD1	Laboratory experiments/teaching aids
CD2	Mini projects/Projects
CD3	Tutorials/Assignments
CD4	Self- learning, such as the use of NPTEL materials and the internet

COURSE INFORMATION SHEET

Course Code: **HS24131**
Course Title: **Communication Skills I**
Pre-requisite(s): -
Co- requisite(s): -
Credits: **1.5 (L:0 T:0 P: 3)**
Class schedule per week: **3**
Class: **B. Tech**
Semester / Level: **FIRST**
Branch: **Biotechnology**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	**Develop Language Proficiency and communicative competence**: Improve students' ability to read, write, speak, and listen effectively in English. In addition, students will also learn and improve politeness strategies in communicative contexts.
2.	**Enhance Verbal and Non-Verbal Communication**: Train students in both spoken and body language communication for personal and professional interactions.
3.	**Enhance Reading Ability:** Equip students with the ability to strategically comprehend and interpret visual and textual information.
4.	**Enhancing Writing Proficiency**: Enable students to write structured reports, emails, resumes, and other professional documents.
5.	**Developing Presentation and Public Speaking Skills:** Self-assurance during talks, presentations and speeches.

COURSE OUTCOMES (COs)
After the completion of this course, students will be able to:

CO1	In a variety of pragmatic and communicative contexts, students will be able to confidently and fluently articulate their ideas.
CO2	This will enable learners to accurately interpret messages for effective interaction by comprehending audio texts and listening selectively.
CO3	Learners will be able to examine texts for particular and intricate details, draw inferences, and provide interpretations.
CO4	Learners will be capable of creating organized written pieces, including paragraphs, essays, and narratives, and will also be able to summarize, paraphrase, and create précis of ideas effectively.
CO5	Learners will be capable of confidently using verbal and non-verbal communication during speeches and presentations.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I Theory **Principles of Fundamental Communication.** Communication theory, various types and methods of communication, communication flow (upward, downward, and horizontal), characteristics of successful communication, obstacles, and approaches, verbal and non-verbal communication, and social context communication— requests, refusals, compliments, and providing constructive feedback. **Practice** **Communication:** Study relevant materials or case studies on effective communication, obstacles, strategies, and both verbal and non-verbal aspects. Understand and contextualize the influence of culture and society on communication in both writing and speaking. **Role plays:** Engage in scenario-based questions focusing on communication, body language, and courtesy. **Dialogue writing:** Presenting viewpoints based on various situations or scenarios—including requests, refusals, compliments, and criticism—in both writing and speaking.	**6**
Module – II **Theory** **Communicating, Depicting, and Hearing:** Salutations, Presenting oneself/others, Descriptive communication for locations, objects, scenarios, challenges, etc. Proficient listening abilities and the various aspects of listening, including types such as intensive, responsive, selective and extensive. A brief introduction to Varieties of English Accents (neutral accent) through audio and video examples. **Practice tasks** **Introducing people/Describing people:** • Introducing oneself and others • Characterizing an individual, image, circumstance • Discussing traits (positive/negative/critical) about a person, object, scenario, or image. **Listening skills:** • Engaging in attentive listening activities • Listening selectively to complete the blanks • Hearing a passage and rephrasing the precise information in your own words (listening comprehension) • Listening to a discussion on a topic and responding critically. • Attending to informal workplace interactions and dialogues.	**6**

Module – III Theory **Enhancing Vocabulary and Grammar** Lexicon (Affixes- Inflections-Derivations), Registers, Idiomatic Expressions and Phrasal Verbs, vocabulary in context. Opposites, similar words, and one-word alternatives. Sentence constructions (word order like SVO, etc.), Paragraphs (Thesis statement, main idea, topic sentences), Generating ideas for paragraph composition. W. S Allen (Book) **Practice** **Vocabulary Building:** • Students utilize specific vocabulary related to various registers to construct paragraphs, narratives, and more. • Students incorporate phrasal verbs to create a coherent paragraph. Exercises involving antonyms, synonyms, and word substitution can be conducted using worksheets. • Engage graphic organizers such as word associations and concept mapping for vocabulary enhancement activities. Identify suffixes, prefixes, idioms, and phrasal verbs: • Analyze texts to find suffixes and prefixes along with their definitions. • Word association and spider diagrams can be utilized to uncover suffixes and prefixes. **Paragraph writing:** • Generate ideas about a topic/concept/idea and prompt students to compose a detailed • paragraph.	**6**
Module – IV **Theory** **Elements of Reading and Writing** Present the sub-skills involved in reading and writing, including the different types of reading such as close reading and intensive reading. Techniques like mind mapping and note-taking. Generating ideas through brainstorming, structuring thoughts, and creating coherent written pieces consisting of an introduction, body, and conclusion. Writing letters, summaries, précis, resumes, essays, narratives, biographies, and news articles. Practice **Reading:** • Encourage students to distinguish between factual and inferential information from a text. • Read a passage and create a mind map outlining the main and supporting ideas of the content. • Read the text and take notes. • Read and interpret the author's perspective. • Read and conduct a critical analysis of the text. • Read a passage and provide constructive feedback. (speaking/writing modality) **Writing:** • Compose a summary. • Write a précis. • Create a resume. • Develop an essay. • Write a narrative account, whether personal or about others. Produce a news column.	**6**

Module – V Theory **Public speaking and presentation abilities** Public speaking and presentation techniques Public speaking, objectives of a speech – to inform, entertain, persuade, or commemorate/celebrate. Methods of persuasion in speeches – ethos, logos, and pathos. Speech preparation – researching background information, organizing content, crafting an introduction, developing main points, and concluding effectively. Showcasing structured speeches – welcome addresses, farewell remarks, expressions of gratitude (examples may be provided in written scripts, videos, or audio recordings). Presentation etiquette, verbal presentations, poster displays, and delivering speeches. **Practice** **Public speaking:** • Deliver an opening speech (during the Annual day, General meeting, sports day, cultural events) • Present a farewell address • Express gratitude through a vote of thanks • Make a persuasive speech (given a specific scenario) Engage in an extempore speech **Presentations:** Conduct a role play • Prepare a PowerPoint presentation Create a poster presentation	**6**

TEXTBOOKS:

- Communication Skills (2015) 2nd edition, Sanjay Kumar & Pushp Lata, Oxford University Press
- Business Correspondence and Report Writing (2017), R.C.Sharma, Krishna Mohan. McGraw Hill

REFERENCE BOOKS:

1. Basic Business Communication-(2004). Lesikar I Flatley, McGraw Hill
2. Business Communication Today, (2017), Bovee, Thill and Chatterjee, Pearson
3. Krishnan, M, & Jha, S.(2024). *Focus: A course in Communication Skills*. Cambridge University Press
4. Suparna Dutta, 2013 Business Communication, PHI Learning Pvt Ltd, New Delhi

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION

REQUIREMENTS) POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN
COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION

PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
End Semester exams	40

Continuous Internal Assessment	% Distribution
Day-to-day performance & assignments	30
Quiz 1	10
Viva- Voce	20

End Semester Examination	% Distribution
Examination: Submission of reports	30
Viva- Voce	10

Assessment Components	CO1	CO2	CO 3	CO 4	CO 5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Examination: Submission of reports	✓	✓	✓	✓	✓

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

INDIRECT ASSESSMENT

1.Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning, such as the use of NPTEL materials and the internet
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	1	1	1		1	1		2	3	3	2	3			
CO2	1			1	1	1		1	2	2	1	2			
CO3	2	3	1	2	2	1		1	2	2	1	3			
CO4	2	2	2	1	2	1		2	2	3	2	3			
CO5	1	1	1		2	2	1	2	3	3	2	3			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD2, CD 3
CO2	CD 3, CD 6
CO3	CD 1, CD 2
CO4	CD 3, CD6
CO5	CD 2, CD3, CD6

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK
(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

FIRST YEAR (SEMESTER-II)

COURSE INFORMATION SHEET

Course Code: MA24103
Course Title: Mathematics II
Pre-requisite(s): Mathematics - I
Co- requisite(s): --
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B.Tech.
Semester / Level: II/1
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

5.	various methods to solve linear differential equations of second and higher order
6.	special functions viz. Legendre's and Bessel's and different properties associated with them
7.	diverse mathematical techniques for solving partial differential equations of first order, along with their applications in wave and heat equations using Fourier series
8.	the theory of functions of a complex variable, complex differentiation and integration
9.	about random variables and elementary probability distribution

COURSE OUTCOMES (COs)

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

CO1	investigate the occurrence of ordinary differential equations in real-life problems and identify the suitable methods available for their solutions.
CO2	develop skills to solve and implement various forms of differential equations and special functions in diverse domains.
CO3	learn to solve various forms of partial differential equations arising in real-world.
CO4	gain an understanding of complex variable functions and their properties in science and engineering.
CO5	comprehend and apply the concept of probability distributions in solving problems related to uncertainty.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Ordinary Differential Equations – I Linear differential equations, Wronskian, Linear independence and dependence of solutions, Linear differential equations of 2^{nd} and higher order with constant coefficients, Operator method, Euler – Cauchy's form of linear differential equation, Method of variation of parameters.	**9**
Module – II Ordinary Differential Equations – II Ordinary and singular points of differential equation, Power and Frobenius' series solutions (root differ by non integer and equal roots). Bessel's differential equation, Bessel function of first kind and its important properties. Legendre's differential equation, Legendre's polynomial and its important properties.	**9**
Module – III Fourier series and Partial Differential Equations Fourier series: Euler formulae for Fourier series, Half range Fourier series. Partial Differential Equations: Method of separation of variables and its application in solving one dimensional wave and heat equations.	**9**
Module – IV Complex Variable-Differentiation & Integration Function of a complex variable, Analyticity, Analytic functions, Cauchy – Riemann equations. Cauchy's theorem, Cauchy's Integral formula, Taylor and Laurent series expansions. Singularities and its types, Residues, Residue theorem.	**9**
Module – V Applied Probability Discrete and continuous random variables, cumulative distribution function, probability mass and density functions, expectation, variance. Introduction to Binomial, Poisson and Normal Distribution.	**9**

TEXTBOOKS:

1. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., McGraw Hill, 2004.
4. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing, 3rd Ed, 2009.
5. R. A. Johnson, I. Miller and J. Freund: Probability and Statistics for Engineers, PHI
6. S. C. Gupta and V. K. Kapoor: Fundamental of Mathematical Statistics, Sultan Chand and Sons

REFERENCE BOOKS:

- W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
- N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
- E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
- G. F. Simmons, Differential Equations with Applications and Historical Notes, TMH, 2nd ed., 2003.
- P. L. Meyer: Introductory Probability and Statistical Applications, Oxford & IBH.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) --

POS MET THROUGH GAPS IN THE SYLLABUS --

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN ---

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN --

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

7. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Laboratory experiments/teaching aids
CD5	Industrial/guest lectures
CD6	Industrial visits/in-plant training
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	1	0	0	0	1	2	**2**	**2**	**2**
CO2	3	3	2	3	2	1	0	0	1	1	2	**2**	**3**	**3**
CO3	3	3	2	3	2	1	0	0	1	1	2	**1**	**2**	**2**
CO4	3	2	2	2	2	1	0	0	1	1	2	**2**	**3**	**3**
CO5	3	3	2	2	2	1	1	1	1	2	3	**1**	**2**	**2**

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: CH24101
Course Title: Chemistry
Pre-requisite(s): Intermediate level Chemistry
Co- requisite(s):
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B.Tech.
Semester / Level: I
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students:

8.	To create concept of chemical bonding in coordination chemistry
9.	To understand the basics of stereochemistry, aromaticity and reaction mechanism of organic molecules
10.	To understand the reaction dynamics and to know different types of catalysis
11.	To apprehend the basic principles and the application of vibrational, electronic and NMR spectroscopy
12.	To develop knowledge on the physical state and electrochemistry of molecules

COURSE OUTCOMES (COs) (3 COs to 6 COs depending upon the course)

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

CO1	Able to explain the bonding in a coordination complex
CO2	Able to explain the 3D structure, aromaticity and stereochemistry of organic molecules
CO3	Able to predict the rate, molecularity and mechanism of a simple as well as catalytic reaction
CO4	Able to explain the UV-vis, IR and NMR spectra of unknown molecules
CO5	Able to interpret the phase diagram of simple one and two component heterogeneous systems in equilibrium and the electrochemical behavior of the molecules

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Bonding in Coordination Complex Introduction to Chemical Bonding, Werner's Theory, Bonding in coordination complexes, Crystal Field Theory, Octahedral, Tetrahedral and Square planar complexes, CFSE, Jahn Teller theorem, Spectral, electronic and magnetic properties of coordination complexes.	**8**
Module – II: Organic Structure and Reactivity Aromaticity, Geometrical isomerism: cis–trans, E/Z, and syn-anti isomerism; Optical isomerism & Chirality; Wedge, Fischer, Newmann and Sawhorse projection formulae and interconversions; D/L, R/S nomenclature system; Conformational studies of n-butane. Addition, Elimination, Substitution and Rearrangement reaction.	**8**
Module – III: Kinetics and Catalysis Kinetics of Chain, Parallel/Competing/Side, Consecutive reactions; Fast reactions; Outline of Catalysis, Acid-base catalysis, Enzyme catalysis (Michaelis-Menten equation), Important catalysts in industrial processes: Hydrogenation using Wilkinsons catalyst, Phase transfer catalyst.	8
Module – IV: Spectroscopic Techniques Absorption Spectroscopy, Lambert-Beers law, Principles and applications of UV-Visible spectroscopy, Principles and applications of Vibrational spectroscopy; Introduction of NMR spectroscopy.	8
Module – V: Phase and Chemical equilibrium Phase rule: terms involved, Phase diagram of one component (Water) & two component (Pb/Ag) system & their applications; Gibbs Free energy, Van't Hoff equation and Chemical Equilibrium; Nernst Equation, Standard electrode potential, EMF measurement and its application, Batteries and Fuel Cells.	8

TEXTBOOKS:
1. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 4 th edition, Pearson.
2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Seventh Edition, Pearson
3. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

REFERENCE BOOKS:
1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier (2009).
3. William Kemp, Organic Spectroscopy, 3 rd Ed., 2008 Macmillan.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

Limited exposure to computational tools, industrial case studies, and skill-based training needed for industry readiness.

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

13. Student Feedback onCourse Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	0	0	0	0	1	0	2	1	1	2
CO2	3	3	2	1	0	0	0	0	1	0	2	2	2	3
CO3	3	3	3	2	1	1	0	0	1	0	3	2	3	3
CO4	3	2	1	3	3	0	0	0	2	0	2	1	2	2
CO5	3	3	2	2	1	2	0	0	1	0	3	1	1	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: CE24101
Course title: Environmental Science
Pre-requisite(s): NA
Co- requisite(s): NA
Credits: 3 L:3 T:0 P:0
Class schedule per week: 2
Class: B.Tech.
Semester / Level: 1st Semester/1
Branch: ALL
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

	To develop basic knowledge of ecological principles and their applications in environment.
	To identify the structure and composition of the spheres of the earth, the only planet sustaining life.
	To analyse, how the environment is getting contaminated and probable control mechanisms for them.
	To generate awareness and become a sensitive citizen towards the changing environment.

COURSE OUTCOMES (COs)

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

CO1	Able to explain the structure and function of ecosystems and their importance in the holistic environment.
CO2	Able to identify the sources, causes, impacts and control of air pollution
CO3	Able to distinguish the various types of water pollution happening in the environment and understand about their effects and potential control mechanisms.
CO4	Able to judge the importance of soil, causes of contamination and need of solid waste management.
CO5	Able to know the impacts of noise pollution and its management.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Ecosystem and Environment Concepts of Ecology and Environmental Science, ecosystem: structure, function and services, Biogeochemical cycles, energy and nutrient flow, ecosystem management. Concept of Biodiversity.	6
Module – II: Air Pollution Structure and composition of unpolluted atmosphere, classification of air pollution sources, types of air pollutants, effects of air pollution, monitoring of air pollution, Air pollution control and management.	6
Module – III: Water Pollution Water Resource; Water Pollution: types and Sources of Pollutants; effects of water pollution; Water quality monitoring, Water quality index, water and wastewater treatment: primary, secondary and tertiary.	6
Module – IV: Soil Pollution and Solid Waste Management Soil profile, soil properties, soil pollution, and Municipal solid waste management. MSW – Functional elements of MSW.	6
Module – V: Noise Pollution Noise pollution: introduction, sources, outdoor and indoor noise propagation, Effects of noise on health, criteria noise standards and limit values, Noise measurement techniques, prevention and control of noise pollution.	6

TEXTBOOKS:

1. A, K. De. (3rd Ed). 2008. Environmental Chemistry. New Age Publications India Ltd.
2. R. Rajagopalan. 2016. Environmental Studies: From Crisis to Future by, 3rd edition, Oxford University Press.
3. Eugene P. Odum. 1971. Fundamentals of Ecology (3rd ed.) -. WB Sunders Company, Philadelphia.
4. C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press.
5. S.C. Santra. 2011. Environmental Science. New Central Book Agency.

REFERENCE BOOKS:

1. D.W. Conell. Basic Concepts of Environmental Chemistry, CRC Press.
2. Peavy, H.S, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw - Hill International
3. G.M. Masters & Wendell Ela. 1991. Introduction to Environmental Engineering and Science, PHI Publishers.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED

TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

- **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internet

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	PSO1	PSO2	PSO3
CO1	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**
CO2	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**
CO3	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**
CO4	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**
CO5	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2

CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code:	**ME24101**
Course Title:	**Basics of Mechanical Engineering**
Pre-requisite(s):	**NIL**
Co- requisite(s):	**NIL**
Credits:	**3** (L: 2 T:1 P: 0)
Class schedule per week:	**3**
Class:	**B. Tech**
Semester / Level:	**SECOND**
Branch:	**Mechanical Engineering**
Name of Teacher:	

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Introduce system of forces, and write equation of equilibrium.
2.	Analyse motion of particle and rigid body subjected to force.
3.	Grasp the importance of internal and external combustion engines.
4.	Apprehend the fundamentals of friction.
5.	Understand the different sources of energy.

COURSE OUTCOMES (COs)

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

CO1	Explain the basics of Mechanical Engineering.
CO2	Apply various laws of mechanics on static and dynamic elements and bodies.
CO3	Analyse various problems of mechanics related to static and dynamic bodies.
CO4	Evaluate the real life problem related to mechanics and energy for its probable solution.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **System of Forces and Structure Mechanics;** Addition of Forces, Moment of a Force, Couple, Varignon's theorem, Free Body Diagram, Equilibrium in Two and Three Dimensions, Equivalent Forces and Moment. Types of Plane Trusses, Analysis of Plane Trusses by: Method of Joints and Method of Sections. Hooke's Law of elasticity, Stress and Strain, Relation between elastic constants.	**8**
Module – II **Kinematics & Kinetics of rigid bodies:** Types of rigid body motion– translation, rotation about fixed axis, equations defining the rotation of a rigid body about a fixed axis, plane motion, absolute and relative velocity in plane motion, instantaneous center of rotation. Equation of motion and D'Alembert's principle.	**8**
Module – III **Friction :** Interfacial Friction (a) Laws of dry friction, static & kinetic co-efficient of friction, Analysis of static, kinetic and rolling friction. (b) Analysis of frictional forces in inclined planes, wedges, screw jacks and belt drives.	**8**
Module – IV **Boilers and Internal Combustion Engine;** Classification of Boilers, Fire tube and Water Tube boilers. Boiler Mountings and Accessories. Boiler efficiency. Classification of I C Engines. Basic components and terminology of IC engines, working principle of four stroke and two stroke - petrol and diesel engine.	**6**
Module – V **Non-Conventional Energy Sources** Renewable and Non-renewable Energy Resources, Advantages and Disadvantages of Renewable Resources, Renewable Energy Forms and Conversion- Solar Energy, Wind Energy, Hydro Energy.	**5**

TEXTBOOKS:

- Engineering Mechanics, Irving H. Shames, P H I. ltd, 2011.
- Boiler operator, Wayne Smith, LSA Publishers, 2013.
- Internal Combustion Engines, M. L. Sharma and R. P. Mathur, Dhanpat Rai Publications, 2014.
  Fundamentals of Renewable Energy Processes, Aldo Vieira Da Rosa, Elsevier publication, 2012.

REFERENCE BOOKS:

- Engineering Mechanics : statics, James L. Meriam, L. G. Kraige, Wiley, 7th Edition, 2011.
- Engineering Mechanics, S. Rajasekaran & G. Sankarasubramaniam, Vikash publishing house, 2018.
- An Introduction to Steam Boilers, David Allan Low, Copper Press Publisher, 2012.
- Internal Combustion Engines – V Ganesan, McGraw hill, 2017.
- Non Conventional Energy Resources, B. H. Khan, McGraw Hill Education Publisher, 2017.
- Principles of Mechanical Engineering, R. P. Sharma & Chilkesh Ranjan, Global Academic Publishers, 2016.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz	10
Assignment	10
Teacher’s Assessment	5

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

14. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1		2	1	1		2	1	1	1
CO2	3	3	2	2	2	1	1	2	1	1	2	1	1	2
CO3	3	3	3	3	2	1	1	2	2	2	2	1	2	2
CO4	2	3	3	3	3	2	2	2	2	2	3	2	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course code: EC24101
Course title:Basic Electronics
Pre-requisite(s):N/A
Co- requisite(s): N/A
Credits: L:2 T:1 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level:0I/01
Branch:ALL B.TECH.

Course Objectives

This course enables the students:

	To understand PN Junction, diodes and their applications.
	To comprehend BJT and the bias configurations.
	To understand operating principles of FETs
	To understand op amp and its applications.
	To apprehend number system, Logic Gates and Boolean algebra.

Course Outcomes

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

CO1	Understand the characteristics of electronic devices like PN-diode, BJT, JFET and MOSFET
CO2	Classify and analyze the various circuit configurations of BJTs and MOSFETs.
CO3	Analyze the characteristics of operational amplifier.
CO4	Design electronic circuits using diodes, transistors, op-amp and logic gates for analogand digital applications.
CO5	Solve day-to-day life problems using electronic circuits.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Diodes and Applications:** Introduction to semiconductor materials, PN junctiondiode, barrier potential, depletion layer width, junction capacitance,diode current equation, I-Vplot, diode-resistance, temperature dependence,breakdown mechanisms, Zener diode – operation and applications, Diode as a Rectifier: Half Wave and Full Wave Rectifiers with and without C-Filters.	**8**
Module – II **Bipolar Junction Transistors (BJT):** Basic operation of PNP and NPN Transistors, Input and Output	**8**

Characteristics of CB, CE and CC Configurations.Transistor biasing: operating point, Fixed bias, emitter bias, voltage divider bias, stability factor, small signal analysis (h-parametermodel) of CE configuration.	
Module – III **Field Effect Transistors:** JFET: Principle of operation,transfer characteristics, MOSFET: Operation of N-MOS, P-MOS, enhancement and depletion type, transfer characteristics, CS biasing of JFET and MOSFET.	**8**
Module – IV **Operational Amplifiers:** Introduction of Operational Amplifier, Characteristics of Operational Amplifier, Differential Amplifier, CMRR, Slew Rate, input and output offset voltages, Inverting and non-inverting amplifiers, Summing Amplifier, Difference amplifier, Differentiator and Integrator.	**8**
Module – V **Boolean Algebra and Logic Gates:** Boolean Algebra, Boolean operators, Truth table of different digital logic gates (AND, OR, NOT, NAND, NOR, EXOR, EX-NOR),application of diode for design of logic gates, realization of logic gates using universal gates, adder, subtractor.	**8**

Textbooks:

15. Millman J., Halkias C.C. "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw-Hill.
16. Boylstead R.L., Nashelsky L., "Electronic Devices and Circuit Theory", Pearson Education, Inc, 11/e.
17. Mano M.M., Michael D. Ciletti, "Digital Design", Pearson Education, Inc, 5/e, 2011.

Reference books:

- Millman J., Halkias C.C., Parikh Chetan, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw-Hill, 2/e.
- Millman J., Halkias C.C., Satyabrata Jit, "Millman's Electronic Devices and Circuits", Tata McGraw-Hill, 3/e.
- Albert Paul, Malvino, David J. Bates, "Electronic principles", McGraw-Hill, 8/e, 2015.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: 3, 11, 12

Topics beyond syllabus/Advanced topics/Design: NA

POs met through Topics beyond syllabus/Advanced topics/Design: 2, 3, 11, 12

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

<u>Direct Assessment</u>

Assessment Tool	% Contribution during CO Assessment
First Quiz	10

Mid Semester Examination	25
Assignment	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

- Student Feedback on Faculty
- Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	1	2	3	1	2	2	3	2	2	0	1	1
CO2	3	3	1	2	3	1	2	2	3	2	2	0	1	1
CO3	3	3	1	2	3	1	2	2	3	2	2	1	1	1
CO4	3	3	1	2	3	1	2	2	3	2	2	1	1	1
CO5	3	3	1	2	3	1	2	2	3	2	2	2	2	2

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: CH24102
Course Title: Chemistry Lab
Pre-requisite(s): Intermediate level Chemistry
Co- requisite(s):
Credits: 1 L: 0 T: 0 P: 2
Class schedule per week: 2
Class: B.Tech.
Semester / Level: I
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

18.	To gain an understanding of the synthesis of organic and inorganic compounds.
19.	To interpret and analyze spectroscopic data effectively.
20.	To develop a strong concept of potentiometric and pH-metric titrations of acids and bases.
21.	To understand and calculate the rate constant of chemical reactions.
22.	To acquire knowledge of determining melting points and estimating eutectic and transition temperatures.

COURSE OUTCOMES (COs)

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

CO1	Able to perform the synthesis of organic and inorganic compounds.
CO2	Able to interpret and analyze spectroscopic data.
CO3	Able to carry out potentiometric and pH-metric titrations of acids and bases.
CO4	Able to determine the rate constant of chemical reactions.
CO5	Able to measure melting points and estimate eutectic and transition temperatures.

SYLLABUS (List of experiments)

1. Gravimetric estimation of Nickel using Dimethylglyoxime.

2. Determination of total Hardness of a given water Sample (Complexometric Titration).

3. Verification of Beer's Law using Fe^{3+} solution by spectrophotometer/colorimeter, and determination of the concentration of an unknown Fe^{3+} solution.

4. Preparation of Diazoamino Benzene and reporting of its melting point and yield.

5. Construction of a melting point–mass percent composition diagram for a two-component mixture and determination of its eutectic temperature.

6. Study of the kinetics of acid-catalyzed hydrolysis of ethyl acetate and evaluation of the rate constant.

7. Determination of the strength of a strong acid using potentiometric titration with a strong base.

8. Determination of the transition temperature of a given salt hydrate.

9. Separation of binary organic mixture by acid-base extraction and analysis using given FTIR and NMR spectrum.

10.Construction of a pH-titration curve for a strong acid versus a strong base

REFERENCE MATERIALS:

23. https://bitmesra.ac.in/edudepartment/content/1/140/553 (link of Lab Manual)
24. **Experimental Physical Chemistry** – B. Viswanathan, P. S. Raghavan, Narosa Publishing House (1997).
25. **Vogel's Textbook of Practical Organic Chemistry**
26. **Experiments in General Chemistry** – C. N. R. Rao, U. C. Agarwal.
27. **Experimental Organic Chemistry, Vol. 1 & 2** – P. R. Singh, D. S. Gupta, K. S. Bajpai, Tata McGraw-Hill

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

- **Student Feedback onCourse Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars (discussion of experimental results and error analysis).
CD5	Group discussions/problem-solving sessions (to analyze experimental data and calculations).
CD6	Industrial/guest lectures (applications of chemical analysis techniques in industry).
CD7	Industrial visits (exposure to real chemical laboratories and processes).

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	2	2	3	1	1	2	2	1	1	1
CO2	3	2	2	3	3	2	1	1	3	2	3	2	2	2
CO3	3	3	1	3	3	1	2	1	2	2	2	3	3	3
CO4	3	3	1	3	2	1	1	1	1	2	3	2	2	3
CO5	3	2	1	2	2	2	1	1	1	1	3	2	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: EC24102
Course title: Basic Electronics Lab
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L: 0 T: 0 P: 2 C:1
Class schedule per week: 02
Class: B. Tech.
Semester / Level: I/01
Branch: ALL B.TECH.

Course Objectives

This course enables the students:

28.	To measure magnitude, time-period, frequency, phase of signals using CRO
29.	To know PN junction characteristics and its applications
30.	To understand the working of transistor amplifier
31.	To understand the working of operational amplifier and circuits
32.	To realize logic gates and implement simple Boolean expression

Course Outcomes

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

CO1	Familiarize with electronics components like diode, transistors, ICs
CO2	Make use of measuring instruments and function generators
CO3	Verify characteristics of diodes,transistors and op-amp
CO4	Design electronic circuits using diodes, transistors, op-ampfor analogapplications
CO5	Design electronic circuits using logic gates for digital applications

List of Experiments

Experiment No.	Name of the Experiments
	(A) HARDWARE BASED EXPERIMENTS
1.	**MEASURMENTS USING CRO** AIM-1: To understand the Measurement of voltage, time-period and frequency of different signals on CRO. AIM-2: To measure the frequency and phase of two different signals using Lissajous pattern.
2.	**HALF-WAVE AND FULL WAVE RECTIFIER CIRCUITS** AIM-1: To understand the basic operation principle of Half-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without C-Filter. AIM-2:To understand the basic operation principle of Full-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without

	C-Filter.
3.	**COMMON EMITTER (CE) TRANSISTOR AMPLIFIER** AIM-1: To understand the basic operation principle of CE transistor amplifier circuit and finding its frequency response. AIM-2: To determine the gain bandwidth product of CE transistor amplifier from its frequency response.
4.	**INVERTING OPERATIONAL AMPLIFIER (OP-AMP)** AIM: To design the inverting operational amplifier using IC741 OP-AMP and find its Gain and Frequency Response.
5.	**DIFFERENTIAL AMPLIFIER** AIM-1: To design common mode and differential mode circuit using IC741 OP-AMP AIM-2:To obtain common mode gain and differential mode gain and calculate CMRR.
6.	**REALIZATION OF LOGIC GATES** AIM-1: To understand basic Boolean logic functions (NOT, AND, OR). AIM-2: To realize the basic logic gates (AND, OR, NOT) using NAND Gate (IC-7400).
(B) SOFTWARE BASED EXPERIMENTS	
1.	**PN JUNCTION CHARACTERISTICS** AIM-1: To determine the forward bias V-I characteristics of PN junction diode and finding itsforward cut-in voltage. AIM-2: To determine the reverse bias V-I characteristics of PN junction diode and finding its reverse breakdown voltage.
2.	**ZENER DIODECHARACTERISTICS** AIM-1: To design a basic voltage regulator circuit using Zener diode. AIM-2: To determine the reverse bias V-I characteristics of Zener diode and finding its reverse breakdown voltage.
3.	**FIELD EFFECT TRANSISTOR CHARACTERISTICS** AIM-1: To determine the output and transfer characteristics of JFET. AIM-2: To measure the voltage,gain of JFET.
4.	**NON-INVERTING OPERATIONAL AMPLIFIER (OP-AMP)** AIM:To design the non-inverting operational amplifier using IC741 OP-AMP and find its Gain and Frequency Response.
5.	**DIFFERENTIATOR AND INTEGRATOR CIRCUITS USING OP-AMP** AIM-1: To design differentiator circuit using IC741 OP-AMP and observe waveforms. AIM-2:To design integrator circuit using IC741 OP-AMP and observe waveforms.
6.	**IMPLEMENTATION OF BOOLEAN FUNCTION** AIM-1: To understand the AND Gate IC (IC 7408) and OR Gate IC (IC 7432) AIM-2: To implement a given Boolean expression using logic gate ICs.

Text Books:

1. Millman J., Halkias C.C., Parikh Chetan, “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill, 2/e.
2. Mano M.M., “Digital Logic and Computer Design”, Pearson Education, Inc, Thirteenth Impression, 2011.

Reference Book:

1. Boylstead R.L., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson Education, Inc, 10/e.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –

33. Student Feedback on Faculty
34. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	1	2	3	1	1	2	2	2	2	**1**	**1**	**1**
CO2	3	3	1	2	3	1	1	2	2	2	2	**1**	**1**	**1**
CO3	3	2	1	2	3	1	1	2	2	2	2	**0**	**1**	**1**
CO4	3	3	1	2	3	1	1	2	2	2	2	**1**	**0**	**1**
CO5	3	2	1	2	3	1	1	2	2	2	2	**0**	**1**	**1**

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: **ME24102**
Course Title: **Engineering Graphics**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits:2 (L:0 T: 0 P:4)
Class schedule per week: **4**
Class: **B. Tech.**
Semester / Level: **SECOND**
Branch: **Mechanical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand the basic principles of Engineering Graphics, which include projections of 1D, 2D and 3D objects.
2.	Visualize a solid object (including sectioned) and convert it into drawing.
3.	Visualize different views of any object.
4.	Develop skill to draw objects using AutoCAD software.
5.	Inculcate the imagination and mental visualization capabilities for interpreting the geometrical details of common engineering objects.

COURSE OUTCOMES (COs)

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

CO1	Explain the fundamentals of Engineering Graphics and projection and acquire visualization skills.
CO2	Demonstrate the concept of projections of points and lines for various engineering applications.
CO3	Apply the concept of projections to construct planes and solids, and its orthographic projections which are positioned in various configurations..
CO4	Demonstrate the understanding of AutoCAD software commands to draw projections of points, lines, planes and solids.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to Engineering Graphics, dimensioning and projections, orthographic projections, Fundamentals of First and Third Angle projection, Orthographic projections of points.	9
Module – II Orthographic projections of straight lines: lines parallel to HP and VP, lines inclined to HP and Parallel to VP, line inclined to VP and parallel to HP, line inclined to both reference planes. Orthographic projections of planes/lamina: lamina perpendicular to both HP and VP, lamina parallel to HP and perpendicular to VP (and vice versa), lamina inclined to HP and perpendicular to VP, lamina inclined to VP and perpendicular to HP, lamina inclined to both reference planes.	9
Module – III Projections of solids (cube, prism, pyramid, tetrahedron) - axis perpendicular to HP and inclined to VP and inclined to one or both planes. Section of solids: sectional plane perpendicular to one plane and parallel/inclined to another plane.	9
Module – IV Working with AutoCAD Commands, Cartesian Workspace, Basic Drawing & Editing Commands, Drawing: Lines, Rectangles, Circles, Arcs, Polylines, Polygons, Ellipses, Creating Fillets and Chamfers, Creating Arrays of Objects, Working with Annotations, Adding Text to a Drawing, Hatching, Adding Dimensions, Dimensioning Concepts, Adding Linear Dimensions, Adding Radial & Angular Dimensions, Editing the Dimensions.	9
Module – V Create views of points, lines, planes, and various types of solids (cube, prism, pyramid, tetrahedron, etc.) using AutoCAD software.	9

TEXTBOOKS:

- Engineering Drawing by N. D. Bhatt, Charotar Publishing House Pvt.Ltd., 53rd, Edition, 2014.
- Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International (P) Limited, 4th Reprint: June, 2017.

REFERENCE BOOKS:

- Engineering Graphics with Autocad by J. D. Bethune, Prentice Hall, 2007.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	60
End Semester Test	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Lab Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

- **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	
CD2	Assignments/Seminars	
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	2		2				2		2	1	2	2
CO2	3	3	2		2				2		2	1	1	1
CO3	3	3	3	2	2			2	2		2	1	2	2
CO4	2	2	2	2	3			2	3	2	2	1	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD3
CO2	CD3
CO3	CD3
CO4	CD3

<u>**COURSE INFORMATION SHEET**</u>

Course Code:	**PE24102**
Course Title:	**Workshop Practice**
Pre-requisite(s):	**None**
Co-requisite(s):	**None**
Credits:	**1 (L:0 T:0 P: 2)**
Class schedule per week:	**2**
Class:	**B.Tech.**
Semester / Level:	**SECOND**
Branch:	**Production and Industrial Engineering**
Name of Teacher:	

Course Objectives:

This course enables the students to:

1	Familiarize with the basics of manufacturing processes.
2	Impart knowledge and skill to use tools, machines, equipment, and measuring instruments.
3	Practice on manufacturing of components using workshop trades.
4	Educate students on the safe handling of machines and tools.
5	Exercise individual as well as group activity with hands-on training in different workshop trades.

Course Outcomes:

At the end of the course, a student should be able to:

CO1	Be conversant with the basic manufacturing processes.
CO2	Identify and apply suitable tools and instruments for carpentry, foundry, welding, fitting, and conventional and modern machining.
CO3	Manufacture different components using various workshop trades.
CO4	Take safety and precautionary measures for self and machines during operations.
CO5	Develop skills to work as an individual or in a team during trade practices.

<u>**SYLLABUS**</u>

LIST OF EXPERIMENTS	**(NO. OF PRACTICAL HOURS)**
1. **CARPENTRY SHOP** **EXPERIMENT-I: Carpentry Tools and Instruments** **Objective**: To study the various tools, instruments, and equipment used in carpentry practice.	**2**
2. **CARPENTRY SHOP** **EXPERIMENT-II: Carpentry Practice** **Objective:** To perform the carpentry work by making a wooden job using different tools.	**2**
3. **FOUNDRY SHOP** **EXPERIMENT-I: Green Sand Moulding** **Objective:** To get acquainted with various tools and equipment used in making green sand mould (to practice green sand mould making with single-piece patterns).	**2**
4. **FOUNDRY SHOP** **EXPERIMENT-II: Aluminium Casting** **Objective:** To get acquainted with melting and pouring metal in a mould (given two-piece patterns of handle) and to make aluminium casting.	**2**

5.	**WELDING SHOP** **EXPERIMENT-I: Manual Metal Arc Welding** **Objective:** To study arc welding processes including arc welding machines (AC & DC), electrodes and equipment. To join two pieces of given metal by the arc welding process.	**2**
6.	**WELDING SHOP** **EXPERIMENT-II: Gas Welding** **Objective:** To study gas welding processes, including types of flames produced, filler metals and fluxes, etc. To join two pieces of given metal by the gas welding process.	**2**
7.	**FITTING SHOP** **EXPERIMENT-I: Fitting Tools and Measuring Instruments** **Objective**: To study the various tools used in the fitting shop and perform fitting operations (like marking, chipping, hack-sawing, filing, drilling, etc.)	**2**
8.	**FITTING SHOP** **EXPERIMENT-II: Fitting Assembly Practice** **Objective:** To make a job clamping plate as per the given drawing by fitting operations and to check for its assembly with a given component.	**2**
9.	**MACHINE SHOP** **EXPERIMENT – I: Centre Lathe Machine** **Objective**: To study lathe machine and to machine a given job on the center lathe as per drawing.	**2**
10.	**MACHINE SHOP** **EXPERIMENT-II: Shaper Machine** **Objective:** To study the Shaper machine and to machine a given job on the shaper as per drawing.	**2**
11.	**MODERN MACHINE SHOP** **EXPERIMENT – I: CNC Lathe Machine** **Objective**: To provide an introduction to the functionality and operation of the CNC Lathe Machine through practical demonstration.	**2**
12.	**MODERN MACHINE SHOP** **EXPERIMENT-II: CNC Surface Grinding Machine** **Objective:** To provide an introduction to the functionality and operation of the CNC Surface Grinding Machine through practical demonstration	**2**

Books recommended:

TEXT BOOK

1. S K Hajra Choudhury, A K. Hajra, “Elements of Workshop Technology: Vol- I and Vol -II”, Media Promotors Pvt Ltd. **(T1)**

2. B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

REFERENCE BOOK

1. P.N. Rao, “Manufacturing Technology Vol-1and Vol-II”, Tata McGraw Hill. **(R1)**

2. Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	
CD7	Simulation	√

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	**% Distribution**				
Day to day performance & Lab files	30				
Quiz 1	10				
Viva-voce	20				
End Semester Examination	**% Distribution**				
Examination: Experiment Performance	30				
Quiz 2	10				
Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes (COs) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs										PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	2	1	0	1	1	1	1	1	1	2	1	1	1
CO2	2	3	2	1	3	1	1	1	2	2	2	1	1	1
CO3	2	2	3	2	3	1	1	2	2	2	2	1	1	1
CO4	1	1	2	1	2	2	3	1	1	1	2	1	2	2
CO5	1	1	2	0	1	0	1	3	3	3	2	1	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

Mapping Between Course Outcomes (COs) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD6
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD3
CO5	CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

SECOND YEAR (SEMESTER-I)

COURSE INFORMATION SHEET

Course Code: MA24201
Course Title: Numerical Methods
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 2 (L: 2 T: 0 P: 0)
Class schedule per week: 2
Class: B. Tech.
Semester / Level: THIRD
Branch: Biotechnology
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Comprehend suitable numerical methods to solve algebraic and transcendental equations.
2.	Learn proper numerical methods to solve linear system of equations.
3.	Approximate a function using various interpolation techniques.
4.	Evaluation of derivatives and integrals using interpolating polynomials.
5.	Find the numerical solutions of initial value problems.

COURSE OUTCOMES (Cos)

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

CO1	Solve algebraic and transcendental equations using numerical methods for real-world problem solving.
CO2	Apply numerical techniques to solve linear system of equations in scientific and engineering computations.
CO3	Use interpolation methods to approximate functions in data analysis and modelling.
CO4	Compute derivatives and integrals for complex mathematical and physical problems.
CO5	Solve ordinary differential equations numerically for dynamic system modeling and Simulations.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I Errors and nonlinear equations: Types and sources of errors, Propagation of errors. Bisection method, Regula-Falsi method, Secant method, Newton-Raphson method and its variants, General Iterative method.	**5**

Module – II System of linear equations: Gaussian Elimination, Gauss-Jordan, LU Decomposition (Crout's method), Gauss-Jacobi and Gauss-Siedel methods to solve linear system of equations.	**5**
Module – III Interpolation: Lagrange's interpolation, Newton's divided differences interpolation formulas, Interpolating polynomial using Newton forward and backward differences.	**5**
Module – IV Differentiation and integration: Differentiation using interpolation formulas, Integration using Newton-Cotes formulas: Trapezoidal rule, Simpson's one-third and three-eighth rules.	**5**
Module – V Solution of ordinary differential equations: Euler's method, modified Euler's method, Runge-Kutta Methods of second and fourth order to solve initial value problems.	**5**

TEXTBOOKS:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age Publications, Fourth Edition, 2004.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, Fourth Edition, 2005.
3. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

REFERENCE BOOKS:

1. S.C. Chapra and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, Seventh Edition, 2014.
2. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Seventh Edition, 2003.
3. R. W. Hamming, Numerical Methods for Scientists and Engineers, Second Edition, Dover Publications Inc. 1987.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) POS

MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION

PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	2		1			1	1	2	2	1	2
CO2	3	3	2	2	2		1			1	1	2	3	2	2
CO3	3	2	2	2	3		1			1	1	2	2	1	2
CO4	3	2	2	2	3		1			1	1	2	2	1	2
CO5	3	3	2	3	3		1			1	1	2	3	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code:	**MT24131**
Course Title:	**UHV2: UNDERSTANDING HARMONY**
Pre-requisite(s):	**NIL**
Co- requisite(s):	**NIL**
Credits:	**3** (L: 3 T: 0 P: 0)
Class schedule per week:	**3**
Class:	**B. Tech.**
Semester / Level:	**THIRD**
Branch:	**Biotechnology**
Name of Teacher:	

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Develop a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2.	Understand (or developing clarity) of the harmony in the human being, family, society and nature/existence
3.	Strengthen of self-reflection
4.	Develop the commitment and courage to act

COURSE OUTCOMES (COs)

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

CO1	At the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Course Introduction - Need, Basic Guidelines, Content and Process for Value Education:** 1. Purpose and motivation for the course, recapitulation from Universal Human Values-I. 2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. 3. Continuous Happiness and Prosperity- A look at basic Human Aspirations. 4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. 5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario 6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co- existence) rather than as arbitrariness in choice based on liking-disliking.	**8**
Module – II **Understanding Harmony in the Human Being - Harmony in Myself!** 1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. 2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. 3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). 4. Understanding the characteristics and activities of 'I' and harmony in 'I'. 5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. 6. Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available tome. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.	**8**

Module – III **Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship:** 1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship 2. Understanding the meaning of Trust; Difference between intention and competence 3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship 4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals 5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.	**8**
Module – IV **Understanding Harmony in the Nature and Existence - Whole existence as Coexistence:**	**8**
1. Understanding the harmony in the Nature 2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature. 3. Understanding Existence as Co-existence of mutually interacting units in all- pervasive space. 4. Holistic perception of harmony at all levels of existence. 5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.	
Module – V **Implications of the above Holistic Understanding of Harmony on Professional Ethics:** 1. Natural acceptance of human values 2. Definitiveness of Ethical Human Conduct 3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order 4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. 5. Case studies of typical holistic technologies, management models and production systems 6. Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations 7. Sum up. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions	**8**

e.g. to discuss the conduct as an engineer or scientist etc.	

TEXTBOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS:

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1
Continuous Internal Assessment	Y
Semester End Examination	Y

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1			2	1	1	3	3	3	2	2	1	1	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24241
Course title: Cellular Dynamics and Molecular Biology
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: III
Branch: Biotechnology
Name of Teacher:

Course Objectives:

This course enables the students to:

1.	To build the knowledge on cell and organelles structure of prokaryotic and eukaryotic cells at the molecular level.
2.	To provide detailed overview of cell and organelles functions including regulation of cellular processes, signaling and proliferation in eukaryotic cells.
3.	To acquaint the molecular mechanism of cell cycle regulation and genetic mechanism of action occurring in eukaryotic cell
4.	To develop basic knowledge on protein processing and transportation mechanism of proteins into eukaryotic cell organelles
5.	To be familiar about the complexity and harmony of the cell and its molecular biological activities.

Course Outcomes

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

CO1	Integrate the different levels of biological complexities from molecules to cells to organisms.
CO2	Gather, critically assess, and utilize primary scientific literature to research on cell-cell interaction, signaling, protein processing and transportation.
CO3	Gain the knowledge of common and advanced mechanisms of cell and molecular biology
CO4	Explain the clear and concise information related to cellular dynamics and molecular biology

Syllabus

MODULE	**(NO. OF LECTURE HOURS)**
Module-I: Cell Basics: Structure of prokaryotic and eukaryotic cell, Electron micrograph of cell wall, cell membranes, FreezeFracture technique, Patch clamp method, FRAP, cell	**8**

organelles.	
Module-II: Cell-cell Interaction and Signaling Principles of cell communication, Principles of cell signaling, Signaling via G-Protein linked cell-surface Receptors and Signaling via enzyme- linked cell-surface receptors, Target cell adaptation, Signal transduction pathways.	**8**
Module-III: Cell Cycle and its Regulation Components of the cell cycle, Regulation of cell cycle, Intracellular control of the cell cycle events, Extracellular control of cell division, Cell growth, Apoptosis, carcinogenesis and its regulation.	**8**
Module-IV: Basic Genetic Mechanism DNA replication, Transcription, Translation, DNA repair, DNA methylation, Chromatin packing, Genetic recombination, Genetic code, RNA splicing, RNA editing, Gene expression and its regulation, Protein synthesis, Manipulating Proteins.	**8**
Module-V: Protein Processing & Transportation: Intracellular Compartmentalization, Protein targeting, mechanism of co-translational transport of protein, Post-translational transport of protein into organelles, Protein entry sorting and modification, Protein degradation.	**8**

TEXTBOOKS:

1. Molecular Biology of the Cell, 4th Edition, Alberts et al. 2002, New York,
2. Molecular Cell Biology, 5th Edition. Lodish et al., 2003
3. The Cell: A Molecular Approach, 6th Edition, Geoffrey M. Cooper & Robert E. Hausman 2013

REFERENCE BOOKS:

1. DeRobertis EDP 2010, Cell and Molecular Biology, 8th Edition
2. Principles of Molecular Biology, 1st Edition, Burton E. Tropp, 2012
3. Recent review articles (Nature Reviews, Molecular Cell Biology, Trends in Cell Biology)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECTASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10

Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	1	1	2	2	2	2	2	3	3	2	2
CO2	3	2	3	3	3	3	2	2	3	1	2	3	3	2
CO3	3	2	2	3	2	1	2	3	3	2	2	3	2	3
CO4	3	1	2	2	2	1	2	2	2	2	2	2	2	3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3,CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24242
Course title: Microbiology
Pre-requisite(s): Basics of Biological Sciences
Co- requisite(s): Microbiology Lab
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: III
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To establish an understanding of the major historical events and basic techniques (concept of aseptic work, cultivation and identification) in microbiology
2.	To describe basic cell structure, metabolism, nutrition, reproduction and ecology of prokaryotic microorganisms, eukaryotic microorganisms and viruses
3.	To outline principles of physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious diseases
4.	To describe nonspecific body defenses and the immune responses and apply this understanding to the infectious disease process as well as the prevention and control of infectious diseases
5.	To develop and execute oral and writing skills necessary for effective communication of the course, the ability to think critically regarding a topic and the delivery of scientific principles to both scientists and non-scientists

Course Outcomes

After the completion of this course, students will be:

CO1	Identify microbiological techniques, microbial evolution, phylogeny and know the defining characteristics of the major groups of microorganisms
CO2	Describe the structure, function and growth of bacteria, structure of viruses
CO3	Evaluate the industrially important microbes and also how microorganisms interact with the environment in beneficial or detrimental ways
CO4	Assess plant- microbe interaction in beneficial or detrimental ways
CO5	Determine ways in which microorganisms play an integral role in disease, and the microbial and immunological methodologies are used in disease treatment and prevention. Apply the scientific method by stating a question; researching the topic; determining appropriate tests; performing tests; collecting, analyzing, and presenting data.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module-I: Basics of Microbiology Brief history on the development and scope of microbiology, Methods in Microbiology-; culture media, Pure culture methods, Staining of Bacteria, Micrometry, Air sampling, Classification and identification of microorganisms	**8**
Module-II: Growth of Microorganism Cell structure and major characteristics of cellular (bacteria, fungi, algae, protozoa) and acellular (viruses) organisms, Archaebacteria, Growth of Microorganisms: Nutritional and physical requirements, Batch culture, Continuous culture, Synchronous growth, Fed-batch culture	**8**
Module-III: Environmental & Industrial Microbiology Bacteriological analysis of water, Water treatment, Bioleaching, Bioremediation, industrially important micro-organisms and secondary metabolites	**8**
Module-IV: Agricultural Microbiology Plant-microbial interactions, Biodeterioration of agricultural products, control of microbes and safe storage of agricultural products/food soil fertility through microbes, microbial insecticides	**8**
Module-V: Medical Microbiology Microbial flora of healthy human host, host-pathogen interactions in animals, Diseases caused by bacteria, virus, fungi and protozoans, natural resistance and nonspecific defense mechanisms.	**8**

Text books:

1. Prescott, Harley, and Klein, Microbiology, 7th Ed., Tata McGraw-Hill, 2008

2. Microbiology: An Introduction by Gerard J. Tortora: 14th Edition Pearson publishers

Reference books:

1. Pelczar, Chan and Krieg, Microbiology, 5th Edition, Tata McGraw-Hill, 1986

2. Frazier and Westhoff, Food Microbiology, 4th Edition, Tata McGraw-Hill, 1995

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) POS

MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

<u>Course Outcome (CO) Attainment Assessment tools & Evaluation procedure</u>

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	3	1				2			2		1	3	2	2
2	3	1	3		2	2			2		1	3	3	2
3	3	1	3			2			2		1	3	2	2
4	3	1	3		3	2			2	1	2	3	3	2
5		1	3		3	2			2		2	3	2	2

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3

CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **BE 24243**
Course title: **Biochemistry**
Co- requisite(s): **NIL**
Credits: **2 L:2 T:0 P:0**
Class schedule per week: **2**
Class: **B. Tech**
Semester / Level: **III**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students to:

1	Understand the structure and function of different types of biomolecules and their role in maintaining homeostasis.
2	Describe types of metabolic pathways like catabolic pathways and anabolic pathways and their control in presence of different enzymes/biocatalysts.
3	Illustrate the chemical nature of enzymes, enzyme active sites, kinetics, enzyme inhibition and their function in biochemical reactions.
4	Impart knowledge about enzyme immobilization, methods of enzyme immobilization and their applications in textile, food and pharmaceutical industry. Gain concept regarding enzyme stability.

Course Outcomes

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

CO 1	Demonstrate an understanding of essential biochemical compounds like structure/function of different biomolecules.
CO 2	Perception of metabolic pathways and the regulation of biological/biochemical processes.
CO 3	Verify the enzyme catalysis, modes of catalytic mechanism and their role in regulatory pathways
CO4	An insight into undertaking suitable experiments/research methods, with practice of ethics and societal and environmental issues.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module-I: Carbohydrates	**6**

Classification, Structure and function of carbohydrates, Glycolysis, Gluconeogenesis, Kreb's Cycle, Electron transport chain, Oxidative phosphorylation, Biosynthesis of carbohydrates and their regulations.	
Module-II: Proteins Structure of standard amino acids, Physicochemical properties of amino acids, Primary, secondary, tertiary, and quaternary structure of proteins, and their stability, Functional classification of proteins, General pathways of amino acid metabolism, Deamination, Transamination, decarboxylation reactions, detoxification of ammonia.	**6**
Module-III: Nucleic Acids Structure of nucleic acids, DNA double helix, Chargaff's rule, Types of DNA and RNA, Organization of eukaryotic DNA, Physicochemical properties of nucleic acid, Synthesis of purines & pyrimidines and degradation of nucleic acids	**6**
Module-IV: Lipids Classification and functions of lipids (simple, compound & derived lipid with examples), Essential fatty acids, Biological membrane structure Transport across the membrane, Beta and omega oxidation pathway, malate-aspartate and citrate shuttle, Biosynthesis of fatty acids.	**6**
Module-V: Enzymes Enzyme classification, Concept of apoenzyme and holoenzyme, Mechanism of enzyme action, Mechanism of enzyme catalysis, Enzyme kinetics, Specific activity, Factors affecting enzyme activity. Types & Mechanism of enzyme inhibition, Enzyme turnover number, Feedback regulation, allosteric enzymes.	**6**

TEXTBOOKS:

1. Eric, E. Conn., Paul, K. Stumpf., George, B. Roy., H, Doi. Outlines of Biochemistry. 5th Edition, Wiley India Private Limited, 2006.
2. Satyanarayana, U., Chakrapani, U. Biochemistry. 5th Edition, Elsevier, 2020.

REFERENCE BOOKS:

1 Nelson, D. L., Lehninger, A. L., Cox, M. M. Lehninger. Principles of Biochemistry. 5th Edition, United Kingdom: W. H. Freeman, 2008.

2 Jeremy, M. Berg., John, L. Tymoczko., Gregory, J. Gatto., L. Stryer. Biochemistry. 9th Edition, Macmillan International Higher Education, 2019.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50

Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes	**Program outcomes**											**PSO**		
	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10	CO11	PSO1	PSO2	PSO3
1	1	2	2	2			1	2	3		1	1	2	
2	1	3	3		2	3	2			2		1		3
3	2	3		3	2		3	2	3	3	2	1	2	
4	3				2	3			3		2		2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **BE24244**
Course title: **Basics of Bioinformatics**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: **B. Tech**
Semester / Level: **III**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	Basic objective is to give students an introduction to the basic principle of bioinformatics
2.	Able to explain the major steps in pairwise and multiple sequence alignment, explain the principle for, and execute pairwise sequence alignment by dynamic programming
3.	Evolutionary tree generation and find the ancestor.
4.	Able to predict the secondary and tertiary structures of protein sequences.
5.	Provide practical training in bioinformatics methods including accessing the major public sequence databases

Course Outcomes

After the completion of this course, students will be:

CO1.	Gain familiarity with the role of bioinformatics in life sciences and demonstrate the ability to use various biological databases for information retrieval and analysis.
CO2.	Develop the ability to perform sequence analysis and alignment using standard bioinformatics tools, and interpret the results to support biological research.
CO3.	Understand the principles of molecular phylogenetics and apply computational methods to explore evolutionary relationships among biological entities.
CO4.	Acquire working knowledge of protein structure prediction and modeling, with an emphasis on understanding the structural basis of protein function.
CO5.	Stay abreast of recent developments in bioinformatics, including systems-level approaches, and apply this knowledge to investigate complex biological systems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)

Module 1: Introduction of Biological databases What is bioinformatics and its relation with molecular biology, Different File formats: sequence and structure, General Introduction of Biological Databases; Nucleic acid databases; Protein databases; Specialized databases; Structure databases	**6**
Module 2: Sequence Analysis: Similarity, Identity, Homology, Selectivity/Sensitivity, Dot matrix method, Global (Needleman- Wunsch) and Local Alignment (Smith-Waterman) using Dynamic programming. Basics of Scoring system and matrices, BLAST, Multiple Sequence Alignment: Basic Concepts.	**8**
Module 3: Molecular Phylogenetics: Molecular Phylogenetics: Basics, molecular clock, Substitution Models of evolution, Tree reconstruction methods (Distance based, character-based method, statistical).	**6**
Module 4: Protein Structure and Modelling: Protein Structure: Primary, Secondary, Super Secondary, Domains, Tertiary, Quaternary, Ramachandran plot. Protein secondary structure prediction methods, Protein Tertiary structure prediction methods: Homology Modelling	**6**
Module 5: Current Advancements in Bioinformatics: Current Advancements in Bioinformatics: Introduction to System Biology, Structural bioinformatics, Chemoinformatics, Immunoinformatics.	**6**

Text books:

1. Introduction to Bioinformatics by Aurther M lesk
2. Developing Bioinformatics Computer Skills By: Cynthia Gibas, Per Jambeck
3. Essential Bioinformatics by Jin Xiong

Reference books:

1. Fundamental Concepts of Bioinformatics, Dan E Krane, Michael L Raymer, Benjamin-Cummings Pub Co (Sept 2002, ISBN 0805346333)
2. David W. Mount (2001) Bioinformatics: Sequence and Genome Analysis. Cold Spring harbor Press

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL
TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL
POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25

End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO-1	3			1		2		1	2		1	2	2	1
CO-2	3	2	2		2			1			2	2	3	2
CO-3	3	2	2	2		1		2	2		3	3	2	3
CO-4	3		1	1	2		2		3	1		2	2	3
CO-5	2		1	1	1	2	2		2		2	2	2	2

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **BE24245**
Course title: **Chemical Process Calculations**
Pre-requisite(s): **Nil**
Co- requisite(s): **Nil**
Credits: **4 L: 3 T: 1 P: 0**
Class schedule per week: **4**
Class: **B. Tech**
Semester / Level: **III**
Branch:
Name of Teacher:

Course Objectives

This course enables the students:

1.	To understand fundamental chemical engineering principles including units, dimensions, and conversion factors.
2.	To analyze and solve steady-state material balances for single and multiple units, with and without chemical reactions.
3.	To formulate and solve energy balances for open and closed systems, incorporating sensible and latent heat, heat of reaction, and heat of mixing.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the fundamentals of units and stoichiometric equations.
CO2	Write material balance for different chemical process with and without involving reaction
CO3	Understand the energy balance concepts and write the energy balance with and without involving reaction s.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module-I: Chemical engineering calculations Units and dimensions, mole units, basis of calculations, the chemical equation and stoichiometry, dimensional analysis.	**8**
Module-II: Material balance fundamentals: Conversion and yield, material balance problems that do not involve chemical reactions.	**8**
Module-III: Material balance problems: Material that involve chemical reactions, recycle, bypass and purge calculations.	**8**
Module-IV: Energy balance concepts: Energy balance concepts and units, enthalpy changes, general energy balance that do not involve reactions.	**8**
Module-V: Energy balance that involves chemical reactions: Energy balance that involves chemical reactions, Heat of solution and mixing	**8**

Text books:

1. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Sixth Edition, Prentice Hall Inc., 2003

2. Felder, R. M. and Rousseau, R. W., "Elementary Principles of ChemicalProcesses",3rd Edn., John Wiley & Sons, New York, 2000.

3. Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition, Tata McGraw-Hill (2004)

Reference books:

1. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I CBS publishers (1973).

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3
Continuous Internal Assessment	Y	Y	Y
Semester End Examination	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
1	3	3		3		2	3	3	2	1	2	2	2	2
2	3		3		2	2				3	1	2	2	2
3	3	2	3	2		2	3	2	3	1	1	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **BE24246**
Course title: **Cell Biology Lab**
Pre-requisite(s): **BE 242411, BE24243**
Co- requisite(s): **NIL**
Credits: 1.0 **L: 0 T: 0 P: 2**
Class schedule per week: 02
Class: **BTech**
Semester Level: **III**
Branch: **Biotechnology**
Name of Teacher:

Course objectives

This course enables the students to:

1	Acquiring detailed knowledge of cell biology
2	Learn about isolation of different cell organelles and biomolecules.
3	Understanding the cell organelles structures and function

Course outcomes

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

1.	Apply knowledge of cell biology to inculcate knowledge of various issues related to cell biological techniques.
2.	Identify, formulate, design, conduct experiments, analyze and interpret data to solve problems in life sciences.
3.	Use the techniques and modern tools necessary for detecting cell structure, organelles and biomolecules
4.	Independently execute the project experimental work by utilizing cell biology techniques towards life science problems

BE24246 Cell Biology Lab Experiments	
Experiment-1	To study the working of microscope.
Experiment-2	To prepare the slides: Fixation, dehydration, embedment and subsequent sectioning with a microtome
Experiment-3	To do cell fractionation: Breaking cells, homogenization and the subsequent isolation of organelles using centrifugation method
Experiment-4	To study different types of cells in the human blood smear.
Experiment-5	To study the effect of plasmolysis and de-plasmolysis using onion peel
Experiment-6	To prepare the slides of mitosis from onion root tip cells
Experiment-7	To determine the chlorophyll content
Experiment-8	To isolate the chloroplasts from the given leaf tissue
Experiment-9	To study the electrophoresis

Experiment-10	To study the living cell membrane: While membranes can be studied within living cells, membrane composition requires isolation and sub-fractionation of the membrane components. Once isolated, the membranes can be solubilized through the use of detergents and analyzed.

Book

1. William H. Heidcamp (Saint Peter, Minnesota, USA), Cell Biology Laboratory Manual

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	**% Distribution**
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	

CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2		2	2	2	2	2	2	2	2	3	3
CO2	2	3	3	3	2		2	3	2	2	2	3	2	3
CO3	2	2	2	2	2		2	2	2	2	1	2	2	3
CO4	3	2	3	3	3	3	3	2	2	3	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: BE24247
Course title: Biochemistry Lab
Pre-requisite(s): BE24243
Co- requisite(s): *NIL*
Credits: 1.0 **L: 0 T: 0 P: 2**
Class schedule per week: 02
Class: **BTech**
Semester Level: **III**
Branch: **Biotechnology**
Name of Teacher:

Course objectives
This course enables the students to:

1	Acquiring detailed knowledge of biochemical events occurring within the cell
2	Learn about isolation of different biochemicals/biomolecules like proteins, RNA, DNA, sugars, and lipids of living organisms
3	Understanding the applications and interactions in the body as well as biochemical and metabolic processes

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

1.	Apply knowledge of biochemistry to inculcate knowledge of various issues related to biochemical events in livings system.
2.	Identify, formulate, design, conduct experiments, analyze and interpret the biochemistry related data to solve problems in life sciences.
3.	Use the techniques and modern tools necessary for detecting the changes of biomolecules in living system
4.	Independently execute the experimental work by utilizing biochemistry related techniques towards life science problems

BE24247 Biochemistry Lab Experiments	
Experiment 1:	To perform the qualitative test for reducing sugar
Experiment 2:	To perform the qualitative test for starch
Experiment 3:	To perform the qualitative test for protein
Experiment 4:	To estimate the concentration of carbohydrates in the provided sample

Experiment 5:	To isolate the protein and estimate the concentration from provided sample
Experiment 6:	To perform the activity of any of the hydrolytic enzyme
Experiment 7:	To isolate the DNA from the provided sample

Book

1. **Gerczei Fernandez, Timea / Pattison, Scott:** Biochemistry laboratory manual for undergraduates: An inquiry-based approach
2. **Arun Rastogi**: Laboratory Manual in Biochemistry

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	

CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	2	2	2	1	2	2	3	3
CO2	2	3	3	3	2	2	2	3	2	1	2	3	2	3
CO3	2	3	2	2	2		2	2	2	3	1	2	2	3
CO4	3	2	3	2	3	3	2	2	2	3	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: **BE24248**
Course Title: **Basics of Bioinformatics Lab**
Pre-requisite(s): **NIL**
Co- requisite(s):
Credits: **1 L: 0 T: 0 P: 2**
Class schedule per week: **2**
Class: **B. Tech.**
Semester / Level: **III**
Branch:
Biotechn
ology
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	Understand the use of biological databases by learning to search and retrieve sequence and structural data from publicly available resources such as NCBI and PDB.
2.	Perform basic characterization and analysis of primary sequences using bioinformatics tools such as the Expasy server.
3.	Develop hands-on skills in performing sequence alignments—both pairwise and multiple—to study similarity, conserved regions, and evolutionary relationships.
4.	Apply algorithms and tools for identifying homologous sequences using BLAST and interpret the biological significance of sequence similarity.
5.	Predict structural features of proteins, including secondary structure, using computational tools and web servers to relate sequence information with functional aspects.

COURSE OUTCOMES (COs)

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

CO1	Apply foundational knowledge of bioinformatics to access and interpret biological sequence and structural data.
CO2	Design and conduct basic computational analyses using bioinformatics tools, and evaluate the results critically.
CO3	Identify patterns, similarities, and evolutionary relationships in biological macromolecules through sequence analysis.
CO4	Utilize modern computational techniques to predict biomolecular characteristics and gain insights into their functions.
CO5	Demonstrate the ability to independently execute bioinformatics protocols, manage data, and interpret outcomes in a biological context.

SYLLABUS (List of experiments)

Experiment 1:	Search and download given sequences from sequence databases.
Experiment 2:	Search and download a given structure from the Protein Data Bank and understand its features and file format.
Experiment 3:	Perform primary sequence characterization using the Expasy server.
Experiment 4:	Generate a dot plot for a given pair of sequences.
Experiment 5:	Download sequences and perform local and global sequence alignments.
Experiment 6:	Search for homologous sequences of a given protein using (PSI) BLAST.
Experiment 7:	Identify conserved regions of the protein family using Multiple Sequence Alignment and characterize their evolutionary relationships.
Experiment 8:	Predict the secondary structure of proteins using a web server.

Books:

1. Bioinformatics and Functional Genomics by Jonathan Pevsner
2. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery by Namita Mendiratta , Parag Rastogi , S.C. Rastogi

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2		2	3				2		1	2	2	1
CO2	3	3	2	2	3				2		1	2	2	2
CO3	3	2	2	2	3	1			2		2	2	3	2
CO4	2	2	2	2	3	2			2		2	2	3	2
CO5	2	2	2	2	3	2			2	2	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

SECOND YEAR (SEMESTER-II)

COURSE INFORMATION SHEET

Course Code:	**ME24202**
Course Title:	**Numerical Methods Lab**
Pre-requisite(s):	**NIL**
Co- requisite(s):	**NIL**
Credits:	**1** (L: 0 T: 0 P: 2)
Class schedule per week:	**2**
Class:	**B. Tech.**
Semester / Level:	**THIRD**
Branch:	**Biotechnology**
Name of Teacher:	

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Execute appropriate numerical methods to solve algebraic and transcendental equations correct up to some certain level of significance.
2.	Solve linear system of equations using direct and iterative methods.
3.	Approximate a function by polynomial using various interpolation techniques along with computation of derivatives and integrals.
4.	Compute numerical solutions of initial value problems.
5.	Handle numerical problems efficiently through programming languages like C, C++ etc. on computer.

COURSE OUTCOMES (COs)

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

CO1	Employ numerical techniques to solve algebraic and transcendental equations
CO2	Analyze and implement numerical methods for solving systems of linear equations
CO3	Construct numerical approximations of functions using interpolation techniques
CO4	Compute derivatives and definite integrals using numerical differentiation and integration methods
CO5	Develop solutions of ordinary differential equations using appropriate numerical schemes

List of Assignments

Write a program to :

1. Find a simple root of $f(x) = 0$ using Bisection method. Read the end points of the interval in which the root lies, maximum number of iterations and error tolerance eps.
2. Find a simple root of $f(x) = 0$ using Regula-Falsi method. Read the end points of the interval in which the root lies, maximum number of iterations and error tolerance eps.
3. Find a simple root of $f(x) = 0$ using Secant method. Read the end points of the interval in which the root lies, maximum number of iterations and error tolerance eps.
4. Find a simple root of $f(x) = 0$ using Newton Raphson method. Read any initial approximation, maximum number of iterations and error tolerance eps.
5. Find the solution of a system of linear equations using Gauss elimination method.
6. Find the solution of a system of linear equations using Gauss-Jordan method.
7. Find the solution of a system of linear equations using Jacobi method.
8. Find the solution of a system of linear equations using Gauss-Seidel method.
9. Approximate the function using Lagrange interpolation formula.
10. Approximate the function using Newton divided difference formula.
11. Approximate the function using Newton's forward and backward interpolation formulae.
12. Evaluate the integral using Trapezoidal rule.
13. Evaluate the integral using Simpson's one-third and three-eighth rules.
14. Solve an IVP, $\frac{dy}{dx} = f(x, y), y(x_0) = y_0$ using Euler method.
15. Solve an IVP, $\frac{dy}{dx} = f(x, y), y(x_0) = y_0$ using the classical Runge-Kutta fourth order method.

TEXTBOOKS:

1. Jain M.K, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age Publications, 2004.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, Fourth Edition, 2005.
3. Y. Kanetkar, Let Us C, BPB Publications, Fifteenth Edition, 2016.

REFERENCE BOOKS:

1. S.C. Chapra and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, Seventh Edition, 2014.
2. R. W. Hamming, Numerical Methods for Scientists and Engineers, Second Edition, Dover Publications Inc. 1987.
3. H. Schildt, C++: The Complete Reference, McGraw-Hill Education, Fourth Edition, 2017.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PS O 1	PS O 2	PS O 3
CO1	3	3	2	2	3	1	1	1	1	2	1	3	2	2
CO2	3	3	2	3	3	1	1	1	2	2	2	3	2	2
CO3	3	3	3	3	3	1	2	1	2	3	2	3	3	3
CO4	3	3	3	3	3	1	2	1	2	3	2	3	2	3
CO5	3	3	3	3	3	1	2	1	2	3	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2,

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: **BE24249**
Course title: **Biology of Immune System**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: **2 L: 2 T: 0 P: 0**
Class schedule per week: 3
Class: **B. Tech**
Semester / Level: **IV**
Branch: **Biotech**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To provide a thorough understanding of various Immunological phenomenon occurring in the body to fight the entry of the antigen.
2.	To provide a thorough understanding of diversity of the antibodies and the different antigen and antibody reactions used for diagnosis of the various diseases.
3.	To provide students with a deep insight about the different immunological diseases.
4.	To teach our students to have a concrete knowledge about the types of vaccines and how are they made.
5.	To acquire in-depth knowledge of immunology, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

Course Outcomes

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

CO1	To apply knowledge of immunology, inculcate a knowledge of various issues related to immunology eg. vaccines etc. and immunological techniques.
CO2	To design and conduct experiments, as well as to analyze and interpret data of different immunological methods.
CO3	To identify, formulate, and solve problems arisen due to the inefficient functioning of the immune system.
CO4	To use the techniques, skills, and modern tools necessary for detection of the immunological diseases, design a immunology research project, collect and analyze data, and interpret results
CO5	to demonstrate knowledge and understanding of the engineering principles and apply these to manage projects work are cognition of the need for and an ability to engage in life-long learning

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module-1:Basic Concepts in Immunology: The immune system, innate and acquired immune system, components of immune system, role of humoral and cell-mediated immunity, Antibodies, the genetic basis of antibody diversity, structure- function, immunoglobulin classes. Polyclonal and Monoclonal antibodies, Catalytic antibodies.	**6**
Module-2: Antigen-Antibody Interaction: Structure and properties of antigens, biological aspects of antibody-antigen interaction. Identification and measurement of antibodies and antigens, Radial Immuno diffusion, Ouchterlony, Double diffusion, Immuno-electrophoresis, Radio Immunoassay, ELISA, Western blot, Immunofluorescence, Comet Assay.	**6**
Module-3: Immunological Response: Immune response, effector mechanisms, cytokines- Role of Cytokines in the Regulation of B Cells, Components of the Complement System.	**6**
Module-4: Major Histocompatibility Complex: Immunology of Transplantation, Immunology of Graft Rejection, MHC proteins, types, Concept and types of vaccines.	**6**
Module-5: Immunological disorders: Immunological disorders and Hypersensitivity: Immunodeficiency and autoimmunity, Types of hypersensitivity.	**6**

Text books:

1.Kuby Immunology. W. H. Freeman & Co.
2.Jareway et al, Immunology, the immune system in health and disease
3.Cellular and molecular immunology, by Abul Abbas, Andrew Lichtman, and Jordan Pober. W. B. Saunders

Reference books:

1. Roitt, Essential Immunology

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL
POS MET THROUGH GAPS IN THE SYLLABUS: NIL
TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN
POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10

Teacher’s assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Cours Outco	**Program Outcomes**											**PSOs**		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	**PSO1**	**PSO2**	**PSO 3**
1	3	3										3	2	2
2	3		3	3	3							3	3	1
3	3				3		2					3	2	2
4		3		3			2	2				3	3	3
5						2			2	2		3	2	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4

CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24250
Course title: Fluid Mechanics and Heat transfer
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV
Branch:
Name of Teacher:

Course Objectives

This course enables the students:

1.	To acquire a sound knowledge on fluid properties
2.	Dynamic characteristics of fluid flow for through pipes
3.	Flow measurement devices
4.	To learn heat transfer by conduction, convection and radiation

Course Outcomes

After the completion of this course, students will be:

1.	Understand the fundamental properties of fluids
2.	Analyze flow of fluid through pipe and Understand and select flow meter(s) used in chemical process industries
3.	Understand the heat transfer by conduction in solids
4.	Understand the mechanism of convective heat transfer
5.	Determine the radiative heat transfer between surfaces

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module-1: Basic Equations of Fluid Flow: Fluid-Flow Phenomena, Newtonian and non-Newtonian fluids, Turbulence and its nature, Reynolds number and transition from laminar to turbulent flow, flow in boundary layers, boundary layer formation in straight tubes, continuity equation, Bernoulli equation with and without fluid friction, pump work in Bernoulli equation.	**8**
Module-2: Flow of Incompressible Fluids: Fluid flow in pipes, friction factor, laminar flow in pipes, Hagen-Poiseuille equation, turbulent flow in pipes and closed channels, effect of roughness, friction factor charts, Reynolds numbers and friction factor relationship, friction losses from sudden expansion and contraction of cross section, flow measuring devices such as venturimeter, orifice meter, pitot tube and rotameter.	**8**
Module-3: Heat Transfer by Conduction in Solids: Fourier's Law, thermal conductivity, Steady state conduction, compound resistance in series, heat flow through a cylinder, one dimensional unsteady state heat conduction.	**8**
Module-4: Heat Transfer by Convection: Thermal boundary layer, Heat transfer by forced convection in laminar and in turbulent flows, heat transfer by natural convection in laminar flow.	**8**
Module-5: Radiation Heat Transfer: Fundamental facts concerning radiation, emission of radiation, black body radiation, absorption of radiation by opaque solids, Kirchhoff's Law, radiation between surfaces, view factors, combined heat transfer by conduction-convection and radiation.	**8**

Text Books :

1. McCabe, Smith and Harriot, Unit Operation of Chemical Engineering T2. Fox and McDonald, Introduction to fluid mechanics
3. Hollman, Heat transfer, 8th Ed.
4. Geankoplis, Transport processes and unit operations

Reference books:

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering " Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome	Program Outcomes													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO3**
1	3					2	3	3	2			2	2	2
2	3		3		2	2				3	1	2	2	2
3	3		3			2		2	3	1	1	2	2	3
4	3		3			2	3				3	3	3	3
5		3		2	3			3		3		2	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: **BE24251**
Course title: **Thermodynamics of Chemical & Biological Systems**
Pre-requisite(s): **NIL**
Co- requisite(s):- **NIL**
Credits: 3 **L: 03 T:0 P:0**
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **IV/2**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To design, calculate and different thermodynamic parameters of chemical and biological system and interpreting experimental data.
2.	To understand the concept basic of thermodynamics principle and energy conversion and discrimination of analytical data
3.	To develop expertise and learn major concepts on applications of thermodynamics on chemical as well as biological systems.
4.	To develop knowledge pertaining to analyze thermodynamic basics for any biological pathway.
5.	Students will be able to understand the solution theory.
6.	To expand skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments.
7.	A clear understanding of thermodynamics concepts prepares a student for making a career as R&D expert/ analyst/ quality control manager/ product development manager etc.
8.	Students are able to search, select, organize and present information related to thermodynamics of any complex chemical and biological system.

Course Outcomes

After the completion of this course, students will be:

CO1	An ability to design, calculate and different thermodynamic parameters of chemical and biological system and interpreting experimental data.
CO2	An ability to analyze a system, component, or process to performing research in chemical/biological system and addressing the challenges associated with the complex chemical/biological system. Know how to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
CO3	An ability to apply the knowledge of various types of industrially used complex solution, metabolic pathways and enzymes modelling.
CO4	An ability to understand, design and application of the processes of molecular transition, energy analysis of any system.
CO5	An ability to prepare a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies in multidisciplinary teams. An ability to identify, formulate, and solve engineering problems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module-I: Continuum and Macrose approach, Systems, control volume, intensive and extensive properties, Thermodynamic equilibrium, State of system, state diagram, path and process, Zeroth law Thermodynamics, concept of temperature, Heat and work conversion, Specific Heats.	**8**
Module-II: Thermodynamic properties of pure substances in solid, Liquid and vapour phases, Equations of state, Thermodynamic property table and charts. First law of Thermodynamics: Energy and its forms, Enthalpy, Compressibilities and expansion coefficient, First law applied to control volumes (Open System) – Steady & Unsteady flow analysis. Typical applications.	**8**
Module-III: Corollaries of Second Law – Reversible and irreversible processes, Thermodynamic (absolute) temperature scale, Inequality of Clausius and concept of Entropy. Cycles:Vapour power cycles – Carnot, Rankine, Air-Stand Cycles –Diesel Cycles.	**8**
Module- IV: Vapour compression refrigeration cycle. Gibbs – Duhem equation, phase rule, single component phase equilibria. Thermodynamics of solutions. Ideal and non-ideal solutions. Estimation and determination of activity coefficients, Chemical Homogenous and heterogeneous reaction systems.	**8**
Module-V: Thermodynamic analysis of Classical and non-equilibrium biochemical reactions: Glycolysis cycle, TCA cycle, Helix-coil transition, coupled reaction.	**8**

Books Recommended:

Text Books

1. P.K. Nag, Thermodynamics

2. Wylen, Fundamentals of classical thermodynamics.

3. Denbigh, Principles of chemical equilibria

Reference books:

1. Dodge, Chemical engineering thermodynamics

1. Stephanoponlos et al, Metabolic engineering, Principles and Methodologies.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)
POS MET THROUGH GAPS IN THE SYLLABUS
TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN
POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	Simulation
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3		3	3	2	1		1	1			2	
CO2		3	3		3		2	3	1	1			3	2
CO3	3	3		3	3	2	1	1	1	1			2	3
CO4	3	2		2	2	2	2	1		2		2	1	2
CO5	3	3		3	3	3	1	2		2	2	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4, CD5
CO4	CD1, CD2, CD3, CD4, CD5
CO5	CD1, CD2, CD3, CD4, CD5

COURSE INFORMATION SHEET

Course Code:	**BE24252**
Course Title:	**Microbiology lab**
Pre-requisite(s):	
Co- requisite(s):	
Credits:	**1** L: 0 T: 0 P: 2
Class schedule per week:	**2**
Class:	**B. Tech.**
Semester / Level:	**Fourth**
Branch:	**Biotechnology**
Name of Teacher:	

COURSE OBJECTIVES

This course enables the students:

A.	To learn the fundamental principles of microbiology lab practices.
B.	To impart the knowledge on microbiological techniques and its application.
C.	To understand the concept of microbiological assay for enzymes and other bioactive compounds

COURSE OUTCOMES (COs)

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

1.	To demonstrate experimental skill of microbiology as well as competence in laboratory techniques.
2.	To develop proficiency in handling microbiological techniques and its further uses.
3.	To demonstrate the experimental skill required to identify the microbe by various techniques.
4.	To design and conduct research in the field of microbiology and may explore the further applications.

List of experiments

Experiment 1:	Cleanliness, media preparation
Experiment 2:	Sterilization, dilution techniques and isolation of pure cultures – techniques
Experiment 3:	Staining techniques in microbiology
Experiment 4:	Identification of unknown bacteria by biochemical tests

Experiment 5:	Bacterial growth curve- Serial dilution plating and turbidity measurement
Experiment 6:	Extracellular enzymatic activities of microbes
Experiment 7:	Standard qualitative analysis of water
Experiment 8:	Antibiotic sensitivity test

REFERENCE MATERIALS:

1. James G. Cappuccino and Natalie Sherman: Microbiology: A Laboratory Manual, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., 2005

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	

CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	Program Outcomes												
	PO1	**PO 2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
1	3	3	1			2	3	3	3	2	3	2	2	2
2	3	3	1			2	3	3	3	2	3	2	2	2
3	3	3	1			2	3	3	3	2	3	2	2	3
4	3	3	3	2	2	2	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code:	**BE24253**
Course title:	**Immunology Lab**
Pre-requisite(s):	**Basic Knowledge of microbiology and Immunology**
Co- requisite(s):	
Credits: 1.5	**L: 0 T: 0 P: 3**
Class schedule per week:	**3**
Class:	**B.Tech**
Semester / Level:	**IV**
Branch:	**Biotechnology**
Name of Teacher:	**Dr Shubha Rani Sharma**

Course Objectives

This course enables the students:

1.	To learn the fundamental principles of microbiology and immunology lab practices.
2.	To impart the knowledge on microbial techniques and its application.
3.	To understand the concept of antigen-antibody interaction-based techniques & its application to detect the various disease conditions.

Course Outcomes

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

1.	To demonstrate experimental skill of microbiology and immunology as well as competence in laboratory techniques.
2.	To develop the proficiency in handling, culturing, identification of microorganism and its further uses.
3.	To demonstrate the experimental skill required to identify the antigen or antigen by various techniques.
4.	To design and conduct the research in the field of microbiology and immunology and may explore the further applications.

SYLLABUS (List of experiments)

Experiment 1:	To detect the blood group of the given sample
Experiment 2:	To perform the Technique of Radial immunodiffusion
Experiment 3:	To learn and perform the technique of Ouchterlony Double Diffusion Technique
Experiment 4:	To perform the pregnancy test with the help of Pregnancy Kit
Experiment 5:	To learn the technique of Immunoelectrophoresis
Experiment 6:	To study the technique of Rocket Immunoelectrophoresis for determination of concentration of antigen in unknown sample
Experiment 7:	To perform widal test for detection of typhoid
Experiment 8:	To perform the sandwich Dot ELISA Test for antigen detection

Experiment 9:	To identify cells in a blood smear
Experiment 10:	To detect syphilis with the help of VDRL test

Text books:
1: D. K. Maheshwari and R. C. Dubey, Practical Microbiology. S. Chand.
2: Frank C. Hay and Olwyn M. R. Westwood, Practical Immunology. Wiley-Blackwell; 4th Revised edition

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3		3		2	2	2	3	1	2	2	2
CO2	3	3	3	3	3	2		2	2	3	1	2	2	
CO3	3	3	2		3		2		2	3	1	3		2
CO4	3	3	3		3		2	2	2	3	1	2	3	3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: **BE24254**
Course Title: **Computational Biology Lab**
Pre-requisite(s): **NIL**
Co- requisite(s):
Credits: **1** L: 0 T: 0 P: 2
Class schedule per week: **2**
Class: **B. Tech.**
Semester / Level: **IV**
Branch: **Biotechnology**
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	Understand the basics of molecular structure representation by retrieving chemical and protein structures from public databases and interpreting various molecular file formats.
2.	Perform homology modelling of proteins using computational tools and validate the quality of the generated 3D structures through structure assessment techniques.
3.	Learn to carry out molecular docking studies using web-based tools, interpret docking scores, and analyze ligand–receptor interactions.
4.	Develop pharmacophore models for a series of ligands and understand their application in virtual screening and drug discovery.
5.	Gain experience in predicting ADMET properties of drug candidates and building a virtual compound library for in silico drug screening applications.

COURSE OUTCOMES (COs)

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

CO1	Apply computational biology principles to retrieve, analyze, and interpret molecular biological data.
CO2	Design and perform computational experiments related to molecular modeling, docking, and drug discovery, interpreting the results effectively.
CO3	Identify and troubleshoot challenges in computational workflows involving virtual screening.
CO4	Utilize advanced bioinformatics and chemoinformatics tools to evaluate molecular properties and support drug discovery efforts.
CO5	Demonstrate the ability to independently manage computational projects, including virtual library creation and analysis of biological data.

List of experiments

Experiment 1:	Search and download molecular structures from chemical databases and understand different file formats
Experiment 2:	Perform homology modeling of a given protein sequence and conduct validation tests
Experiment 3:	Perform molecular docking studies using web servers and analyze docking results
Experiment 4:	Develop a pharmacophore model for a given set of ligands
Experiment 5:	Download and characterize the ADMET of selected drug molecules
Experiment 6:	Develop a virtual library of chemical compounds for virtual screening or drug discovery purposes
Experiment 7:	Introduction to AI/ML
Experiment 8:	Generate 2D interaction plot for selected complex structures and its analysis

Books:

1. Molecular Modeling: Basic Principles and Applications, 3rd Edition by Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers
2. Practical Chemoinformatics by Muthukumarasamy Karthikeyan , Renu Vyas

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	**% Distribution**

Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2		2	3				2		1	2	2	1
CO2	3	3	2	2	3				2		1	2	2	2
CO3	3	3	2	2	3	1			2		2	2	3	2
CO4	2	2	2	2	3	2			2		2	2	3	2
CO5	2	2	2	2	3	2			2	2	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code:	**BE24255**
Course Title:	**Fluid mechanics and Heat transfer lab**
Pre-requisite(s):	
Co- requisite(s):	
Credits:	**1** L: 0 T: 0 P: 2
Class schedule per week:	
Class:	**B. Tech.**
Semester / Level:	**IV**
Branch:	
Name of Teacher:	

COURSE OBJECTIVES

This course enables the students to:

1	To acquire a sound knowledge on fluid properties
2	Dynamic characteristics of fluid flow for through pipes
3	Flow measurement devices
4	To learn heat transfer by conduction, convection and radiation

COURSE OUTCOMES (COs)

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

CO1	Understand the fundamental properties of fluids
CO2	Analyze flow of fluid through pipe
CO3	Understand and select flow meter(s) used in chemical process industries
CO4	Understand the fundamentals of heat transfer mechanism

List of experiments

Experiment 1:	To obtain the Reynolds number in different flow conditions (CO:1)
Experiment 2:	To calibrate Venturi meter and to study the variation of coefficient of discharge with the Reynolds number
Experiment 3:	To calibrate an orifice meter and to study the variation of coefficient of discharge with the Reynolds number Experiment
Experiment 4:	To verify the Bernoulli's theorem experimentally

Experiment 5:	To study the pattern of flow in free and forced vertex, calculate the thermal conductivity of the given liquid
Experiment 6:	Calculate the heat transfer coefficient for a pipe by natural convection, forced convection
Experiment 7:	Determine the emissivity of the given material
Experiment 8:	Impact of jet on vanes (Flat and hemispherical plate), Jet pump test rig

REFERENCE MATERIALS:

1. Lab manuals (available on department website)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO3**
1	3					2	3	3	2			2	2	2
2	3		3		2	2				3	1	2	2	2
3	3		3			2		2	3	1	1	2	2	3
4	3		3			2	3				3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

THIRD YEAR (SEMESTER-I)

COURSE INFORMATION SHEET

Course code:	**BE24341**			
Course title:	**Bioanalytical Techniques**			
Pre-requisite(s):				
Co- requisite(s):				
Credits:	**3**	L: 3	T: 0	P: 0
Class schedule per week:	3			
Class:	B. Tech			
Semester / Level:	Fifth/ Third			
Branch:	**Biotechnology**			
Name of Teacher:				

Course Objectives

This course enables the students:

1.	Develop the ability to design and conduct experiments, including making measurements and interpreting experimental data from living system and addressing the problems associated with the interaction between living systems and nonliving materials.
2.	An understanding of the use of different instruments, discrimination of analytical data; and functions of different components of the selected instruments and their effects on data analysis.
3.	To develop expertise, an understanding of the range and theories of instrumental methods available in biological research/ biotechnology.
4.	To develop knowledge pertaining to the appropriate selection of instruments for the successful analysis of complex mixture.
5.	To provide an understanding of and skills in advanced methods of separation and analysis.
6.	To expand skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments.
7.	A clear understanding of bioanalytical technique prepares a student for making a career as R&D expert/ analyst/ quality control manager/ product development manager etc.
8.	Students are able to search, select, organize and present information related to bioinstrumentation.

Course Outcomes

After the completion of this course, students will be:

1.	able to apply knowledge of mathematics, science, and engineering and will be able to design and conduct experiments, as well as to analyze and interpret data related to the domain of Bioinstrumentation.
2.	able to design a system, component, or process to perform research in biological systems and address the challenges associated with Centrifugation Techniques and Electrokinetics. He will be able to know how to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3.	able to apply the knowledge of various types of industrially used Chromatographic Techniques and imaging methods; advantages and disadvantages, design criteria, molecular imaging, instrumentation and various aspects of operation.
4.	able to understand, design and application of the processes of Spectroscopy and Thermal Analysis
5.	able to prepare a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies in multidisciplinary teams and able to identify, formulate, and solve engineering problems.

BE301 BIOANALYTICAL TECHNIQUES

MODULE	**(NO. OF LECTURE HOURS)**
Module-I Centrifugation Techniques and Electro-kinetics: Principle, instrument and application of steady state sedimentation, density gradient centrifugation, analytical centrifugation.	**8**
Module-II Electro-kinetics: Electro-osmosis and electrophoresis, Helmholtz-Smoluchowski equation, Zeta potential, Principle, design and application of Gel electrophoresis; SDS-PAGE, gradient gels, Two dimensional gels, isoelectric focusing.	**8**
Module-III Chromatographic Techniques: Principles, design and application of column chromatography, partition and adsorption chromatography, Affinity Chromatography; Ion Exchange Chromatography, Gas Chromatography, HPLC	**8**
Module-IV Spectroscopy -I: Beers Lamberts law, Principles, Instrumentation and applications of Visible and UV Spectrophotometry; Spectroflourimetry (FRET); FTIR, NMR spectroscopy.	**8**
Module-V Spectroscopy – II and Thermal Analysis: Principles, Instrumentation & applications for flame emission / atomic absorption spectrophotometry and their comparative study; ICP (b) Mass spectrometry; Principles, Instrumentation and applications. Instrumentation and application of Differential scanning calorimetry and Thermogravimetry.	**8**

TextBooks:

1. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry. 3rd edition, Edward Arnold (Publishers) Ltd.
2. Willard, Merrit and Dean, Instrumental Methods and Analysis, 7th edition, D. Van Nostrand Company, Inc.
3. Ewing GW, Instrumental Methods of Chemical analysis. McGraw Hill Book Company.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS : NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

Indirect Assessment

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**												
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	PO11	PSO 1	PSO 2	PSO 3
1	3	3	3	3	3	2	3	2	3	2	3	3	3	3
2	3	3	3	3	3	2	3	2	3	2	3	3	3	3
3	3	3	2	3	3	2	3	2	3	2	3	3	3	3
2	3	3	2	3	3	2	3	2	3	2	3	3	3	3
5	3	3	2	3	3	2	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course Code	**BE24342**
Course Title	Functional Genomics, rDNA Technology and Genome Editing
Pre-requisite(s)	Basic Cell and Molecular Biology
Credits	3 (L:3 T:0 P:0)
Class Schedule per Week	3
Class	B. Tech
Semester/Level	Fifth
Branch	Biotechnology
Name of Teacher	

COURSE OBJECTIVES

This course aims to:

1.	Introduce students to tools and techniques used in functional genomics and rDNA technology.
2.	Provide in-depth knowledge of gene function, regulation, and manipulation.
3.	Familiarize students with genome editing tools and their applications.
4.	Encourage understanding of the ethical and societal implications of genome editing and GMOs.

COURSE OUTCOMES (COs)

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

CO No.	Course Outcome
CO1	Describe the concepts of gene function, regulation, and genome organization, and apply gene expression analysis methods.
CO2	Analyze and apply tools and techniques in functional genomics and functional annotation, including model organism systems.
CO3	Design recombinant DNA constructs and explain molecular techniques used in rDNA technology and gene cloning.
CO4	Demonstrate understanding of genome editing technologies, assess their applications, and evaluate ethical, environmental, and societal implications of genome manipulation and GMOs.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module-I: **Exploring Gene Function** Genetics to genomics to functional genomics, Forward vs. Reverse Genetics, Exploring gene structure and regulation, Techniques for gene expression analysis, Reporter assays and protein localization techniques, miRNA and siRNA, RNA Interference.	**8**
Module-II: Introduction to Functional Genomics Genome organization, Next-generation sequencing technologies (NGS) and data analysis pipelines. Comparative and functional genomics, Functional annotation of genes and genomes: Gene ontology (GO) and pathway analysis. Introduction to model organisms in functional genomics research (yeast, C. elegans, zebrafish, Arabidopsis)	**8**
Module-III: Foundation of rDNA Technology Restriction and modifying enzymes, DNA ligases, and different types of vectors (plasmids, BACs), Planning and design of recombinant DNA constructs, Advanced techniques in DNA manipulation (PCR, gel electrophoresis, Site directed Mutagenesis, Southern blotting)	**8**
Module-IV: Transformation, Cloning and Expression Methods for introducing rDNA into host cells, Promoter selection and strategies for optimal gene expression, Recombinant protein purification techniques	**8**
Module-V: Genome Editing and ethical considerations CRISPR-Cas system: mechanism, different configurations, and applications, Other genome editing technologies (TALENs, base editors), Applications of genome editing in Personalized medicine and gene therapy, Ethical considerations and regulations surrounding genome editing, Production of biopharmaceuticals, genetically modified organisms (GMOs) and their applications in agriculture and medicine, Environmental and societal considerations of GMOs.	**8**

TEXTBOOKS

1. Brown, T. A. “Genomes”
2. Primrose and Twyman, “Principles of Gene Manipulation and Genomics”
3. Green & Sambrook, “Molecular Cloning: A Laboratory Manual”
4. Doudna, J., “A Crack in Creation”

REFERENCE BOOKS

1. Alberts et al., “Molecular Biology of the Cell”
2. Watson et al., “Recombinant DNA”
3. Pierce, B., “Genetics: A Conceptual Approach”

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

2. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	2	1	1	1	3	2	3
CO2	3	3	3	3	2	1	1	2	1	1	1	3	3	3
CO3	2	3	3	3	2	1	1	2	1	1	1	3	3	3
CO4	3	2	3	3	2	2	2	2	1	1	1	3	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE 24343
Course Title: Mass Transfer Operations
Pre-requisite(s): Chemical Process Calculations (BE 206); Fluid Mechanics & Heat Transfer (BE 209)
Co-requisite(s): Bioseparation Engineering (BE 307); Reaction Engineering (BE 304)
Credits: **3** L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fifth/ Third
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students to:

A.	Understand the basic principles of mass transfer operations.
B.	Decide among different extraction methods for industrial operation.
C.	Separate a component from a mixture.
D.	Apply their knowledge to purify a biomolecule after production.

Course Outcomes

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

CO1	Explain the basic principles involve in mass transfer operations.
CO2	Design a distillation column.
CO3	Separate biomolecules using the solvent extraction method
CO4	Extract soluble particles from solids using the leaching method.
CO5	Isolate a bio-molecule by advanced separation methods.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module 1: Diffusion Molecular diffusion in fluids; Theory of diffusion: Fick's law, analogy between heat, mass and momentum transfer; Diffusivity; Mass Transfer Coefficients;	**8**

Vapour liquid equilibrium; Phase diagram; Roult's Law for ideal solution; Relative volatility	
Module 2: Distillation Introduction to distillation, different types of distillations. Distillation column: basic Design, McCabe-Thiele Method to calculate the number of ideal plates, 'q' line, feed plate location; Reflux ratio, maximum, minimum and optimum reflux; minimum number of plates; plate efficiency.	**8**
Module 3: Liquid-liquid extraction Introduction to extraction; Ternary liquid equilibria: triangular graphical representation and binodal curve; single stage batch extraction; multistage continuous operation; determination of number of stages.	**8**
Module 4: Solid-liquid extraction Leaching, solid-liquid equilibria; factors influencing leaching; equipment used in solid-liquid extraction; single-stage leaching; continuous multistage leaching; graphical determination of number of stages.	**8**
Module 5: Advanced Separation Processes Aqueous two-phase extraction, Supercritical fluid extraction, Reverse micelle extraction, Pervaporation, Membrane bioreactor, Membrane distillation	**8**

Textbooks:

1. Warren McCabe, Julian Smith, Peter Harriott, Unit Operation of Chemical Engineering, 7th Ed., McGraw Hill Education, 2017
2. Robert Treybal, Mass Transfer Operations, 3rd Ed., McGraw Hill Education, 2017

Reference books:

1. Leonard A. Wenzel, Curtis W. Clump, Louis Maus, L. Bryce Andersen Alan S. Foust, Principles of Unit Operations, 2nd Ed., Wiley, 2008
2. B.K. Dutta, Principles of Mass Transfer and Separation Processes, 1st Ed., Prentice Hall India Learning Private Limited, 2006

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

Indirect Assessment

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	Simulation
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	2	2	3	2	2	2	1			1	2	2	2
CO 2	3	3	3	3	3			1	2	2	1	3	2	3
CO 3	3	3	3	3	3		2	2	2	2	1	3	2	2
CO 4	3	3	3	3	3	2	2	1		2	1	2	2	3

CO 5	3	3	3	3	3	2		1	2	2	1	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4, CD5
CO2	CD1, CD2, CD3, CD4, CD5
CO3	CD1, CD2, CD3, CD4, CD5
CO4	CD1, CD2, CD3, CD4, CD5
CO5	CD1, CD2, CD3, CD4, CD5

COURSE INFORMATION SHEET

Course code: **BE 24344**
Course Title: **Reaction Engineering**
Pre-requisite(s): Knowledge about Mathematics and Chemistry
Co- requisite(s): Nil
Credits: **3 L: 3 T: 0 P:**
Class schedule per week: 03
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	Introduce basic concepts of chemical kinetics like homogeneous and heterogeneous reactions, rate of reaction, order and molecularity of reaction, concentration and temperature dependency of rate of reaction
B.	Knowledge on different types of chemical reactors
C.	Design of chemical reactors under isothermal conditions
D.	Kinetics of heterogeneous reactions

Course Outcomes

After the completion of this course, students will be:

1.	Apply the principles of reaction kinetics, formulate rate equations and analyse the batch reactor data.
2.	Analyze the experimental kinetic data to select a suitable reactor for a particular application and to workout conversion and space time for different types of reactors.
3.	Evaluate selectivity, reactivity and yield for parallel and mixed reactions.
4.	Examine how far real reactors deviate from the ideal.
5	Kinetics of heterogeneous reactions

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module-1: Kinetics of Homogeneous Reactions: Classification of reactions, reaction rate, speed of reaction, rate equation, concentration-dependent term of rate equation, rate constant, order and molecularity, representation of elementary and nonelementary reactions, kinetic models for nonelementary reactions, temperature-dependent term of a rate equation, activation energy and temperature dependency.	**8**
Module-2: Kinetic Analysis of Batch Reactor Data: Integral and differential methods for analyzing kinetic data, interpretation of constant volume batch reactor, data for zero, first, second and third order reactions, half-life period, irreversible reaction in parallel and series, auto catalytic reaction.	**8**
Module-3: Kinetic Interpretation of Batch Reactor Data for Single Reactions: Interpretation of variable volume batch reaction data for zero, first and second order reactions, Ideal batch reactor, steady state CSTR and plug flow reactors and their use for kinetic interpretation.	**8**
Module-4: Design for Single Reaction: **Design for Single Reaction**: Size comparison of single reactors, plug flow reaction in series and/or parallel, equal and different size of mixed reactor in series, finding the best system for given conversion, recycle reactor, Energy balance equations for batch, CSTR and PFR and their application to the design of reactors; Non ideality; Residence time distribution.	**8**
Module-5: Reaction Catalyzed by Solids: **Reaction Catalyzed by Solids**: Introduction to heterogeneous reactions, rate equation for surface kinetics, pore diffusion resistance combined with surface kinetics, porous catalyst particles, performance equations for reactors containing porous catalyst particles, experimental methods for finding rates; references to bio catalysis, immobilized enzymes.	**8**

Text Books

1. Levenspiel, O. Chemical Reaction Engineering Ed.3, John Wiley & Sons (Asia)

Reference

1. K.A. Gavhane, Chemical Reaction Engineering I, Ed 7, 2006, Nirali Prakashan
2. H.ScottFoggler, Elements of Chemical Reaction Engineering, Ed 5, 2016, Prentice Hall

3. Paulin Doran, Bioprocess Engineering Principles. Ed 2, 2013, Elsevier

GAPS IN THE SYLLABUS (TO MEET

INDUSTRY/PROFESSION REQUIREMENTS) NIL POS

MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

OURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**											**PSOs**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	1	2	3
1	3	3	3	3	3	2					2	2	2	2
2		3	3	2	3						2		2	2
3	2	3	3				1	2			3	2	3	3
4	1	3	3	3	3	2				2	2	3	2	2
5	3	3	3	2	2	2	3				3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2, CD3
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD2, CD3

COURSE INFORMATION SHEET

Course Code	**BE24345**
Course Title	**Functional genomics & rDNA Technology Lab**
Pre-requisite(s)	**Basic Cell and Molecular Biology**
Credits	**1 (L:0 T:0 P:2)**
Class Schedule per Week	**2**
Class	**B. Tech. Biotechnology**
Semester/Level	**Fifth**
Branch	**Biotechnology**
Name of Teacher	

COURSE OBJECTIVES

This course aims to:

1.	This is a research based course in which student will learn to apply molecular biology techniques (focused on nucleic acids) in the laboratory to ask scientific questions.
2.	Students will learn principles and practice of basic bacterial culture techniques, transformation, agarose gel electrophoresis, nucleic acid purification (plasmid and genomic DNA, RNA), nucleic acid quantification.
3.	DNA restriction digestion and analysis, Southern hybridization, library construction, polymerase chain reaction (PCR), and basics of computer-based DNA sequence analysis and data acquisition over the internet.
4.	In addition, students will learn about the nature and selection of DNA cloning vectors, restriction enzymes, modifying enzymes, polymerases, and other reagents used in molecular biology.
5.	Students will examine aspects of bioinformatics and genomics, and newer/advanced molecular technologies such as next-generation sequencing. Student will apply newly learned molecular techniques toward solving real biological research questions.

COURSE OUTCOMES (COs)

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

CO No.	**Course Outcome**
CO1	Demonstrate safe laboratory practices and explain the principles of standard molecular techniques including bacterial culture, nucleic acid purification, and gel electrophoresis.
CO2	Perform key molecular biology protocols such as DNA/RNA isolation, transformation, restriction digestion, PCR, and troubleshoot experimental procedures.
CO3	Apply bioinformatics tools to support molecular experiments, including sequence retrieval, BLAST, multiple sequence alignment, and PCR primer design.
CO4	Design, execute, and document molecular biology experiments, including PCR-based DNA cloning, and interpret results within the context of scientific hypothesis testing.

List of Experiments

EXPERIMENT 1	**Introduction to Laboratory Safety and Basic Techniques:** Safety guidelines, lab orientation, equipment handling.
EXPERIMENT 2	**Pipetting and Solution Preparation:** Accurate pipetting, preparation of molar and percentage solutions.
EXPERIMENT 3	**Isolation of Genomic DNA from Bacteria and Plant Tissue :** Cell lysis, purification, and analysis.
EXPERIMENT 4	**Isolation of Plasmid DNA from Bacteria:** Alkaline lysis method, yield and purity assessment.
EXPERIMENT 5	**Restriction Digestion of DNA:** Use of specific restriction enzymes and buffer systems.
EXPERIMENT 6	**Agarose Gel Electrophoresis:** Gel preparation, DNA loading, staining and visualization.
EXPERIMENT 7	**Primer Designing and PCR:** Use of online tools (Primer3, NCBI Primer-BLAST), PCR amplification.
EXPERIMENT 8	**Bioinformatics Tools for Genomic Analysis:** BLAST, ORF Finder, sequence retrieval, primer analysis.

TEXTBOOKS

1. Green & Sambrook, *Molecular Cloning: A Laboratory Manual*
2. Wilson & Walker, *Principles and Techniques of Biochemistry and Molecular Biology*
3. Dinesh Kumar et al., *Laboratory Manual for Biotechnology*
4. Online NCBI Resources and Tools (BLAST, Primer-BLAST)

REFERENCE BOOKS

1. T.A. Brown, *Genomes*
2. Primrose & Twyman, *Principles of Gene Manipulation and Genomics*
3. Alberts et al., *Molecular Biology of the Cell*

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Lab Journal	30

Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	**% Distribution**
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	1	2		2	1	1	1	3	2	1
CO2	3	3	2	2	2	1	1	1	1	1		3	2	2
CO3	3	3	3	2	1	1		1	1			3	3	2
CO4	3	2	3	3	2	1				1	1	3	3	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: BE24346
Course title: Bio-Analytical Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 3 **L: 0** **T: 0** **P: 3**
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fifth/ Third
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1.	Develop the ability to design and conduct experiments, including making measurements and interpreting experimental data from living system and addressing the problems associated with the interaction between living systems and nonliving materials.
2.	An understanding of the use of different instruments, discrimination of analytical data; and functions of different components of the selected instruments and their effects on data analysis.
3.	To develop expertise, an understanding of the range and theories of instrumental methods available in biological research/ biotechnology.
4.	To develop knowledge pertaining to the appropriate selection of instruments for the successful analysis of complex mixture.
5.	To provide an understanding of and skills in advanced methods of separation and analysis.
6.	To expand skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments.
7.	A clear understanding of bioanalytical technique prepares a student for making a career as R&D expert/ analyst/ quality control manager/ product development manager etc.
8.	Students are able to search, select, organize and present information related to bioinstrumentation.

Course Outcomes

After the completion of this course, students will be:

1.	will be able to design and conduct experiments, as well as to analyze and interpret data related to the domain of Bioinstrumentation.
2.	able to design a system, components, or process to perform research in biological systems and address the challenges associated with bioanalytical techniques.
3.	able to prepare a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies in multidisciplinary teams and able to identify, formulate, and solve engineering problems.

List of Experiments

Experiment 1:	Demonstration and Experiment on Gas and Liquid Chromatography
Experiment 2:	Mass analysis of molecules using Mass Spectrometry
Experiment 3:	Measurements of absorbance and transmittance using UV/VIS spectrophotometry
Experiment 4:	Demonstration and Experiment on SEM
Experiment 5:	Material characterization using DSC, TGA
Experiment 6:	Demonstration and Experiment on GEL Electrophoresis
Experiment 7:	Material separation using ultracentrifuge (AUC)
Experiment 8:	Analysis of AES/AAS using ICP-OES

TextBooks:

1. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry. 3rd edition, Edward Arnold (Publishers) Ltd.
2. Willard, Merrit and Dean, Instrumental Methods and Analysis, 7th edition, D. Van Nostrand Company, Inc.
3. Ewing GW, Instrumental Methods of Chemical analysis. McGraw Hill Book Company.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Lab Journal	30
Lab quizes	20

Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3
Continuous Internal Assessment	Y	Y	Y
Semester End Examination	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Mini-Project/Projects
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	Program Outcomes												
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
1	3	3	3	3	3	2	3	2	3	2	3	3	3	3
2	3	3	3	3	3	2	3	2	3	2	3	3	3	3
3	3	3	2	3	3	3	3	2	3	2	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **BE 24347**
Course Title: **Mass Transfer Operations Lab.**
Pre-requisite(s): **NIL**
Co-requisite(s): **BE 24 343**
Credits: **1** **L: 0** **T: 0** **P: 2**
Class schedule per week: 02
Class: **B. Tech**
Semester / Level: **Five**
Branch: **Biotechnology**
Name of Teacher:

This course enables the students to:

1.	Acquire sound knowledge on mass transfer operations
2.	Understand mass transfer equipment.
3.	Learn solid-liquid mass transfer.

Course Outcomes

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

CO1	Analyze the fundamental properties of mass transfer.
CO2	Perform liquid-liquid separation by various methods.
CO3	Perform Mass transfer with and without chemical reaction.
CO4	Execute the operations of Mass Transfer equipments.

List of Experiments

Experiment No:	**Name of Experiments**
Experiment 1	To perform binary distillation in a bubble-cap column
Experiment 2	To perform batch distillation in a packed column
Experiment 3	To determine the drying rate of a material in rotary dryer
Experiment 4	To plot the drying curve under fluidized bed conditions.
Experiment 5	To perform Mass transfer with chemical reaction
Experiment 6	To perform Mass transfer without chemical reaction
Experiment 7	To perform Vapour in air diffusion
Experiment 8	To perform adsorption with chemical reaction in a packed bed

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	1	2		1	1	2	2	2
CO2	3	3	3	3	3	2	1	2	1		1	2	3	3
CO3	3	3	2	2	3		2	2	1		1	3	2	2

CO4	3	3	3	2	3		2	2			1	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

THIRD YEAR (SEMESTER-II)

COURSE INFORMATION SHEET

Course code: BE24357
Course Title: Bioprocess Engineering
Pre-requisite(s): BE101 Biological Science for Engineers, BE303 Mass Transfer Operations **Co- requisite(s): NIL**
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives:

This course enables the students:

1	To understand the process of microbial growth and synthesis of bioproducts, methods of measurements of growth and mass balance of the bioprocess
2	Regarding medium formulations and sterilization, types of sterilizes and role of filers on sterilization
3	Provide knowledge of kinetics of enzymes both in free and in immobilized state and stability of biocatalyst
4	Gain knowledge about the mode of reactor operation and significance of CFD in bioprocessing

Course Outcomes:

After the completion of this course, students will be:

CO 1	Able to explain the kinetics of cell biomass accumulation and product formation under operational conditions
CO 2	Perception of analyzing data and interpretation of mass balance, yield calculations etc
CO 3	Competent to identify and design sterilizers for removal of microbial contaminants
CO 4	An insight of undertaking on improving biocatalyst's efficiency by immobilization techniques and types of reactor and related applications

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module-I: Cell Growth and Product Formation	**8**

Cell growth and bio-product formation kinetics, Quantification of cell growth, growth patterns and kinetics in batch culture, environmental factors affecting growth kinetics, heat generation by microbial growth, unstructured non segregated model, models for transient behaviour	
Module-II: Mass Balance and Yield Concepts Yield and maintenance coefficients, calculation based on elemental balances, degree of reduction, theoretical predictions of yield coefficients	**8**
Module-III: Sterilization Media and air sterilization, Sterilization equipment, Kinetics of death, Batch and continuous sterilization of media, Role of membrane filters for sterilization of media and air	**8**
Module-IV: Enzyme Immobilization Kinetics of free and immobilized enzymes, Immobilized enzyme reactors and Diffusion limitations	**8**
Module-V: Operating considerations for bioreactors Batch, fed-batch and continuous bioreactors, ideal plug flow tubular reactors, Concepts of computational fluid dynamics in bio-processing	**8**

Text Books:

1. Shuler and Kargi, Bioprocess Engineering – Basic Concepts. Prentice Hall PTR, 2002
2. Doran, Bioprocess Engineering Principles, Academic Press, 1995
3. Bailey and Ollis, Biochemical Engineering Fundamentals, 1986

Reference Books:

1. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.
2. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10

Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes	**Program Outcomes**											PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO 10**	**PO1 1**	PSO 1	PSO 2	PSO 3
1	1	1	2	1	1						1	1		
2			3		2	2		2			2	1	2	
3	2	2	2	2			3	3		2	3	1	2	3
4	3				3	3	3		3	3	2		2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3

CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: **BE24358**

Course Title: **Bioseparation Engineering**

Pre-requisite(s):

Co-requisite(s): **BE307 Bioprocess Engineering**

Credits: 3 L:3 T:0 P:0

Class schedule per week: 03

Class: **B. Tech**

Semester / Level: **VI/3**

Branch: **Biotechnology**

Name of Teacher:

Course Objectives

This course enables the students:

A.	To understand outline of recovery processes, removal of biomass including solids matters by filtration, centrifugation and sedimentation etc and learn the techniques of cell disruption, their limitations and applications
B.	To gain knowledge regarding principles, methods and applications of different methods for extraction of desired product from the clarified fermentation broth
C.	About the concept of various chromatographic techniques for separation and identification of targeted compound
D.	Provide the information of finishing operations and quality control related issues for the purified product

Course Outcomes

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

CO1	Separate cells from fermentation broth and extract intracellular products
CO2	Isolate proteins using adsorption, precipitation, and extraction methods
CO3	Separate proteins by different membrane separations
CO4	Purify proteins using various chromatographic techniques
CO5	Perform crystallization and drying to make a finished product

COURSE INFORMATION SHEET

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module 1: Principle of Separation Based on Size and Shape: Filtration, Centrifugation, Disruption of living cells to release the intracellular products: Mechanical and Non-mechanical methods.	**8**
Module 2: Separation of Soluble Products: Adsorption, Adsorption isotherms. Liquid-liquid extraction, Aqueous two-phase extraction, Salt precipitation.	**8**
Module 3: Membrane-Based Separation: Principle, Modules, Types: Reverse osmosis, Ultrafiltration, Microfiltration, Dialysis and Electro-dialysis.	**8**
Module 4: Chromatography: TLC, Gel-filtration, Ion-exchange, Affinity and Pseudo-affinity, Hydrophobic Interaction, Partition.	**8**
Module 5: Finishing Operations: Crystallization, drying of product and packaging.	**8**

Text Books:

1. Nooralabettu Krishna Prasad, Downstream Process Technology, 1st Ed., Phi learning Pvt. Ltd, New Delhi, 2010
2. B. Sivasankar, Bioseparations: Principles and Techniques, 1st Ed., Prentice Hall, 2005
3. Michael L. Shuler, Fikret Kargi, Bioprocess Engineering – Basic Concepts, 2nd Ed., Pearson Education India, 2015

Reference Books:

1. Paul A. Belter, E. L. Cussler Wei-Shou Hu, Bioseparations: Downstream Processing for Biotechnology, Wiley India, Pvt Ltd., 1st Ed., 2011
2. James Bailey, David Ollis, Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill Education, 2017

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

Indirect Assessment –

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	3	3				2				1	2	2	2
CO2	3	3	2	2	3			1	2	2	1	3	2	3
CO3	3	2	3	3	3	2	2	2	2	2	1	3	2	2
CO4	3	3	3	3	3	2	2			2	1	2	2	3
CO5	3	2	2	2	3			1	2	1	1	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD2
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code:	**BE24359**
Course Title:	**Plant & Agriculture Biotechnology**
Pre-requisite(s):	
Co- requisite(s):	
Credits:	**3 (L: 3 T: 0 P:0)**
Class schedule per week:	**3**
Class:	**B. Tech.**
Semester / Level:	**Sixth**
Branch:	**Biotechnology**
Name of Teacher:	**Dr. Sheela Chandra**

COURSE OBJECTIVES

The course will enable the students to:

1.	Learn the fundamentals of culturing plant cells and tissues, culture environment.
2.	Describe the phenomenon of organogenesis, embryogenesis and somaclonal variation.
3.	Learn various techniques like micropropagation, single cell culture, suspension culture, protoplast culture, hairy root culture
4.	Acquire knowledge on various recombinant DNA techniques to produce genetically modified with novel traits

COURSE OUTCOMES (Cos)

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

CO1	Familiarize with organization of PTC Lab., aseptic manipulations and learn techniques of culturing tissues, single cells, protoplast and anther culture, hairy root culture and germplasm conservation.
CO2	Undertake large scale in vitro propagation of plants through micropropagation.
CO3	Generate plants with desirable/novel traits through genetic manipulations using different methods of gene transfer and marker associated selections.
CO4	Recognize the importance of plant secondary metabolites, their commercial production.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module 1: *In vitro* Culture: Basics about equipment's and laboratory set up, Introduction to Plant Tissue Culture —its history, development and applications, Plant tissue culture media, Plant growth regulators, Types of cultures, Sterilization techniques, Major challenges and prospects of traditional and modern plant biotechnology, Lab safety aspects**.**	**8**
Module: Micropropagation: Techniques and various steps involved in micropropagation, Stages of micropropagation, Organogenesis, Embryogenesis, Artificial Seeds, Commercial Micropropagation, Production of disease-free plants and certification of tissue culture raised plants, Somaclonal variation.	**8**
Module 3: Production of Haploid Plants & Protoplast Culture: Androgenesis and Gynogenesis, Significance and uses of haploids. Embryo Culture and Embryo Rescue and its Applications in Plant Improvement. Protoplast Culture and Somatic Hybridization.	**8**
Module4: Strategies for Producing Novel Plants: Development of crops adaptable to stresses using *Agrobacterium* and particle bombardment mediated transformation, gene silencing and hairy root culture, Plants as factories for biopharmaceuticals, Use of nanotechnology in Agricultural sciences, Precision agriculture, Value addition in crops and sustainable agriculture.	**8**
Module5: Secondary Metabolite Production& Germplasm Conservation: Primary vs secondary metabolites, Role of plant tissue culture in secondary metabolite production, Hairy root culture, Strategies for the enhancement of secondary metabolite production. Germplasm and methods of its conservation.	**8**

Text Books:

1. M. K. Razdan: An introduction to plant tissue culture. Science Publishers (2003) 2nd ed.
2. Timir Baran Jha and Biswajit Ghosh: Plant Tissue Culture: Basic and Applied
3. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Oxford University Press,(2008) 2nd ed.

Reference Book:

1. A. Mizrahi, Biotechnology in Agriculture
2. Satyanarayana, U. Biotechnology
3. Dixon and Gonzales, Plant Cell Culture – A Practical Approach.

4. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, 7th
5. Edition, Blackwell Publishing (2006) 7th ed.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

3. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES (Cos) AND Pos and PSOs

Course Outcomes (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1:	3	3	3	2	2	2		1	2	1	2	3	2	3
CO2:	3	3	3	2	2	2		2	2	1	2	2	2	3
CO3:	1	3	3	1	1	1	1	1	1	1	2	2	2	3
CO4:	2	2	2	1	1	2	1	2	1	1	2	3	2	3

Grading: No correlation – 0, Low correlation – 1, Moderate correlation – 2, High Correlation – 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24361
Course title: Bioprocess Engineering Lab
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L: 0 T: 0 P: 3
Class schedule per week: 2
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students to:

A.	Establish an understanding of the growth characteristics of microorganisms in liquid culturing conditions.
B.	To familiarize students with different methods of fermenter and fermentation process.
C.	To give them knowledge about preparation of standard plots for estimation of desired product and residual components.
D.	To expose students for analysis of mass balance related with kinetics of enzyme/ cells at laboratory as well as industrial level.

Course Outcomes

After the completion of this course, students will be:

1.	Able to understand the role of media and constituents for growth and their effect on process.
2.	Able to know about different phases of growth in batch mode cultivation and mass balance analysis
3.	Capable of knowing the role of calibration process like pH, DO etc in fermentation systems
4.	They will be able to design the steps of kinetic study of enzymes both at free state and immobilized state at laboratory and industrial scale

Experiment 1:	Study of different culture systems and media
Experiment 2:	Bioreactor parts and accessories
Experiment 3:	Shake Flask Culture
Experiment 4:	Calibration of pH electrode and DO probe
Experiment 5:	To prepare standard plot of sugar, protein and ammonia
Experiment 6:	Growth of microorganisms and mass balance
Experiment 7:	Immobilization of enzymes by entrapment
Experiment 8:	Kinetic study of enzymes

List of Experiments

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	**% Distribution**
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes	**Program outcomes**											**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	PSO1	PSO2	PSO3
1	1	2				1	1				1	1	2	
2	1	3		2	2	1	2	3		3	2	1		3
3	1	2	3		3	2	3		3	3		1	2	
4	1	2	3	2		3		3			3			3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: BE 24362
Course Title: Bioseparation Engineering Lab
Pre-requisite(s): BE 24347
Co-requisite(s): BE 24358
Credits: 1 L: 0 T: 0 P: 2
Class schedule per week: 02
Class: B. Tech
Semester / Level: Six
Branch: Biotechnology
Name of Teacher:

This course enables the students to:

1.	Obtain sound knowledge of bio-separation processes
2.	Understand chromatography
3.	Familiar with different mass transfer operations

Course Outcomes

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

CO1	Analyze the fundamental properties of bio-separation
CO2	Perform different chromatographic separation of biomolecules.
CO3	Separate proteins by adsorption, precipitation, electrophoresis and extraction
CO4	Purify a protein from a mixture.

List of Experiments

Experiment No	Name of Experiments	CO
Experiment 1	To isolate pigment from plant leaves using different solvents	1,3,4
Experiment 2	To separate pigments using thin-layer chromatography (TLC)	1,2,4
Experiment 3	To precipitate proteins using ammonium sulphate salt	1,3,4
Experiment 4	To perform cell lysis by different methods.	1,3,4
Experiment 5	To purify protein using gel filtration chromatography	1,2,4
Experiment 6	To purify protein using ion exchange chromatography	1,2,4
Experiment 7	To perform protein adsorption using calcium carbonate	1,3,4
Experiment 8	To familiarize the operating principles of HPTLC (High-Performance Thin Layer Chromatography) System	1,2
Experiment 9	To familiarize the operating principles of HPLC (High-Performance Liquid Chromatography) System	1,2

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	1	2		1	1	2	3	2
CO2	3	3	3	3	3	2	1	2	1		1		3	3

CO3	3	3	2	2	3		2	2	1		1	3	2	2
CO4	3	3	3	2	3		2	2			1	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: BE24363
Course title: Plant Cell Technology Lab
Pre-requisite(s): None
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 3
Class schedule per week: 03
Class: B. Tech
Semester : VI
Branch: Biotechnology
Name of Teacher: Dr. Sheela Chandra

Course Objectives:

On successful completion of this course you should be able to:

1.	Explain major components of cell and tissue culture media, e.g. minerals, growth factors, hormones, and what governs the choice of components.
2.	Explain steps taken to establish and optimize media for different species without the aid of texts.
3.	Perform the common cell culture techniques, e.g. callus culture, Embryo culture and embryogenesis in plants.
4.	Competently perform laboratory procedures and demonstrate practical application and conceptual knowledge of cell and plant tissue culture for biotechnology investigations and applications.

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

CO1	Understanding Science: Articulate the methods of science and explain why current scientific knowledge is contestable and testable through further inquiry.
CO2	Scientific knowledge: Demonstrate a depth and breadth of knowledge and understanding of biological sciences.
CO3	Inquiry and problem solving: Analyse and solve problems in biotechnology by collecting, accurately recording, interpreting, and drawing conclusions from scientific data.
CO4	Personal and professional responsibility: work responsibly, safely, legally and ethically in an individual and team context.

Experiments Lists

Experiment No.	Name of Experiments
Experiment 1	Demonstration of various instruments/equipment used in the PCT lab.
Experiment 2	Preparation of Culture Media
Experiment 3	Sterilization of Culture Media
Experiment 4	Sterilization of explant and its inoculation in culture media
Experiment 5	Growth pattern analysis of inoculated explant
Experiment 6	Development and propagation of cell suspension culture
Experiment 7	Preparation of synthetic seeds by encapsulation of somatic embryos in Alginate Beads
Experiment 8	Agrobacterium mediated transformation for hairy root culture.
Experiment 9	Isolation of protoplasts, plating and regeneration

Books:

1. O.L. Gamborg and G. C. Phillips (Eds.): Plant Cell, Tissue and organ Culture: Fundamental methods. A Springer Lab Manual.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course outcomes			Programme Outcomes										
	PO1	PO 2	PO3	PO4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PS O1	PSO 2	PS O3
CO 1	3	2	3	1	1	1	1	1	1	1	1	2	2	2
CO2	3	3	3	2	2	2	2	1	1	1	2	2	2	1
CO3	1	3	3	2	2	2	1	1	1	2	3	3	1	2
CO4	3	3	3	2	2	2	2	1	1	1	1	1	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

FOURTH YEAR (SEMESTER-I)

COURSE INFORMATION SHEET

Course code: BE 24441
Course Title: Bioreactor Design & Analysis
Pre-requisite(s): Nil
Co-requisite(s): Nil
Credits: 3 L: 3 T: 1 P:0
Class schedule per week: 04
Class: B. Tech
Semester / Level: VII/4
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students to:

A.	Imparts advanced knowledge of bioreactor design for efficient utilization of the principles in bioprocess technology.
B.	Determine mixing time in agitated tanks.
C.	Understand instrumentation and control of bioprocesses.
D.	Perform the simulations in bioprocesses.

Course Outcomes

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

CO1	Explore the basic concepts of bioreactor design.
CO2	Calculate the size and Design of various bioreactors
CO3	Evaluate Non-ideal mixing and models for non-ideal reactors.
CO4	Perform methods and strategies for bioreactor Scale-up
CO5	Analyze instrumentation and control of bioprocesses

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module 1: Basic Principles Introduction to Fluid Rheology; Oxygen transfer in a bioreactor; Principles of kinetics for chemical and biochemical reactions; Chemostat analysis; Different components of a typical bioreactor	**8**

Module 2: Bioreactor design Fundamentals of ideal batch, mixed flow (MF) and plug flow reactor (PFR), Design equations; Fed-batch system analysis; Types of reactors – Continuous Stirred Tank Reactor (CSTR), Packed Bed Reactor (PBR), Fluidized Bed Reactor (FBR), Bubble column reactor, Airlift reactor, Trickling bed reactor, Hollow fibre reactor, Perfusion system, Photo-bioreactor	**8**
Module 3: Non-ideal Reactors Concept of non-ideal reactors; Residence time distribution (RTD); models of non-ideal reactors–axial dispersion, tank-in-series model	**8**
Module 4: Scale up and Scale down Scale-up concepts; Different approaches for scaling-up of a bioreactor; Scale down method	**8**
Module 5: Instrumentation and control of bioprocesses Methods of measuring process variables; Instruments associated with bioreactor; Physical and chemical sensors; Different controllers; Introduction to Biosensors.	**8**

Text Books:

1. Stanbury P. F., Whitaker A., Hall S.J., Principles of Fermentation Technology, Ed. 3, Butterworth-Heinemann, 2016
2. Levenspiel, O. Chemical Reaction Engineering Ed.3, John Wiley & Sons (Asia), 2004

Reference Books:

1. Bailey and Ollis, Biochemical Engineering Fundamentals, 1986
2. Shuler and Kargi, Bioprocess Engineering – Basic Concepts. Prentice Hall PTR, 2002
3. Doran, Bioprocess Engineering Principles, Academic Press, 1995

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

2. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	Simulation
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	3	2	2	2	1			1	2	2	2
CO 2	3	3	3	3	3			1	2	2	1	3	1	3
CO 3	3	3	2	3	3		2	2	2	2	1	3	2	2
CO 4	3	3	3	3	2	2	2	1		2	1	2	1	3

CO 5	3	3	3	3	3	2		1	2	2	1	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2
CO3	CD1, CD3, CD4, CD5
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: **BE 24442**
Course title: **INTEGRATIVE NANOBIOTECHNOLOGY**
Pre-requisite(s):
Co- requisite(s):
Credits: **3** L: 03 T:00 P:00
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **VII**
Branch: **Biotechnology**
Name of Teacher: Dr. Sneha Singh

Course Objectives
This course enables the students:

1.	To gain knowledge about the concepts, diverse applications of nanobiotechnology and its interdisciplinary aspect.
2.	To learn the principle and phenomena governing the nanoscale effect on material properties and their applicability
3.	To gain a working knowledge in nanotechnology techniques (synthesis & characterization) and acquire the ability to use them to solve problems in bioengineering and biomedicine.
4.	To correlate the impact of nanoscience and nanotechnology in a global, economic, environmental, and societal context.
5.	To identify career paths at the interface of nanotechnology, biotechnology, environmental, engineering, medicine and research.

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

1.	Understand the fundamentals of nanoscale phenomena, science at nanoscale, responsible for unique behaviour of nanomaterial and their classifications
2.	Acquire the in-depth knowledge and skill about specific types of nanomaterials, be able to fabricate nanomaterials using different nano-fabrication methods
3.	Acquire the knowledge and skills to characterize nanomaterials using different techniques.
4.	Familiarize themselves with nanobiotechnology potentialities and be able to apprehend and explain use of nanomaterials in different biomedical applications. Ability to recognize the potential concerns and measures to be taken for nanomaterials.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module-1: Introduction to Nanotechnology:	**8**

Definitions and concept, Historical background, Nanoscale phenomena & Properties, nanomaterials classification, Nano system in nature, biomimetics, bionanomaterials	
Module-2: Synthesis of Nanomaterials: Physical methods, Chemical methods, Biological methods, Advantages & Limitation	**8**
Module-3: Engineered Nanomaterials: Synthesis, properties and applications of Carbon nanotubes, Fullerenes, Metal nanoparticles, Quantum Dots, Dendrimers, Polymeric nanomaterials	**8**
Module-4: Characterization techniques: Spectroscopy (UV-Vis, Fluorescence, FT-IR) Electron microscopy, light scattering, Zeta potential, X-ray diffraction, AFM, EDAX	**8**
Module-5: Emerging applications & Concerns: Biosensors & Nanobiosensors, Nanomedicine, Bioimaging, Drug Delivery, Tissue Engineering, Environmental remediation, Nanotoxicology challenges.	**8**

Textbooks:

1. Niemeyer and Mirkin ed. Nanobiotechnology: concepts, applications & perspectives, Wiley–VCH, 2004.
2. Jain, KK. Nanobiotechnology in molecular diagnostics: current techniques and applications
3. Schaefer, H. E. (2010). *Nanoscience: the science of the small in physics, engineering, chemistry, biology and medicine*. Springer Science & Business Media.
4. Kulkarni, S. K., & Kulkarni, S. K. (2015). *Nanotechnology: principles and practices*. Springer.
5. Murty, B. S., Shankar, P., Raj, B., Rath, B. B., & Murday, J. (2013). *Textbook of nanoscience and nanotechnology*. Springer Science & Business Media.
6. T. Pradeep (2012). *A Textbook of Nanoscience and Nanotechnology.* Tata McGraw Hill Education Pvt. Ltd.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50

Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**												**PSO**		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
1	3	3				2	2		1	1	1	1	3	2	2
2	3	3	3	2	2	2	2	1	2	1	2	1	3	3	3
3	3	3	3	2	3	2		1	1		2	1	3	3	3
4	3	2	3	2	2	3	2	2	2	1	2	1	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3, CD4

<u>**COURSE INFORMATION SHEET**</u>

Course Code: MT 24204

Course Title: CONSTITUTION OF INDIA

Pre-requisite(s):
Co- requisite(s):
Credits: L: **02** T: 0 P: 0
Class schedule per week: 2
Class: Bachelor of Technology
Semester / Level: 6th/4th
Branch:
Name of Teacher: Dr Anand Kumar

COURSE OBJECTIVES

This course aims to impart to students:

1.	To describe the importance and role of Constitution of India
2.	To explain the provisions related to Social Problems and Issues in Constitution
3.	To explain the significance of the Constitution for maintaining social unity and integrity
4.	To describe the process for formulating and designing public policies in accordance with constitutional provisions

COURSE OUTCOMES (COs)

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

CO1	Outline the need and importance of the Indian Constitution
CO2	Explain the fundamental rights and duties of citizens of India
CO3	Relate appropriate Constitutional Provisions with relevant social issues
CO4	Describe the role of different departments of government
CO5	Describe the Government policies and programs designed for the society at large

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to the Constitution of India, Salient Features of the Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy	9
Module – II Union and State Executives: President and Prime Minister, Council of Ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha. Governor: Role and Position, Chief Ministers and Council of Ministers**.**	9
Module – III The Indian Judicial System - The Supreme Court and The High Court's - composition, Jurisdiction and functions, The Role of the Judiciary.	9
Module – IV Local Government- District's Administration: Role and Importance, The Panchayatas - Gram Sabha, Constitution and Composition of Panchayatas,Constitution and Composition of Municipalities	9
Module – V Miscellaneous- Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.	4

TEXTBOOKS:

1. The Constitution of India by "Ministry of Law India" Kindle Edition

2. Constitutional History of India by Prof.M.V.PYLEE-S.Chand Publishing

3. Indian Administration by Avasti and Avasti-Lakshmi Narain Agarwal Educational Publishers.2017 edition.

4. Introduction to the Constitution of India by D DBasu by Lexis Nexis: 20th edition.

5. Constitution of India V.N.Shukla's EBC Explorer Edition 13th,2017

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
End Semester Examination	50
Quiz (s)	20
Assignment	5
Mid-Semester Exam	25

Continuous Internal Assessment	% Distribution
Quiz (s)	20
Assignment	5
Mid-Semester Exam	25

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	2	2	2	2	
Semester End Examination	2	2	2	2	2

INDIRECT ASSESSMENT

4. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture using boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/Teaching aids
CD6	Industrial/Guest lectures
CD7	Industrial visits/In-plant training
CD8	Self, learning such as the use of NPTEL materials and the internet simulation

CD9	Tutorials/Assignments

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**2**	**0**	**0**	**1**
CO2	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**0**	**0**	**0**
CO3	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**
CO4	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**
CO5	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**1**

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

CO1	Outline the need and importance of the Indian Constitution
CO2	Explain the fundamental rights and duties of citizens of India
CO3	Relate appropriate Constitutional Provisions with relevant social issues
CO4	Describe the role of different departments of government
CO5	Describe the Government policies and programs designed for the society at large

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1: Lecture using boards/LCD projectors/OHP projectors
CO2	CD1: Lecture using boards/LCD projectors/OHP projectors
CO3	CD1: Lecture using boards/LCD projectors/OHP projectors
CO4	CD2: Tutorials/Assignments
CO5	CD3: Seminars

COURSE INFORMATION SHEET

Course code: BE 24443
Course Title: Bioreactor Design Lab
Pre-requisite(s): BE 24 347
Co-requisite(s): BE 24 441
Credits: 1 **L: 0 T: 0 P: 2**
Class schedule per week: 02
Class: B. Tech
Semester / Level: Seven
Branch: Biotechnology
Name of Teacher:

This course enables the students to:

1.	Obtain sound knowledge of bioreactor operations.
2.	Understand the essential components of a bioreactor.
3.	Familiar with different control systems associated with bioreactor

Course Outcomes

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

CO1	Analyze the important components of a bioreactor
CO2	Determine various parameters in a bioreactor.
CO3	Calculate the reaction rate during a bioprocess in a reactor.
CO4	Scale up a bioreactor.

List of Experiments

Experiment No	Name of Experiments	CO
Experiment 1	To understand the operation of different components of an industrial bioreactor	1,2
Experiment 2	To learn the standard operating procedure (SOP) to run a bioreactor	1,2
Experiment 3	To study the growth kinetics of bacteria in a batch reactor	1,2,3
Experiment 4	To determine various parameters in a fed-batch system	1,2,4
Experiment 5	To determine various parameters in a MFR	1,2,4
Experiment 6	To determine the volumetric oxygen transfer rate in a bioreactor.	1,3
Experiment 7	To calibrate different instruments used in bioreactor control	1,3
Experiment 8	To understand the scale-up using different-size bioreactors	1,4

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO 1	3	2	3	3	3	3	1	2		1	1	2	2	2
CO 2	3	2	2	3	3	2	1	2	1		1	2	3	3

CO 3	3	3	2	2	3		2	2	1		1	3	2	2
CO 4	3	3	3	2	3		2	2		1	1	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: BE 24444
Course title: INTEGRATIVE NANOBIOTECHNOLOGY LAB
Pre-requisite(s): Nanomaterials characterization facility
Co- requisite(s): BE 24442
Credits: **01** L: T: P:
Class schedule per week: 02
Class: B.Tech
Semester / Level: VII
Branch: Biotechnology
Name of Teacher: Dr. Sneha Singh

Course Objectives

This course enables the students:	
1.	To understand the concept & phenomena of nanotechnology in biological and biomedical research
2.	To guide the students to comprehend how nanomaterials can be used for a diversity of analytical and medicinal rationales.

Course Outcomes

CO 1	Acquire the knowledge and skill in various visualization and characterization techniques for nanomaterials
CO 2	Acquire the knowledge and skill in fabrication of nanomaterials through various methods
CO 3	Recognize and relate to the structural and functional principles of biomolecular interactions to nanomaterials, factors involved and their significance in designing nanomaterials.
CO 4	Analyse the stability and dispersity profile of nanomaterials. Familiarize themselves with nanobiotechnology potentialities and concerns associated with nanomaterials usage and handling.

List of Experiments	
1.	To study various instruments used for nanoscale visualization and characterization
2.	Synthesis and characterization of nanomaterial by physical method
3.	Synthesis and characterization of nanomaterial by wet chemical method
4.	Synthesis and characterization of nanomaterial by biological method
5.	Synthesis and characterization of polymeric carrier for nanoparticle delivery
6.	Synthesis and characterization of nanoconjugates using drugs/biomolecules

7.	Study of dispersity and stability profile of nanoparticles

Books Recommended:

1. Murty, B. S., Shankar, P., Raj, B., Rath, B. B., & Murday, J. (2013). Textbook of nanoscience and nanotechnology. Springer Science & Business Media.
2. Pradeep (2012). A Textbook of Nanoscience and Nanotechnology. Tata McGraw Hill Education Pvt. Ltd.
3. Bréchignac, C., Houdy, P., & Lahmani, M. (Eds.). (2008). *Nanomaterials and nanochemistry*. Springer Science & Business Media.

Reference Materials:

Class lectures, Laboratory manual, e-resources

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	Program Outcomes												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 1	PSO 1	PSO 2	PSO 3
1	3	3			3	2	2	1	1		1	1	3	3	3
2	3	3	3	3	3	2	2	1	1		1	1	3	3	3
3	3	2	3	3	3	2	2	1	1		1	1	3	3	3
4			3		3	2	2	1	1		1	1	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

FOURTH YEAR (SEMESTER-II)

BE24450/BE24490 Project -IV/Industry Internship

BE24498: Comprehensive Viva

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

PROGRAM ELECTIVE COURSES

COURSE INFORMATION SHEET

Course code:	**BE 24256**				
Course Title:	**Cheminformatics**				
Pre-requisite(s):	**BE24244**				
Co-requisite(s):	**Nil**				
Credits:	**3**	**L: 3**	**T: 0**	**P:0**	
Class schedule per week:	**3**				
Class:	**B. Tech.**				
Semester / Level:	**IV/2**				
Branch:	**Biotechnology**				
Name of Teacher:					

Course Objectives

This course enables the students:

1.	An ability to work on basic science as well as biotech/pharmaceutical industry in multidisciplinary teams and independently.
2..	Learn various aspects to design and validate new drug-like molecules, measurements and interpreting experimental data from biological system and addressing the challenges associated with the interaction between small molecules and body system.
3.	Grab the theoretical knowledge, parameters for searching and designing pharmacophore model for a particular disease related protein in biological research/ biotechnology/ pharmaceutical in industry and research lab.
4.	Enable students to understand the processes associated with quantative structure activity Relationship (QSAR), COMFA, virtual screening, ADMET and combinatorial chemistry
5.	A master degree in this field prepares a student for careers in biotech/ pharmaceutical research in different domains including industry.

Course Outcomes

After the completion of this course, students will be:

CO1	An ability to apply knowledge and to design, analyze and conduct experiments, related to domain of drug designing.
CO2	An ability to validate new drug-like molecules. Know how to meet the desired needs within realistic constraints.

CO3	An ability to apply the knowledge to find various parameters for searching and designing pharmacophore model for a particular disease related protein in biological research/ biotechnology/ pharmaceutical in industry and research lab.
CO4	An ability to understand the processes associated with quantative structure activity Relationship (QSAR), COMFA, virtual screening, ADMET and combinatorial chemistry.
CO5	An ability to identify, formulate, and solve engineering problems.

Syllabus

MODULE	**(NO. OF LECTURE HOURS)**
Module-I: Introduction to Chemoinformatics Common public domain databases used in chemoinformatics research, Computer representation and searching of chemical structures: 2D and 3D molecular structures, Graph theoretical representations of molecules and substructure searching, Conformation generation for small Molecules, Distance keys.	**8**
Module-II: Pharmacophore Concept of 3D pharmacophore and methods for deriving 3D pharmacophores, Pharmacological properties and global properties of small molecules, Lipinski's rule	**8**
Module-III: Molecular descriptors Different 2D and 3D descriptors, Concept of chemical similarity and distance metrices- using 2D and 3D descriptors, Quantative structure activity Relationship (QSAR): 2D and 3D QSAR, QSPR, COMFA	**8**
Module-IV: Data Mining Data mining techniques for high throughput screening data, Chemical compound libraries and virtual screening, Protein ligand docking and scoring	**8**
Module-V: Computer aided drug design Computational prediction of ADMET properties, Design of virtual combinatorial libraries	**8**

Text Books:

1. Andrew R. Leach, Valerie J. Gillet, An Introduction to Chemoinformatics. Publisher:Springer; 1st edition (May 1, 2003) Language: English ISBN-10: 1402013477 ISBN-13: 978- 1402013478

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PS O3
CO1	3	3		3	3	2	2		2	2	1	2	2	2
CO 2		3	3		3		2	2	2	2	1	3	1	3
CO 3	3	3		3	3	2	2	2	2	2	1	3	2	2
CO 4	3	3		3	3	2	2	2		2	1	2	1	3
CO 5	3	3		3	3	2	2	2		2	2	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD4
CO4	CD1, CD3, CD4
CO5	CD1, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE 24257
Course Title: Enzyme Technology
Pre-requisite(s): BE204 Biochemistry and Enzyme Technology
Co-requisite(s): Nil
Credits: 3 L: 3 T: 0 P:0
Class schedule per week: 3
Class: B. Tech.
Semester / Level: IV/2
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Learn the fundamental principles of enzyme technology.
2.	Apply the knowledge of enzyme kinetics and its application in industrial bioprocess development.
3.	Understand the use of enzymes as a tool in pharmaceutics and agriculture.

Course Outcomes

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

CO1	Analyze different mechanisms of enzyme action.
CO2	Evaluate various parameters in an enzyme-substrate reaction in the presence or absence of any chemical interference
CO3	Purify and characterize enzymes produced by isolated microorganisms.
CO4	Immobilize enzymes for improved stability and reusability
CO5	Explore enzymes for industrial and therapeutic applications.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module 1: Introduction to Enzymes Chemical nature of enzymes, Energy of activation, properties of enzyme, enzyme classification, Enzyme activity, factors effecting enzyme activity, enzyme-substrate	**8**

reactions: Lock and Key hypothesis, Induced fit hypothesis, mechanism of enzyme action, Allosteric enzymes, Isoenzymes, Multienzyme complex, and Multifunctional enzymes	
Module 2: Enzyme Kinetics Single substrate and bi-substrate enzyme kinetics, Enzyme inhibition-competitive, uncompetitive and non-competitive inhibition, irreversible inhibitions	**8**
Module 3: Purification and Characterization of Enzymes General procedures for isolation and selection of microorganisms involved in enzyme production: primary and secondary screening, high-throughput screening; Strategies of extraction and purification of enzymes, Molecular weight determination and characterization of enzymes	**8**
Module 4: Enzyme Immobilization Methods of enzyme immobilization, Kinetics of immobilized enzymes, Enzyme stabilization by different engineering approaches	**8**
Module 5: Applications of Enzymes Importance of enzymes in disease diagnostics and analytical purposes, Therapeutic application of enzymes, Role of various enzymes in industrial products	**8**

Textbooks:

2. Nelson D.L. and Cox M.M., Lehninger Principles of Biochemistry, McMillan North Publication, 3rd Edition, 2002.
3. Devasena T., Enzymology, Oxford University Press, 1st Edition, 2010

Reference books:

1. Godfrey T., Reichelt J. and West S., Industrial enzymology, Nature Publishing Group; 2nd Edition, 1996

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	2	1			1	1	2	2	2
CO2	3	3	2	3	3	2	1	2	1	1	1	2	3	3
CO3	3	3	3	3	3	2	2	2	1	1	1	3	2	2
CO4	3	3	3	3	2	2	2	2		3	1	2	3	3
CO5	3	3	3	3	2	2		2	1	1	1	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: BE24258
Course title: Natural Product Biotechnology
Pre-requisite(s): BE24243 Biochemistry
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To identify the major sources of natural substances and their significance
2.	To establish an understanding of the major classes of phytochemicals, biosynthesis pathways and screening of natural products
3.	To expose students to the different methods of isolation, separation, purification and characterization of natural products
4.	To develop the understanding of different methods of production of biotech natural products at laboratory as well as industrial level

Course Outcomes

After the completion of this course, students will be:

1.	Able to know about the various sources of natural products and their importance
2.	Able to know about the major classes of phytochemicals, their biosynthesis and screening techniques
3.	Able to distinguish the different methods of isolation and analytical techniques for separation, purification and characterization of natural products
4.	Able to design the steps of production of natural products at laboratory and industrial scale

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: Natural Substances: Sources and Importance; Interrelationships of major biosynthetic pathways of secondary metabolites, Classification of Phytochemicals	**8**
Module-2: Biosynthesis and Screening of Natural Products: Glycosides -shikimic acid and phenylalanine pathways, Terpenoids-Monoterpenoids, Alkaloids-Ephedrine, Phenylpropanoids via the Shikimic Acid Pathway	**8**
Module-3: Analysis of Natural Products: Extraction by aqueous and non-aqueous methods, purification by TLC, HPTLC, HPLC, characterization by Mass and NMR spectrometry; Plant metabolomics	**8**
Module-4: Production techniques of Natural Products-I: Extraction (Essential oils, Pigments); Plant cell culture (Ginseng, Shikonin, Taxol)	**8**
Module-5: Production techniques of Natural Products-II: Fermentation (Biopharmaceuticals, Nutraceuticals, Flavouring agents); Heterologous natural product biosynthesis	**8**

Text Books:
1. Kar, A., Pharmacognosy and pharmacobiotechnology. 2nd Edition, New Age International (P) Ltd., 2007.
2. Stankovic, M.S., Medicinal Plants and Natural Product Research, MDPI, 2020.

Reference Books:
1. Gahlawat, S.K., Salar, R.K., Siwach, P., Duhan, J.S., Kumar, S., Kaur, P. Plant Biotechnology: Recent Advancements and Developments. 1st Edition, Springer, Singapore, 2017.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50

Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PS O3**
1	3					2						2	2	2
2	3	2				2						2	2	2
3	3	3	2			2		2	2		2	2	2	3
4	3	3	3	2	2	2	2	3	2	2	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24259
Course title: Biofuels and Biorefineries
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV
Branch:
Name of Teacher:

Course Objectives

This course enables the students:

1.	To establish an understanding of the major types of biofuels and energy, biosynthetic pathways, processing and applications.
2.	To give knowledge of Biofuel properties, specifications and guidelines.
3.	To describe production strategies for various Biofuels and to introduce them with technology development for Biofuel production.
4.	To outline principles of biomass conversion of fuels
5.	To describe Environmental assessments due to uses of biofuels-Biofuels economics
6.	To introduce students with biofuels economics

Course Outcomes

After the completion of this course, students will be:

1.	Able to know about different types of biofuels, biosynthetic pathways, processing and applications.
2.	Acquiring knowledge of biofuel properties, specifications and guidelines
3.	They will be able to evaluate the industrially important biofuel and design the technology for the same.
4.	They will be able to analyze the biofuel issues and correlate them with economic aspects.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module 1 Introduction: World energy scenario, consumption pattern, fossil fuel depletion and environmental issues. **Biomass**: Availability and abundance, photosynthesis, composition and energy potential, virgin biomass production and selection, waste biomass (municipal, industrial, agricultural and forestry) availability, abundance and potential, biomass as energy resources: dedicated energy crops, annual crops (maize, sorghum sugar beet, hemp), perennial herbaceous crops (sugarcane, switchgrass, miscanthus), short rotation woody crops (poplar, willow), oil crops and their biorefinery potential, microalgae as feedstock for biofuels and biochemical, enhancing biomass properties for biofuels, challenges in conversion **Biorefinery**: Basic concept, types of biorefineries, biorefinery feedstocks and properties, economics	**8**
Module 2 Biomass Pretreatment: Barriers in lignocellulosic biomass conversion, pretreatment technologies such as acid, alkali, autohydrolysis, hybrid methods, role of pretreatment in the biorefinery concept **Physical and Thermal Conversion Processes**: Types, fundamentals, equipments and applications; thermal conversion products, commercial success stories **Microbial Conversion Process**: Types, fundamentals, equipments and applications, products, commercial success stories	**8**
Module 3 Biodiesel: Diesel from vegetable oils, microalgae and syngas; transesterification; FT process, catalysts; biodiesel purification, fuel properties **Biooil and Biochar:** Factors affecting biooil, biochar production, fuel properties, biooil upgradation **Bioethanol and Biobutanol**: Corn ethanol, lignocellulosic ethanol, microorganisms for fermentation, current industrial ethanol production technology, cellulases and their role in hydrolysis, concepts of SSF and CBP, advanced fermentation technologies, ABE fermentation pathway and kinetics, product recovery technologies	**8**
Module 4: Hydrogen, Methane and Methanol: Biohydrogen generation, metabolic basics, feedstocks, dark fermentation by strict anaerobes, facultative anaerobes, thermophilic microorganisms, integration of biohydrogen with fuel cell; fundamentals of biogas technology, fermenter designs, biogas purification, methanol production and utilization **Organic Commodity Chemicals from Biomass**: Biomass as feedstock for synthetic organic chemicals, lactic acid, polylactic acid, succinic acid, propionic acid, acetic acid, butyric acid, 1,3-propanediol, 2,3-butanedioil, PHA	**8**
Module 5:Integrated Biorefinery: Concept, corn/soybean/sugarcane biorefinery, lignocellulosic biorefinery, aquaculture and algal biorefinery, waste biorefinery, hybrid chemical and biological conversion processes, techno- economic evaluation, life-cycle assessment	**8**

Text Books :

1. Donald L. Klass, Biomass for Renewable Energy, Fuels, and Chemicals, Academic Press, Elsevier, 2006.
2. Prabir Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier, 2013.
3. A.A. Vertes, N. Qureshi, H.P. Blaschek, H. Yukawa (Eds.), Biomass to Biofuels : Strategies for Global Industries, Wiley, 2010.
4. S. Yang, H.A. El-Enshasy, N. Thongchul (Eds.), Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals and Polymers, Wiley, 2013.
5. Shang-Tian Yang (Ed.), Bioprocessing for Value Added Products from Renewable Resources, Elsevier, 2007.

Reference Book:

1. David Pimentel, "Biofuels, Solar and Wind as Renewable Energy Systems", Published by Springer-Verlag., ISBN No. 978-9048179459, 2010.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y

Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PS O2**	**PSO 3**
1	3					2	3	3	2			2	2	2
2	3		3		2	2				3	1	2	2	2
3	3		3			2		2	3	1	1	2	2	3
4	3		3			2	3				3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE 24348
Course title: Stem Cell and Tissue Engineering
Pre-requisite(s):
Co- requisite(s): Nil
Credits: **3** L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives
This course enables the students:

1.	To gain an understanding of the basic concepts, advantage and major potentials of stem cells and tissue engineering
2.	To encourage the learning towards fabricating tissue engineering products to cater to various health related problems efficiently than conventional strategies
3.	To get familiarize with conditions for Setting up stem cell culture and tissue engineering laboratory

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

1.	Understand the fundamentals of stem cell technology, basic requirement and techniques used in stem cells culturing
2.	Apply the developed concept to design and create different types of functional biomaterials at laboratory scale.
3.	Familiarize themselves with stem cell and tissue engineering potentialities and be able to apply the knowledge gained in different biomedical applications.
4.	Develop an understanding of the intricacies involved in setting up stem cell & tissue engineering laboratory and be able to design the laboratory required for tissue regeneration.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module 1: Basics of Stem Cell Biology: Universal mechanisms of animal development, hematopoietic differentiation pathway, potency and plasticity of stem cells, types & sources of stem cell with characteristics (embryonic, adult, haematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells, induced pluripotent stem cells), tissue types, tissue components, extracellular matrix, cell-matrix and cell-cell interaction.	**8**

Module 2: Stem Cell Culture Requirements: Isolation, selection and characterizations of stem cells, markers & their identification, methods for stem cell culture, growth factor requirements and their maintenance in culture, feeder and feeder free cultures, cell cycle regulators in stem cells, preservation of stem cells.	**8**
Module 3: Stem Cell application in Regenerative medicine: Biomaterials & Tissue Engineering: Biomaterial Stem cell interactions, properties, characterization, Biomaterials/Biopolymers used in Tissue Engineering. Ideal properties and types: biomimetics, properties like mechanical property, wettability, biodegradability and surface property. Types: Polymeric (natural and synthetic), nano-materials, ceramics, composites, hydrogels and metallics, mechanical forces on cells; cell adhesion; cell migration.	**8**
Module 4: Clinical applications of stem cells: Stem cell strategies for organogenesis and regeneration. Role of stem cells in treating neurodegenerative diseases, spinal cord injury, heart disease, diabetes, Burns and skin ulcers, muscular dystrophy, orthopedic injuries, eye diseases.	**8**
Module 5 **Stem Cell Culture Facility:** Setting up stem cell culture and tissue engineering laboratory, hazards in stem cell storage & transplantation. Stem cell banking, Ethical concerns with stem cells and regulatory requirements.	**8**

Text Books:

1. Freshney, R. I. (2015). *Culture of animal cells: a manual of basic technique and specialized applications*. John Wiley & Sons..
2. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two-Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult &Fetal Stem Cells, 2012, Academic Press.
3. Satish Totey, Kaushik D. Deb, Stem Cell Technologies: Basics and Applications
4. Van Blitterswijk, C., De Boer, J., Thomsen, P., Hubbell, J., Cancedda, R., De Bruijn, J. D., ... & Williams, D. F. (2008). *Tissue engineering*. Elsevier.
5. Lecture notes & Research articles discussed.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50

Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**											**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	PSO1	PSO2	PSO3
1	3	3					1		1		1	3	2	2
2	2	3	3	3	3	2	1		1		1	3	3	3
3	2		2	2		3	1	1	1	1	1	3	3	3
4			3	3	3	2	1	1	1	1	1	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1
CO3	CD1, CD2, CD4
CO4	CD1, CD3

COURSE INFORMATION SHEET

Course code: BE24349
Course title: Pharmaceutical Biotechnology
Pre-requisite(s): Co- requisite(s): Nil
Credits: 3 L: 03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives This course enables the students:

1.	Understand the basic concepts involved in biopharmaceutical drug production, genomics and gene therapy
2.	Knowledge about therapeutic effects and side effect of biopharmaceuticals. Knowledge about new drug development procedures, drug approval, ADMET of drugs
3.	Appreciate and understand the manufacturing and quality control of drugs and legal steps involved in progressing a new drug to market
4.	Demonstrate knowledge and understanding of currently relevant and newly emerging aspects of pharmaceutical biotechnology

Course Outcomes

After the completion of this course, students will be:

1.	Students will have a basic understanding of the scientific method. explain the strategies and various steps of new drug discovery process
2.	Able to explain the concept of genomics, gene therapy, pharmacogenomics and pharmacodynamic
3.	Apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals
4.	Carry out the quality control procedures in the production of various biopharmaceuticals. Explain the economics and regulatory aspects in the development of pharmaceuticals.

Syllabus

MODULE	**(NO. OF LECTURE HOURS)**
Module-1: Molecular Biotechnology:	**8**

Genomics and its impact on medicine. Molecular medicine, Rational drug design.	
Module-2: Gene Testing & Diagnostics: Gene testing, pharmacogenomics, Molecular diagnostics.	**8**
Module-3: Cancer Biology & Gene therapy: Oncogenes, tumor suppressor genes, growth factors, Genetic diseases and DNA based diagnosis of genetic diseases. Gene therapy.	**8**
Module-4: Formulation of Biotech Products: Microbiological consideration, use of excipients, Drug delivery methods, Shelf life of biopharmaceuticals, pharmacodynamics of protein therapeutics.	**8**
Module-5: Genetically Engineered Pharmaceuticals: Insulins, Growth Hormones, Vaccines, Interferons & interleukins, Tissue type plasminogen activator, Economic aspects in pharmaceutical biotechnology.	**8**

Text Books:

1 Molecular Biotechnology - Therapeutic Applications and Strategies by SUNIL Maulik and Salil D. Patel , Wiley-Liss

2 Pharmaceutical Biotechnology: A Programmed Text 1st Edition by Steven Strauss, Santo William Zito, S. William Zito, CRC Press

3 Pharmaceutical Biotechnology. Fundamentals and Applications, Third Edition. Edited By Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm, Springer

4 Pharmaceutical Biotechnology. Vyas S.P , V.K. Dixit; CBS Publishers & Distributors

Reference Books:

1. Kar, A., Pharmacognosy and pharmacobiotechnology. 2nd Edition, New Age International (P) Ltd., 2007.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50

Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome	**Program Outcomes**													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
1	3	3	3									2	2	2
2	3	3		3	3	3						2	2	2
3			3	3	3	3	2					2	2	3
4							2				3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4

CO2	CD1, CD2,
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24364
Course title: Fermentation Engineering
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 03 L: 3 T: 0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/3
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1.	The course introduces the basic principles of Fermentation Technology which involves various strategies for strain selection and improvement, media formulation, sterilization, inoculums development, various fermenter configurations and mode of operations.
2.	Agitation and mixing characteristics in fermentation
3.	Knowledge about heat transfer in fermenter
4.	Fermentation process and equipment design concepts

Course Outcomes

After the completion of this course, students will be:

CO1	To apply chemical engineering principles to fermentation processes
CO2	To analyze different types of fermenters and their operations.
CO3	To configure fermenter and its mode of operations by varying parameters
CO4	To study Heat transfer in Fermenter
CO5	To understand different equipments and applications of fermentation technology

Syllabus

MODULE	(NO. OF LECTURE HOURS)

Module-I: Introduction Introduction to Industrial Fermentation process; Historical overview of industrial fermentation products; Biochemistry of Fermentation – Bacterial, Fungal and Yeast Fermentation; Comparison between traditional and modern methods of fermentation; Industrially useful microorganisms and its products.	**8**
Module-II: Integration of Bio Reactors on Industrial Fermentation Processes Classification of fermenters; fermenter operation (batch, fed-batch, continuous); Conventional and non-conventional fermenters; equipment characteristics	**8**
Module-III: Fluid Flow, Mass Transfer, Agitation and Mixing in Fermenters Agitation and mixing characteristics in fermentation, Power requirement, Influence of power input on oxygen transfer. Rheology: Viscosity and shear stress. Newtonian and non- Newtonian fluids. Rheology of fermentation broths. Flow patterns in stirred tanks. Quantification of mixing phenomena in stirred vessels; Oxygen transfer in fermentation; Relationship between OTR, volumetric mass transfer coefficient and hydrodynamic parameters in bioreactors at several levels with consideration to Rheology.	**8**
Module-IV: Heat Transfer in Fermenters Heat transfer characteristics in fermentation; Types of heat exchangers; heat exchangers in large scale fermentation production; internal cooling; jacket cooling; film cooling; refrigerants used for fermentation cooling; heat exchangers design concepts.	**8**
Module-V: Fermentation Process and Equipment Design Concepts Pharmaceutical fermentation equipment; Case studies – Fermentation for pharmaceutical products; Simulation of pharmaceutical manufacturing processes using software.	**8**

Text Book:

1. Bioprocess Engineering Principles 2nd Edition, by Paulin Doran, eBook ISBN: 9780080917702; Paperback ISBN: 9780122208515; Academic Press 2012

References:

1. Fundamental Bioengineering Volume 1 Ed : John Villadsen; Advanced Biotechnology Series; Series Editors: S. Y. Lee, J. Nielsen, G. Stephanopoulos; Print ISBN: 978-3-527-33674-6 ; ePDF ISBN: 978-3-527-69746-5; Wiley - VCH 2016
2. Fermentation and Biochemical Engineering Handbook (Third Edition) *Edited by:Celeste C. Todaro and Henry C. Vogel* ISBN: 978-1-4557-2553-3; Elsevier 2014.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	Simulation
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	2	2	1			1	2	2	2
CO2	3	3	3	3	3			1	2	2	1	3	1	3
CO3	3	3	2	3	3		2	2	2	2	1	3	2	2
CO4	3	3	3	3	2	2	2	1		2	1	2	1	3
CO5	3	3	3	3	3	2		1	2	2	1	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1, CD2
CO3	CD1, CD3, CD5
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: BE24349
Course title: Biomaterials
Pre-requisite(s): Co- requisite(s): Nil
Credits: 3 L: 03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1	To learn about the fundamental concepts in biomaterial science, and their specific properties.
2	Understand material selection, classes of biomaterials used in medicine, and structure-function relationship.
3	Explain the basic principles of biocompatibility and implant performance. List different strategies to modify and/or design materials that are biocompatible.
4	Explain what biodegradability is and how it affects biomaterial design.
5	To get familiarized with biomaterials used in different medical applications and their testing techniques.

Course Outcomes

After the completion of this course, students will be:

1	Able to understand the fundamental concepts and properties of biomaterial.
2	Able to understand major classes of biomaterials: metals, ceramics, and polymers with specific medical requirements.
3	Able to understand the mechanism of biological response to implanted biomaterials and the ability to improvise strategies for designing biocompatible biomaterials.
4	Able to understand the mechanism of biodegradation of biomaterials to improvise strategies for designing biodegradable biomaterials.
5	Able to learn techniques to examine surface chemistry of biomaterials.

Syllabus

	(NO. OF

MODULE	LECTURE HOURS)
Module-1: Fundamentals of Biomaterials Science: Functional requirements of biomaterials and tissue replacement, Salient properties of important material classes, Property requirement of biomaterials, Disinfection and sterilization of biomaterials.	**8**
Module-2: Biomaterials: Basic properties of metals, polymers, ceramics, and biodegradable materials.	**8**
Module-3: Biological Response to Biomaterials: Biocompatibility, tissue-blood-materials interaction, foreign body response to implanted biomaterials, Immune response to foreign materials.	**8**
Module-4: Surface Characterisation Techniques: X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), scanning tunneling microscopy (STM), atomic force microscopy (AFM), Transmission electron microscopy (TEM).	**8**
Module-5: Biomaterial Applications: Biomaterials used in different medical applications.	**8**

Textbooks:

1. Biomaterials Science, An Introduction to Materials in medicine, eds. Ratner, B.D. et al. 2nd Ed. 2004.
2. Biomaterials: The Intersection of Biology and Materials Science by J.S. Temenoff and A.G. Mikos, Pearson Prentice Hall, 2008.

Reference Book:

1. Bronzino, J. D. The Biomedical Engineering Handbook. Germany: CRC Press, 2000.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome	Program Outcomes												
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	2	1	2	2	2	1	2	3	1	2
CO2	3	3	3	2	1	2	2	2	2	1	2	3	1	2
CO3	2	2	3	3	3	1	1	2	2	1	2	3	1	2
CO4	3	2	3	3	3	1	2	2	2	1	1	3	1	2
CO5	3	3	2	2	3	2	1	2	2	1	1	3	1	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD3, CD4

COURSE INFORMATION SHEET

Course Code	**BE24366**
Course Title	**Food Science and Technology**
Pre-requisite(s)	**Basic Biology and Chemistry**
Credits	**3 (L:3 T:0 P:0)**
Class Schedule	**3 per week**
Class	**B. Tech. Biotechnology**
Semester/Level	**Fifth**
Branch	**Biotechnology**
Name of Teacher	

COURSE OBJECTIVES

This course aims to:

1.	Develop an understanding of food composition and the concept of a balanced diet.
2.	Describe microbial interactions and their significance in food systems.
3.	Outline food preservation methods and principles to prevent/control food spoilage.
4.	Establish knowledge related to food quality, analysis, and food safety laws.
5.	Enable critical thinking and effective communication of scientific food principles to diverse audiences.

COURSE OUTCOMES (COs)

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

CO No.	Course Outcome
CO1	Understand food composition, nutrient requirements, and apply principles of balanced diet and diet planning.
CO2	Analyze microbial interactions in food systems, including fermentation, spoilage, and foodborne illnesses.
CO3	Evaluate food processing and preservation techniques, food safety laws, and quality control standards.
CO4	Apply scientific knowledge and communication skills to develop and market innovative food products for diverse audiences.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module-I: Food Groups and Their Classification	**8**

Concept of balanced diet and malnutrition; RDAs for different physiological stages and age groups; diet planning. Macronutrients, micronutrients, enzymes, and pigments: their role and processing behavior. Introduction to food rheology and its application in food systems.	
Module-II: Food Microbiology Microbial growth and its control in food; fermented foods; food spoilage and food-borne illness. Factors affecting microbial spoilage and classification of foods based on spoilage patterns.	**8**
Module-III: Food Processing and Preservation Traditional cooking and preservation methods—cooking, smoking, baking, frying (types, advantages, disadvantages). Shelf-life enhancement techniques. Protein engineering: objectives, methods, applications, and limitations in food systems.	**8**
Module-IV: Food Safety Laws and Standards Pre- and post-harvest factors affecting food quality. Physical, chemical, and microbial quality parameters; proximate analysis. Sample preparation for food analysis. Overview of Indian food laws—voluntary and mandatory regulations, certification bodies.	**8**
Module-V: Impetus in Food Industry New Product Development (NPD) and strategies. Food process design and marketing. Materials used in cooking and storage—from metals to plastics—advantages and disadvantages. Commercial food types and need for innovation.	**8**

TEXTBOOKS

1. Srilakshmi, B. *Food Science*
2. Potter, N.N. & Hotchkiss, J.H., *Food Science*
3. Frazier, W.C., *Food Microbiology*
4. Manay, S. N., & Shadaksharaswamy, M., *Food Facts and Principles*

REFERENCE BOOKS

1. Fellows, P.J., *Food Processing Technology*
2. Jay, J.M., *Modern Food Microbiology*
3. Lawrie, R.A., *Meat Science*
4. ICMR and FSSAI Guidelines (Latest Editions)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

<u>DIRECT ASSESSMENT</u>

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Simulation
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO 1	3	2	1		1	2	2	1	1	1	1	3	2	1
CO 2	3	3	2	2		1						3	3	1
CO 3	3	3	3	2	2		2			1		3	3	1
CO 4	2	2	2	3	2	3	2				2	2	3	

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code:	**BE 24367**
Course title:	**Cellular and Applied Electrophysiology**
Pre-requisite(s):	**Nil**
Co- requisite(s):	**Nil**
Credits:	**3 L: 3 T: 0 P: 0**
Class schedule per week:	**3**
Class:	**B. Tech**
Semester / Level:	**VI/3**
Branch:	**Biotechnology**
Name of Teacher:	**Dr. Rakesh Kumar Sinha**

Course Objectives

This course enables the students:

1.	To impart knowledge for interdisciplinary, applied engineering and technology.
2.	To understand basic cellular electrical characteristics and its electrical/electronic circuit analogy.
3.	To record and analyze the electrophysiological characteristics of living system.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the generation of cell potentials.
CO2	Learn and apply the cellular electrical activities with basic electrical/electronic components.
CO3	Analyze the electrical model of generation and transmission of action potentials.
CO4	Evaluate the electrophysiological characteristics of living system.
CO5	Understand and create a model for real life applications of electrophysiology.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module 1: Introduction Natural biological sensors and transducers; General anatomy of excitable cells/tissues; Ion movements in excitable cells and tissues; General concept of resting potential, depolarization, repolarization, and action potentials in terms of ionic movements; Types of electrical potentials generated in different types of excitable cells.	**8**
Module 2: Basic Laws of Cell Electrophysiology	**8**

Physical laws involved in ionic movement in excitable cells; Nernst-Plank equation; Nernst equation; Ion distribution and gradient maintenance; Active and passive transport of ions; Donnan equilibrium; Movement of ions across biological membrane; Goldman-Hodgkin-Katz (GHK) model and equation; Diversity of voltage gated ion channels.	
Module 3: Electrical Circuit Analogy Equivalent circuit representation of biological membrane; Membrane conductance; Ionic conductance; Parallel conductance model and circuit representation of passive properties of cell; Generalized graph of voltage-current relationship; Functional and nonlinear properties of excitable cells; Active conductance (nonlinear properties of excitable cells) and their electrical circuit representations; Fundamentals of synaptic transmission; Transmission of action potentials through large nerve/muscle fiber.	**8**
Module-4: Electrophysiological Signals and Recording Types of electrodes to record electrical signals of body; Concept of body-electrode interface; General electrophysiological signals (electrocardiogram, electromyogram and electroencephalogram) of human body; Evoked responses; Arrangements to record electrophysiological signals.	**8**
Module-5: Engineering Applications General concept of voltage and current clamping; Types of recording systems used in cellular electrophysiology; Monopolar and bipolar recording concepts; Universal biomedical signal recorder; Noise and their removal from signals; Examples of diagnostic importance of electrophysiological signals; Fundamentals of man-machine interface.	**8**

Text Books:

1. Guyton, A.C. Medical physiology, 8th/ 9thIntnl Edn., Philadelphia, W.B. Saunders, 2001/2006.
2. E.R. Kandel& J. Shwartz (ed.): Principles of Neural Science, 3rd ed., 1991.
3. Foundations of cellular neurophysiology; Johnston, D., Wu, S. Cambridge: MIT Press, 1995.

Reference Books:

1. Handbook for Biomedical Instrumentation by R. S. Khandpur, 3rd edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014.
2. J.J.B. Jack, D. Noble & R.W. Tsien: Electric Current Flow in Excitable Cells, Oxford University Press, 1983.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3		3									3	1	3
CO2	3	3										3		2
CO3	3		3		3							3	1	1
CO4	3	3	3			2							1	2
CO5		3	3			2	2						2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: BE24445
Course title: Metabolic Engineering
Pre-requisite(s): BE202 Cell and Molecular Biology, BE204 Biochemistry and Enzyme Technology
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1.	Students will understand about cellular metabolism, their coordination and regulation
2.	Will get knowledge about metabolic kinetics, mass balances and metabolic regulation identifications
3.	To impart knowledge about the programming and cell capability and metabolic flux analysis
4.	To establish an understanding about metabolic control and pathways analysis, modelling and various application

Course Outcomes

After the completion of this course, students will be:

1.	able to understand about detailed cellular metabolism, coordination and their regulation
2.	Know about kinetics and mass balances for transient cases as well as flux analysis
3.	Able to understand various pathways involved in metabolic control analysis
4.	Able to design different models and algorithm as well as understand about detailed application

Syllabus

MODULE	(NO. OF LECTURE HOURS)

Module-1: **Cellular Metabolism:** Overview of cellular metabolism, Fueling Metabolism, Supply of biomass precursors, Coordination of metabolic reactions, Metabolic strategies and regulation.	**8**
Module-2: **Metabolic Networks:** Kinetics, mass balances for the steady state, mass balances for the transient case, Metabolic regulation identification.	**8**
Module-3: **Metabolic Flux Analysis:** Linear programming, Cell capability analysis, Genome scale, Isotope labeling, Metabolic flux analysis and its applications	**8**
Module-4: **Metabolic Control Analysis:** Determination of flux control coefficient, Metabolic control analysis in linear and branched pathways, Analysis of metabolic control and the structure	**8**
Module-5: **Metabolic Network Design and Application**: Metabolic pathway modeling, Metabolic pathway synthesis algorithms, Application in pharmaceuticals, Chemical bioprocess, Food technology, Environmental bioremediation.	**8**

Text Books:

1. Metabolic Engineering: Principles and Methodologies. Edited by G. Stephanopoulos, A.A. Aristidou, J. S. Neilson. (1998) Academic Press, San Diego, CA.
2. Metabolic Engineering Edited by S. Y. Lee & E.T. Papoutsakis (1999) Marcel Dekker, New York, pp.423.

***References*:**

1. Biochemistry by J. M. Berg, J. L. Tymoczko and LubertStryer (2002) Fifth Edition, W.H. Freeman, New York.
2. Understanding the Control of Metabolism by David Fell (1997) Portland Press, London,.
3. Modeling Metabolism with Mathematica. P. J. Mulquiney and P. W. Kuchel, CRC Press, 2003.
4. Pathway Analysis and Optimization in Metabolic Engineering. N. V. Torres and E. O. Voit, Cambridge University Press, 2002.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes	Program Outcomes											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO3
1	3	3	3		3		2				2	1	2	3
2	3	3			3			2		2	2	1	3	2
3	3		3			2		2	2	2	2	2	2	3
4	3			3		2	2			2	2	1	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: **BE24446**
Course title: Bioinformatics Algorithms
Pre-requisite(s): **BE205**
Co- requisite(s): Nil
Credits: **3** L:3 T:0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1.	An ability to work on basic science as well as biotech/pharmaceutical industry in multidisciplinary teams and independently.
2.	Learn various aspects to design and validate algorithms for bio-sequence analysis and interpreting experimental data from biological system and addressing the challenges associated with the interaction between different biomolecules.
3.	Grab the theoretical knowledge, parameters for searching and designing algorithm Design Paradigms, Motif Finding & Genome Rearrangements for a particular disease related Gene in biological research/ biotechnology/ pharmaceutical in industry and research lab.
4.	Enable students to understand the processes associated with DBMS architecture, Machine learning techniques and Bigdata analysis related to computational Biology.
5.	An UG degree in this field prepares a student for careers in biotech/ pharmaceutical research in different domains including industry.

Course Outcomes

After the completion of this course, students will be:

1.	An ability to apply knowledge and to design, analyse and conduct experiments, related to domain of Bioinformatics.
2.	An ability to validate new Bio-sequences. Know how to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3.	An ability to apply the knowledge to find various parameters for searching and designing metabolic pathway, genomics, proteomics for a particular disease related protein/Gene in biological research/ biotechnology/ pharmaceutical in industry and research lab.

4.	An ability to understand the processes associated with DBMS architecture, Machine learning techniques and Bigdata analysis related to computational Biology.
5.	An ability to design the processes conserved domain search and sequence comparison
6.	A UG degree in this field prepares a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies. An ability to function in multidisciplinary teams. An ability to identify, formulate, and solve engineering problems.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: Database System Versus File Systems: Characteristics of Database, Database Concepts, Schemas & Instances, Database users and Administrators, DBMS architecture. Biological Literature Information access, storage and retrieval systems- Primary and secondary databases of genomics, trascriptomics, proteomics and metabolomics. Knowledge on freeware and commercial software.	**8**
Module-2: Introduction, Sorting, Searching, Complexity of algorithms: worst case, average case and amortized complexity, Algorithm Design Paradigms, Big-O and Theta notations.	**8**
Module-3: Mapping Algorithms: Motif-Search Trees, Finding Motifs, Finding a Median String. Greedy Algorithm : Motif Finding & Genome Rearrangements, Sorting by Reversals. Approximation Algorithms	**8**
Module-4: DNA Sequence comparison: Manhattan Tourist Problem – Edit Distance and Alignments – Longest Commons Subsequences – Global Sequence Alignment – Scoring Alignment – Local Sequence Alignment – Alignment with Gap Penalties – Multiple Alignment-Gene Predictions – Approaches to Gene Prediction - Spiced Alignment – Divide and Conquer Algorithms.	**8**
Module 5: Machine learning techniques: ANN and Genetic Algorithm. Applications in Biotechnology	**8**

Text books:

1. T.H. Cormen, C.E. Leiserson, and R.L. Rivest, Introduction to Algorithms, The MIT Press, Cambridge, Massachusetts, USA, 1990
2. Neil C. Jones and Pavel A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT Press, First Indian Reprint 2005.
3. Gary Benson Roderic page (Eds), Algorithms in Bioinformatics, Springer International Edition, First Indian Reprint 2004.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5	CO6
Continuous Internal Assessment	Y	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3		3		3							2		2
CO2	3	3	3			2							2	2
CO3	3		3		3		2					2	2	3
CO4	3					2	2	2				3		2
CO5		3	3			2	2						2	3
CO6				3							1	3	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24447
Course title: Process Biotechnology
Pre-requisite(s): BE307 Bioprocess Engineering
Co- requisite(s):
NIL
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week:
3
Class: B. Tech
Semester / Level: VII/4
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1	Understand the basic mechanism of bacterial growth
2	Regarding medium formulation, sterilization process and synthesis of primary and secondary meatboliyes
3	Provide knowledge of kinetics of enzymes both in free and in immobilized state and stability of biocatalyst
4	Understand the mode of reactor operation in bioprocessing

Course Outcomes:

After the completion of this course, students will be:

CO 1	Able to calculate kinetics and yield of bacterial growth as well as understand enzyme kinetics
CO 2	Experienced in performing different types of sterilizers and their significance
CO 3	Skilled in production mechanism of primary and secondary metabolites mechanism of primary and secondary metabolites
CO 4	An insight into undertaking on types of reactor and related applications

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-I: Cell growth and kinetics Pattern of growth behaviour in batch culture, factors affecting the process of growth and model for Product formation, Mass balance, Yield prediction	**8**
Module-II: Enzyme kinetics Introduction to enzymes, Michaelis–Menten kinetics, Linear plots. Determining rate parameters, Effect of pH and temperature, Enzyme immobilization	**8**
Module-III: Sterilization Importance of Sterilization, Introduction and the kinetics of death, various type of sterilization equipments, role of oxygen transfer rate	**8**
Module-IV: Production of primary and secondary metabolites Bioprocesses for production of organic acids; solvents; antibiotics, proteins; polysaccharides; lipids etc.	**8**
Module-V: Bioreactors, **Mode of bioreactor operation** Batch, Fed-batch and Continuous bioreactors, Operation and control of bioreactors.	**8**

Text Books:

1. Michael L. Shuler, Fikret Kargi, Bioprocess Engineering – Basic Concepts, 2nd Ed., Pearson Education India, 2015
2. James Bailey, David Ollis, Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill Education, 2017

Reference Books:

1. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, 2nd Ed., Oxford University Press, 2003.
2. Pauline M. Doran, Bioprocess Engineering Principles, 2nd Ed., Academic Press, 2012

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50

Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

Course Outcomes	**Program Outcomes**											**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	PSO 1	PSO 2	PSO 3
1	1	1	2	2	1						1	1		3
2	2		1		2	2		1				1	2	
3	3	3	3	3			3	2		3	2		2	3
4	2				3	3	2		3	3	3		2	3

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

OPEN ELECTIVE COURSES

COURSE INFORMATION SHEET

Course code: **BE24261**
Course title: **Fundamentals of Bioinformatics**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: **B. Tech**
Semester / Level: **IV**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	Basic objective is to give students an introduction to the basic principle of bioinformatics
2.	Able to explain the major steps in pairwise and multiple sequence alignment, explain the principle for, and execute pairwise sequence alignment by dynamic programming
3.	Evolutionary tree generation and find the ancestor.
4.	Able to predict the secondary and tertiary structures of protein sequences.
5.	Provide practical training in bioinformatics methods including accessing the major public sequence databases

Course Outcomes

After the completion of this course, students will be:

CO1.	Gain familiarity with the role of bioinformatics in life sciences and demonstrate the ability to use various biological databases for information retrieval and analysis.
CO2.	Develop the ability to perform sequence analysis and alignment using standard bioinformatics tools, and interpret the results to support biological research.
CO3.	Understand the principles of molecular phylogenetics and apply computational methods to explore evolutionary relationships among biological entities.
CO4.	Acquire working knowledge of protein structure prediction and modeling, with an emphasis on understanding the structural basis of protein function.
CO5.	Stay abreast of recent developments in bioinformatics, including systems-level approaches, and apply this knowledge to investigate complex biological systems.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module 1: Introduction of Biological databases What is bioinformatics and its relation with molecular biology, Different File formats: sequence and structure, General Introduction of Biological Databases; Nucleic acid databases; Protein databases; Specialized databases; Structure databases	**8**
Module 2: Sequence Analysis: Similarity, Identity, Homology, Selectivity/Sensitivity, Dot matrix method, Global (Needleman- Wunsch) and Local Alignment (Smith-Waterman) using Dynamic programming. Basics of Scoring system and matrices, BLAST, Multiple Sequence Alignment: Basic Concepts.	**8**
Module 3: Molecular Phylogenetics: Molecular Phylogenetics: Basics, molecular clock, Substitution Models of evolution, Tree reconstruction methods (Distance based, character-based method, statistical).	**8**
Module 4: Protein Structure and Modelling: Protein Structure: Primary, Secondary, Super Secondary, Domains, Tertiary, Quaternary, Ramachandran plot. Protein secondary structure prediction methods~~,~~ Protein Tertiary structure prediction methods: Homology Modelling	**8**
Module 5: Current Advancements in Bioinformatics: Current Advancements in Bioinformatics: Introduction to System Biology, Structural bioinformatics, Chemoinformatics, Immunoinformatics.	**8**

Text books:

1. Introduction to Bioinformatics by Aurther M lesk
2. Developing Bioinformatics Computer Skills By: Cynthia Gibas, Per Jambeck
3. Essential Bioinformatics by Jin Xiong

Reference books:

1. Fundamental Concepts of Bioinformatics, Dan E Krane, Michael L Raymer, Benjamin- Cummings Pub Co (Sept 2002, ISBN 0805346333)
2. David W. Mount (2001) Bioinformatics: Sequence and Genome Analysis. Cold Spring harbor Press

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL
TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL
POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment

Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO-1	3			1		2		1	2		1	2	2	1
CO-2	3	2	2		2			1			2	2	3	2
CO-3	3	2	2	2		1		2	2		3	3	2	3
CO-4	3		1	1	2		2		3	1		2	2	3
CO-5	2		1	1	1	2	2		2		2	2	2	2

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4

CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24262
Course title: Techniques in Pharmaceutical Biotechnology
Pre-requisite(s): Co- requisite(s): Nil
Credits: 3 L: 03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: IV
Branch: All
Name of Teacher:

Course Objectives

This course enables the students:

1.	Understand the basic concepts involved in biopharmaceutical drug production, genomics and gene therapy
2.	Knowledge about therapeutic effects and side effect of biopharmaceuticals. Knowledge about new drug development procedures, drug approval
3.	Appreciate and understand the manufacturing and quality control of drugs and legal steps involved in progressing a new drug to market
4.	Demonstrate knowledge and understanding of currently relevant and newly emerging aspects of pharmaceutical biotechnology

Course Outcomes

After the completion of this course, students will be:

1.	Students will have a basic understanding of the scientific method. explain the strategies and various steps of new drug discovery process
2.	Able to explain the basic concepts of genomics, gene therapy, pharmacogenomics and pharmacodynamics
3.	Able to understand the applied the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals
4.	Able to understand the quality control procedures in the production of various biopharmaceuticals. Explain the economics and regulatory aspects in the development of pharmaceuticals.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: Molecular Biotechnology:	**8**

Genomics and its impact on medicine. Molecular medicine, Rational drug design.	
Module-2: Gene Testing & Diagnostics: Gene testing, pharmacogenomics, Molecular diagnostics.	**8**
Module-3: Cancer Biology & Gene therapy: Oncogenes, tumor suppressor genes, growth factors, Genetic diseases and DNA based diagnosis of genetic diseases. Gene therapy.	**8**
Module-4: Formulation of Biotech Products: Microbiological consideration, use of excipients, Drug delivery methods, Shelf life of biopharmaceuticals, pharmacodynamics of protein therapeutics.	**8**
Module-5: Genetically Engineered Pharmaceuticals: Insulins, Growth Hormones, Vaccines- Hepatitis B & Corona, Interferons & interleukins, Economic aspects in pharmaceutical biotechnology.	**8**

Text Books:

1 Molecular Biotechnology - Therapeutic Applications and Strategies by SUNIL Maulik and Salil D. Patel , Wiley-Liss

2 Pharmaceutical Biotechnology: A Programmed Text 1st Edition by Steven Strauss, Santo William Zito, S. William Zito, CRC Press

3 Pharmaceutical Biotechnology. Fundamentals and Applications, Third Edition. Edited By Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm, Springer

4 Pharmaceutical Biotechnology. Vyas S.P , V.K. Dixit; CBS Publishers & Distributors

Reference Books:

1. Kar, A., Pharmacognosy and pharmacobiotechnology. 2nd Edition, New Age International (P) Ltd., 2007.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination	25
End Sem Examination	50
Quiz	10

Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
1	3	3	3									2	2	2
2	3	3		3	3	3						2	2	2
3			3	3	3	3	2					2	2	3
4							2				3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24353
Course title: Fundamentals of Bioelectronic Devices
Pre-requisite(s): EE101 Basic Electrical Engineering
Co- requisite(s): BE215 Cellular Electrophysiology
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03 Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives:

This course enables the students:

1.	To impart knowledge for interdisciplinary, applied engineering and technology.
2.	With respect to design consideration, to understand the standard structure of biomedical instrumentation systems.
3.	To learn the technicality associated with instrumentation and design of basic biosignal and imaging equipment.
4.	To understand the engineering aspects for safety and hazards associated with biomedical instruments.

Course Outcomes:

After the completion of this course, students will be:

1	Understand the human physiology and man-machine interaction components in medical environment
2	Understand the fundamentals of the concept and design of biomedical equipment.
3	Analyse the electrical hazards associated with medical equipment so that the safety equipment can be devised or suggested
4	Understanding the interdisciplinary nature of the device design and readiness for working in a team environment

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: General Physiology and Fundamentals of medical instrumentation Physiology of cardiac system, pulmonary system, urinary system, nervous system and muscles. Generation and propagation of action potentials in muscle, heart and nervous system; Basic Medical Instrumentation System, Bioelectric Signals and Electrodes, Components of the Man-Instrument System	**8**
Module-2: Electrophysiological Devices Electrocardiograph; Electromyograph; Electroencephalograph; Phonocardiograph; Plethysmograph; Pulmonary function test devices; Blood pressure and flow measurement.	**8**
Module-3: Assistive, Therapeutic and Surgical Devices Pacemaker; Defibrillator; Anesthesia machine; Ventilator; Heart-Lung machine; Hemodialysis machine; Audiometry and Hearing aids; Nerve and Muscle stimulators; Therapeutic and Surgical diathermies.	**8**
Module-4: Medical Imaging Systems Generation of X-ray; X-ray imaging device; Catheterization system; Computer Assisted Tomography; Generations of Computer Assisted Tomography System; Ultrasound and Doppler equipment; Magnetic Resonance Imaging device; Functional Imaging with Gamma camera; Single Photon Emission Tomography; Positron Emission Tomography.	**8**
Module-5: Biotelemetry Systems Antennas for biomedical application; Physiological telemetry; Radio Telemetry system; Portable telemetry system; Land-line telemetry system.	**8**

Text Books:

1. Textbook of Medical Physiology by A. C. Guyton, 8th edition, Prism Indian Publication, Bangalore, 1991.
2. Handbook for Biomedical instrumentation by R. S. Khandpur, 3rd edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014.
3. Medical instrumentation, Application &Design by J. G. Webstar, 4th edition, Wiley Student Edition, New Delhi, 2009.
4. Introduction to Biomedical Equipment Technology by J. J. Kar and J. M. Brown, 4th edition, Pearson India Education Services Pvt. Ltd., Noida, 2016.

Reference Books:

1. Biomedical Engineering and Instrumentation, Basic Concepts and Applications by J. D. Bronzino, 1st Edison, PWS Publishers, Boston, 1986.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

1. Conducting presentations in group and writing reports
2. Giving assignments to the students on some relevant topics
3. Industrial visits

POs met are: a, b, c, f

Topics beyond syllabus/Advanced topics/Design

1. Lecture on brain-computer interaction
2. Lecture on specialized imaging devices

POs met through Topics beyond syllabus/Advanced topics/Design
POs met are: f, g

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

a. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1:	1	1	1	1		1	1	1	2	1	1	3	1	3
CO2:	2	1	3	3	3	3	3	1		1	1	3	1	3
CO3:	2	1	3	1		3	1	1		1	1	3	1	3
CO4:	3	1	1	1		3	3	3	3	3	3	3	1	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1
CO3	CD1
CO4	CD1
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course code: BE24354
Course title: Biotreatment of Municipal & Industrial Waste
Pre-requisite(s): Co- requisite(s): Nil
Credits: 3 L: 03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: V
Branch: All
Name of Teacher:

Course Objectives

This course enables the students:

A.	To familiarize students with the nature of wastes and their impact on the environment.
B.	To develop the students' abilities to analyse and design systems for the collection, handling, treatment and utilization of wastes.
C.	Understand modern treatment technologies and regulations.
D.	Student will be able to apply this knowledge to address new questions and basic design of a waste water plant and solid waste management aspects.

Course Outcomes

After the completion of this course, students will be:

1.	Use appropriate methods for testing water and wastewater. Demonstrate skills in analytical and critical thinking as well as problem solving abilities.
2.	Understand solid waste disposal methods and the advantages as well as disadvantages of the methods.
3.	Formulate and integrate processes to treat water and wastewater including food processing wastewater in order to meet the effluent discharge requirements. Able to give basic design the waste water treatment plants.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-I Waste and its analysis: Definition of waste, and its classification, Principles and Microbiology of waste water treatment-physical, chemical and biological characteristics of waste water, BOD, COD.	**8**
Module-II: Philosophy of municipal wastewater treatment: Philosophy of treatment; Unit operations and processes; physical, chemical and biological methods. Primary Treatment: Screening, Commutation, Grit removal, removal of oil and grease.	**8**

Module-III: Secondary treatment: **Aerobic processes of secondary treatment**– activated sludge, lagoons, stabilization ponds, suspended growth, nitrification, trickling filters, rotating biological contactors, anoxic suspended growth and fixed film denitrification. **Anaerobic processes of secondary treatment** – biological concepts, suspended growth and fixed film processes and reactor configuration. **Sequential batch reactor for combined processes** (aerobic and anaerobic).	**10**
Module-IV Tertiary Treatment: Effluent disposal and reuse. Emerging biotechnological processes in waste water treatment for municipal, industrial waste waters. Designing aspects of Wastewater treatment plant.	**7**
Module-V Solid waste management and control- Landfills, Recycling and processing of organic residues, minimal national standards for waste disposal, Composting technologies.	**7**

Text Books:

1. George Tchobanoglous , et al., Wastewater Engineering: Treatment and Reuse; Metcalf & Eddy, Inc.
2. Sudha Goel, Water and Wastewater Engineering, Cambridge Press
3. Cheremisinoft N.P., Biotechnology of waste water treatment.

Reference Book:

1. Ram Chandra, Environmental waste management, CRC Press

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**

Continuous Internal Assessment	Y	Y	Y
Semester End Examination	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	Simulation
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
1	3	3	3	3	3	2	1	1	1	1	1	3	2	1
2	2	2	3	3	3	3	1	1	1	1	1	2	1	1
3	3	3	2	3	2	3	2	1	1	1	1	2	1	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **BE24370**
Course title: **Fundamentals of Bioinformatics Algorithms**
Pre-requisite(s): **BE205**
Co- requisite(s): Nil
Credits: **3** **L:3** **T:0** **P:0**
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **VI**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	An ability to work on basic science as well as biotech/pharmaceutical industry in multidisciplinary teams and independently.
2.	Learn various aspects to design and validate algorithms for bio-sequence analysis and interpreting experimental data from biological system and addressing the challenges associated with the interaction between different biomolecules.
3.	Grab the theoretical knowledge, parameters for searching and designing algorithm Design Paradigms, Motif Finding & Genome Rearrangements for a particular disease related Gene in biological research/ biotechnology/ pharmaceutical in industry and research lab.
4.	Enable students to understand the processes associated with DBMS architecture, Machine learning techniques and Bigdata analysis related to computational Biology.
5.	An UG degree in this field prepares a student for careers in biotech/ pharmaceutical research in different domains including industry.

Course Outcomes

After the completion of this course, students will be:

1.	An ability to apply knowledge and to design, analyse and conduct experiments, related to domain of Bioinformatics.
2.	An ability to validate new Bio-sequences. Know how to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3.	An ability to apply the knowledge to find various parameters for searching and designing metabolic pathway, genomics, proteomics for a particular disease related protein/Gene in biological research/ biotechnology/ pharmaceutical in industry and research lab.
4.	An ability to understand the processes associated with DBMS architecture, Machine learning techniques and Bigdata analysis related to computational Biology.
5.	An ability to design the processes conserved domain search and sequence comparison
6.	A UG degree in this field prepares a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies. An ability to function in multidisciplinary teams. An ability to identify, formulate, and solve engineering problems.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: Database System Versus File Systems: Characteristics of Database, Database Concepts, Schemas & Instances, Database users and Administrators, DBMS architecture. Biological Literature Information access, storage and retrieval systems- Primary and secondary databases of genomics, trascriptomics, proteomics and metabolomics. Knowledge on freeware and commercial software.	**8**
Module-2: Introduction, Sorting, Searching, Complexity of algorithms: worst case, average case and amortized complexity, Algorithm Design Paradigms, Big-O and Theta notations.	**8**
Module-3: Mapping Algorithms: Motif-Search Trees, Finding Motifs, Finding a Median String. Greedy Algorithm: Motif Finding & Genome Rearrangements, Sorting by Reversals. Approximation Algorithms	**8**
Module-4: DNA Sequence comparison: Manhattan Tourist Problem – Edit Distance and Alignments – Longest Commons Subsequences – Global Sequence Alignment – Scoring Alignment – Local Sequence Alignment – Alignment with Gap Penalties – Multiple Alignment-Gene Predictions – Approaches to Gene Prediction - Spiced Alignment – Divide and Conquer Algorithms.	**8**
Module 5: Machine learning techniques: ANN and Genetic Algorithm. Applications in Biotechnology	**8**

Text books:

1. T.H. Cormen, C.E. Leiserson, and R.L. Rivest, Introduction to Algorithms, The MIT Press, Cambridge, Massachusetts, USA, 1990
2. Neil C. Jones and Pavel A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT Press, First Indian Reprint 2005.
3. Gary Benson Roderic page (Eds), Algorithms in Bioinformatics, Springer International Edition, First Indian Reprint 2004.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10

Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Continuous Internal Assessment	Y	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3		3		3							2		2
CO2	3	3	3			2							2	2
CO3	3		3		3		2					2	2	3
CO4	3					2	2	2				3		2
CO5		3	3			2	2						2	3
CO6				3							1	3	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4
CO6	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24371
Course title: COMPREHENSIVE NANOMATERIALS
Pre-requisite(s):
Co- requisite(s):
Credits: **3** L: 03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives
This course enables the students:

1.	To gain knowledge about the concepts, diverse applications of nanotechnology and its interdisciplinary aspect.
2.	To learn the principle and phenomena governing the nanoscale effect on material properties and their applicability
3.	To gain a working knowledge in nanotechnology techniques (synthesis & characterization) and acquire the ability to use them to solve problems in engineering.
4.	To correlate the impact of nanoscience and nanotechnology in a global, economic, environmental, and societal context.
5.	To identify career paths at the interface of nanotechnology, biotechnology, environmental, engineering, medicine and research.

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

1.	Understand the fundamentals of nanoscale phenomena, science at nanoscale, responsible for unique behaviour of nanomaterial and their classifications
2.	Acquire the in-depth knowledge and skill about specific types of nanomaterials, be able to fabricate nanomaterials using different nano-fabrication methods
3.	Acquire the knowledge and skills to characterize nanomaterials using different techniques.
4.	Familiarize themselves with nanomaterials potentialities and be able to apprehend and explain use of nanomaterials in wide array of applications. Ability to recognize the potential concerns and measures to be taken for nanomaterials.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: Introduction: Definitions and concept, Historical background, physics and chemistry at nanoscale, Surface plasmon resonance, quantum confinement, Properties at nanoscale, nanomaterials classification	**8**
Module-2: Synthesis of Nanomaterials: Physical methods, Chemical methods, Biological methods, Advantages & Limitation	**8**
Module-3: Engineered Nanomaterials:	**8**

Synthesis, properties and applications of fullerenes, Carbon nanotubes, Metal nanoparticles, Quantum Dots, Nanowire, Nanofiber	
Module-4: Characterization techniques: Spectroscopy (UV-Vis, FT-IR) Electron microscopy, light scattering, Zeta potential, AFM, EDAX, XRD	**8**
Module-5: Emerging engineering applications & Concerns: Nanobiosensor, Nanomedicine, Electronics, Energy, nanofluidics, imaging, computation, nanotoxicity and safety considerations	**8**

Text Books:

1. Murty, B. S., Shankar, P., Raj, B., Rath, B. B., & Murday, J. (2013). Textbook of
    a. nanoscience and nanotechnology. Springer Science & Business Media.
2. Pradeep (2012). A Textbook of Nanoscience and Nanotechnology. Tata McGraw Hill
    a. Education Pvt. Ltd.
3. Bréchignac, C., Houdy, P., & Lahmani, M. (Eds.). (2008). *Nanomaterials and nanochemistry*. Springer Science & Business Media.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**											**PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
1	3	3				2	2		1	1	1	3	3	3
2	3	3	3	2	2	2	2	1	2	1	2	3	3	3
3	3	3	3	2	3	2		1	1		2	3	3	3
4	3	2	3	2	2	3	2	2	2	1	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24451
Course title: Bioenergy and Biofuels
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: VII
Branch:
Name of Teacher:

Course Objectives

This course enables the students:

1.	To establish an understanding of the major types of biofuels and energy, biosynthetic pathways, processing and applications.
2.	To give knowledge of Biofuel properties, specifications and guidelines.
3.	To describe production strategies for various Biofuels and to introduce them with technology development for Biofuel production.
4.	To outline principles of biomass conversion of fuels
5.	To describe Environmental assessments due to uses of biofuels-Biofuels economics
6.	To introduce students with biofuels economics

Course Outcomes

After the completion of this course, students will be:

1.	Able to know about different types of biofuels, biosynthetic pathways, processing and applications.
2.	Acquiring knowledge of biofuel properties, specifications and guidelines
3.	They will be able to evaluate the industrially important biofuel and design the technology for the same.
4.	They will be able to analyze the biofuel issues and correlate them with economic aspects.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: Types of biomass (e.g. wood waste, forestry residues, agricultural residues, perennial annual crops, organic municipal solid waste). Composition of lignocellulose (lignin, hemicellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment; degradation of cellulose; Trichoderma cellulases; bacterial cellulases and comparison with degradation of high starch crops	**8**

Sources of energy, introduction of biofuels, availability of biomass, composition of biomass, terrestrial biomass, aquatic biomass. Physical and chemical properties of biomass. Useful and undesirable features of biofuels.	
Module-2: Biogas: The substrate, the digester, the microorganisms, the process of biogas production, factors affecting biogas yields, advantages, disadvantages. Bioethanol: Bioethanol vs. Petrol, production of bioethanol, ethanol recovery. Biobutanol. Properties and standards of bioethanol. Lignocellulosic biomass composition and characterizations.	**8**
Module-3: Sources and processing of biodiesel (fatty acid methyl ester); nature of lipids, especially fatty acids and triglycerides. Sources and characteristics of lipids for use as biodiesel feedstock; and conversion of feedstock into biodiesel (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO). Engineering, economics and environmental issues of biodiesel; major policies and regulations pertaining to the production, distribution, and use of biodiesel. Comparison of biodiesel with conventional diesel. Standards of biodiesel, current technologies and challenge	**8**
Module-4: Hydrogen Production:Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production- Storage of Hydrogen Gaseous, Cryogenic and Metal hydride. Biohydrogen: Production of biohydrogen from anaerobic bacteria, photosynthetic algae, photosynthetic - hydrogenase system. Pyrolysis, bio-oil upgradation.	**8**
Module-5: Alternate fuels: global & Indian scenario-Feedstock economics, Biofuels demand and supply-Clean air/energy policy act-Environmental assessments -Biofuels economics and policy, Boutique fuels.	**8**

Text Books:

1. Sameer A Zogdekar, “Biofuels Introduction and Country Experiences”, Published by ICFAI University Press., ISBN No. 978-8131416051, 2008.
2. David M Mousdale, “Biofuels: Biotechnology, Chemistry and Sustainable Development”, Published by Taylor And Francis Group CRC Press., ISBN No.978-1439812075, 2008.
3. Alain A Vartes, Nasib Qureshi, “Biomass to Biofuels: Strategies for Global Industries”, Published by John Wiley & Sons Ltd., ISBN No. 978-0470513125, 2009.

Reference Book:

3. David Pimentel, “Biofuels, Solar and Wind as Renewable Energy Systems”, Published by Springer- Verlag., ISBN No. 978-9048179459, 2010.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
1	3					2	3	3	2			2	2	2
2	3		3		2	2				3	1	2	2	2
3	3		3			2		2	3	1	1	2	2	3
4	3		3			2	3				3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24452
Course title: Molecular Modelling and Drug Designing
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: VII
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1.	**Introduce the fundamental concepts of molecular modelling,** including comparative and homology modelling techniques, and familiarize students with relevant databases and tools used in protein modelling.
2.	**Enable students to understand and apply molecular mechanics and simulation techniques,** particularly Molecular Dynamics (MD), including the concept and application of various force fields.
3.	**Develop proficiency in optimization algorithms,** such as Steepest Descent, Conjugate Gradient, and Simulated Annealing, and distinguish between Molecular Dynamics and Monte Carlo simulation techniques.
4.	**Provide knowledge of molecular docking methods and scoring functions,** and their practical applications in virtual screening, QSAR, and drug-receptor interaction studies.
5.	**Impart understanding of the drug discovery pipeline,** including lead identification, optimization, physicochemical principles of drug action, and ADMET profiling with emphasis on Lipinski's Rule of Five.

Course Outcomes

After the completion of this course, students will be:

CO1.	To equip students with key skills of molecular modeling techniques currently practiced in any pharmaceutical research and development unit.
CO2.	Analyze and discuss the results in light of molecular biological knowledge.
CO3.	Development of useful tools for automation of complex computer jobs, and making these tools accessible on the network.

Syllabus

MODULE	(NO. OF LECTURE HOURS)

Module 1: Basics of Molecular Modelling, Comparative modeling of proteins: comparison of 3D structure, Homology modelling and its steps, side chain and loop modeling. Tools & databases used in protein modelling.	**8**
Module 2: Molecular Mechanics, Simulation techniques: Molecular Dynamics simulation, Concepts of Force-field	**8**
Module 3: Optimization algorithms: Steepest descents, Conjugate gradient, Simulated Annealing. Monte Carlo simulation: Random number generation, Difference in MD & MC	**8**
Module 4: Molecular Docking: Methods and Scoring Functions, application in screening, QSAR studies	**8**
Module 5: General approach to discovery of new drugs, lead discovery, lead modification. Physiochemical principles of drug action, Lipinski rule and ADMET.	**8**

TEXT BOOKS:
1. A. R.Leach - Molecular Modeling Principles and Application, 2nd edition, Longman Publications,
2. Introduction to Bioinformatics by Aurther M lesk

Reference books:
1. Fundamental Concepts of Bioinformatics, Dan E Krane, Michael L Raymer, Benjamin- Cummings Pub Co (Sept 2002, ISBN 0805346333)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**
Continuous Internal Assessment	Y	Y	Y
Semester End Examination	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminasr
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	1	1	1	1	3	3	3	2
CO2	3	3	3	2	2	1	1	1	1	1	3	2	2	3
CO3	3	3	3	3	2	2	1	1	1	1		2	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

In Depth Specialization

COURSE INFORMATION SHEET

Course code: **BE24351**
Course title: **Molecular Simulation of Biomolecules**
Co- requisite(s):
Credits: **4** L: 3 T: 1 P: 0
Class schedule per week: 03
Class: B.Tech.
Semester / Level: V -VI (In-depth Specialization in Computational Biotechnology with B. Tech (Biotechnology))
Branch:
Name of Teacher:

Course Objectives

This course enables the students:

1.	To impart knowledge on Molecular Simulation of Biomolecules.
2.	To learn the technicality associated with instrumentation and design of basic Molecular Simulation of Biomolecules
3.	To perform and analyse the engineering aspects for Molecular Simulation of Biomolecules.
4.	To record and interpret the characteristics of data obtained about Molecular Simulation of Biomolecules.

Course Outcomes

After the completion of this course, students will be:

1.	Apply fundamental concepts and computational approaches to analyze molecular interactions and biological systems.
2.	Demonstrate understanding of modeling principles and techniques used in simulating biomolecular behavior.
3.	Use simulation tools and techniques to study structural and dynamic aspects of biomolecules.
4.	Apply optimization methods to enhance the accuracy of molecular predictions and interpretations.
5.	Evaluate the scope and application of advanced simulation approaches in biological research.

Syllabus

MODULE	**(NO. OF LECTURE HOURS)**
Module 1: Molecular Docking: Methods and Scoring Functions, Analysis and prediction of protein-ligand complexes, Quantitative assessment of binding interactions	**8**
Module 2: Basics of Molecular Modelling and Simulation Studies, Molecular Mechanics: Concepts of Force-field	**8**
Module 3: Simulations techniques : Basics of Molecular Dynamics, Monte Carlo Simulations	**8**

Module 4: Optimization algorithms: Steepest descents, Conjugate gradient, Simulated Annealing	**8**
Module 5: Overview of Advanced Sampling Methods and their applicability.	**8**

Textbook:
1. ***Molecular Modelling: Principles and Applications, 2nd Edition (Illustrated)*** byAndrew R. Leach, Addison-Wesley Longman Ltd, (February 2001) ISBN: 0582382106

Reference:
1. Guidebook on Molecular Modeling In Drug Design (Illustrated), J. G. Vinter, Mark Gardner (Editor), J. G. Vinter (Editor), CRC Press (May 1994) ISBN: 0849377722

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	2	1	1	1	1	3	3	3	2
CO2	3	3	2	2	3	2	1	1	1	1	3	3	3	2
CO3	3	3	3	3	3	2	1	1	1	1	3	3	3	3
CO4	3	3	3	3	3	2	1	1	1	1	2	2	3	3
CO5	2	2	2	2	2	2	1	1	1	1	2	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **BE24352**
Course Title: **Perl and Bioperl**
Pre-requisite(s): **BE24244**
Co-requisite(s): **Nil**
Credits: **4** **L: 3 T: 1 P:0**
Class schedule per week: **4**
Class: **B. Tech.**
Semester / Level: **V/2**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	Familiarity with AIX/UNIX or Windows operating systems, Proficiency with a text editor, such as vi or emacs
2.	Understand the syntax and semantics of the Perl language, understand how to develop and implement various types of programs in the Perl language
3.	Introduces the extensive module library, with particular attention to using Perl for working with databases
4.	Various forms of data representation and structures supported by the Perl language
5.	Introduction to the storage, representation, integration, analysis, and retrieval of bioinformatic data (annotation, sequence and structural information)

Course Outcomes

After the completion of this course, students will be:

CO1	Looking for a powerful programming environment
CO2	Become familiar with the use of a wide variety of internet applications, biological database and will be able to apply these methods to research problems.
CO3	Development of useful tools for automation of complex computer jobs, and making these tools accessible on the network

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module 1: Advanced Unix commands Introduction-ls-cat-more-, Advanced Unix commands-mv-rm-rmdir-uniq-sort, Advanced	**8**

Unix commands-grep.	
Module 2: Introduction and basic syntax Data types: Scalar, Array, List, Hash, anonymous data types, references, special variables, common built-in scalar, array and hash functions.	**8**
Module 3: Regular Expressions Basic input/output, File handling and File and directory manipulations, Complex data structures using references.	**8**
Module 4: OOP Object oriented perl: Scope of a variable, Subroutines, Modules and packages, Objects, classes, methods, inheritance, polymorphism.	**8**
Module 5: CGI-Programming: Passing parameters and Interaction with web and databases, Use of common CPAN modules, Bioperl Introduction, Objects and Classes, Applications: Sequences, Alignments, BLAST analysis.	**8**

TEXTBOOKS

1. Harshawardhan P Bal, Perl Programming for Bioinformatics, Tata McGraw Hill, 2003.
2. James Tisdall, Mastering Perl for Bioinformatics, O'Reilly, 2003.

Reference books:

1. Fundamental Concepts of Bioinformatics, Dan E Krane, Michael L Raymer, Benjamin- Cummings Pub Co (Sept 2002, ISBN 0805346333)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40

Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**
Continuous Internal Assessment	Y	Y	Y
Semester End Examination	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	3		3	3	2	2		2	2	1	2	2	2
CO 2		3	3		3		2	2	2	2	1	3	1	3
CO 3	3	3		3	3	2	2	2	2	2	1	3	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course Code:	**BE24368**
Course Title:	**Biosequence analysis and programming lab**
Pre-requisite(s):	**NIL**
Co- requisite(s):	
Credits:	**1** L: 0 T: 0 P: 2
Class schedule per week:	**2**
Class:	**B. Tech.**
Semester / Level:	**IV**
Branch:	**Biotechnology**
Name of Teacher:	

COURSE OBJECTIVES

This course enables the students to:

1.	Understand the basics of molecular structure representation by retrieving chemical and protein structures from public databases and interpreting various molecular file formats.
2.	Perform homology modelling of proteins using computational tools and validate the quality of the generated 3D structures through structure assessment techniques.
3.	Learn to carry out domain and motif prediction studies using web-based tools, interpret results.
4.	Develop phylogenetic trees for given sequence.
5.	Gain experience in C programming, operating system.

COURSE OUTCOMES (COs)

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

CO1	Apply computational biology principles to retrieve, analyze, and interpret molecular biological data.
CO2	Design and perform computational experiments related to molecular modeling, interpreting the results effectively.
CO3	Identify and troubleshoot challenges in computational workflows.
CO4	Utilize advanced tools and software for data analysis.
CO5	Demonstrate the ability to independently manage computational projects, including operating system handling and analysis of biological data.

List of experiments

Experiment 1	Pairwise sequence Alignment: BLAST and FASTA, Multiple Sequence alignments: Clustal W/X and web based programs
Experiment 2	Accessing Online Bioinformatics Resources, Database Searching Techniques: NCBI, EBI, DDBJ.
Experiment 3	To study protein secondary structure prediction To search motifs and domain analysis
Experiment 4	To study protein tertiary structure prediction by homology modeling
Experiment 5	To validate and verify modeled structure through different online tools
Experiment 6	Linux and Unix OS: Overview, Installation and System handling commands
Experiment 7	Working with Internet: WWW, TELNET, FTP
Experiment 8	Phylogenetic analysis using Phylip (various analysis and drawing rooted and unrooted trees)
Experiment 9	C Programming : Windows and Linux platform

Text Books:

2. Molecular Modeling: Basic Principles and Applications, 3rd Edition by Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers
3. Practical Chemoinformatics by Muthukumarasamy Karthikeyan , Renu Vyas

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	**% Contribution during CO Assessment**
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	**% Distribution**
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2		2	3				2		1	2	2	1
CO2	3	3	2	2	3				2		1	2	2	2
CO3	3	3	2	2	3	1			2		2	2	3	2
CO4	2	2	2	2	3	2			2		2	2	3	2
CO5	2	2	2	2	3	2			2	2	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: BE24369
Course Title: **Advanced Algorithm Techniques and Communication**
Pre-requisite(s): **BE24244**
Co-requisite(s): **Nil**
Credits: **4 L: 3 T: 1 P:0**
Class schedule per week: **3**
Class: **B. Tech.**
Semester / Level: **VI/2**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	Familiarity with Genome editing tools, Proficiency with coding languages.
2.	Understand the syntax and semantics of the coding language, understand how to develop and implement various types of tools in genomics studies.
3.	Introduces the extensive ML and its applications in Biotechnology.
4..	Various forms of data representation and web page designing with various scripts.
5.	Introduction to the data communication systems: LAN, WAN,MAN, VPN technology

Course Outcomes

After the completion of this course, students will be:

CO1	Looking for a powerful programming environment
CO2	Become familiar with the use of a wide variety of internet applications, scripts for web page designing and will be able to apply these methods to research problems.
CO3	Development of useful tools for automation of complex computer jobs, and making these tools accessible on the network

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: Genomics study: Structure, function and physico-chemical properties of Nucleic Acid, Next generation sequencing techniques, Genome assembly, Gene identification methods, Genome annotation techniques, Motif analysis and presentation, Blast2GO	8

Module-2: Statistical modeling: Log-likelihood, Maximum-likelihood and Expectation Maximization, Bayesian network, Markov and hidden markov models. Clustering Algorithms, K-means.	**8**
Module-3: Machine learning: Artificial-Neural Network, Support vector machine, Decision trees, K-nearest neighbour (KNN), Suffix tree and its applications in Bioinformatics.	**8**
Module-4: Web Designing: IIS and Active Server Pages, Web Designing: HTML/ DHTML, JavaScript Language, VBScripts.	**8**
Module-5: Data communication: ISO-OSI Reference Model, Network Topologies and Protocols, LAN (Star, Ethernet, Bus, EPABX), WAN, MAN. Data communication (ISDN, VPN, DSL, Cable modem), Communication links (Wire Pairs, Coaxial cables, Fibre optics, Microwaves, Satellite, Wireless etc.)	**8**

Text Books:

1. Durbin, R., Eddy, S.R., Krogh, A., Mitchison, G. Biological sequence analysis. Probabilistic models of proteins and nucleic acids. Cambridge University Press, Cambridge. 1998.

2. Forouzan, B. A. Data Communications and Networking. 4th Edition. 2017

Reference Books:

1. Jones, N. C., Pevzner, P. A. An Introduction to Bioinformatics Algorithms. (Computational Molecular Biology), MIT Press. 2004.

2. Grant, G. R., Ewens,W. J., Statistical Methods in Bioinformatics: An Introduction. New York: Springer-Verlag. 2005.

3. Kosko, B. Neural Network & Fuzzy systems, PHI publisher.1994.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	3		3	3	2	2		2	2	1	2	2	2
CO 2		3	3		3		2	2	2	2	1	3	1	3
CO 3	3	3		3	3	2	2	2	2	2	1	3	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: **BE24448**
Course title: **Systems Biology**
Pre-requisite(s):
Co- requisite(s):
Credits: **3** L: 3 T: P:
Class schedule per week:
Class: **B. Tech**
Semester / Level:
Branch: **Biotechnology**
Name of Teacher: **Dr. Anjana Dwivedi**

Course Objectives

This course enables the students to:

1.	To inculcate systems thinking that is integrative approach rather than reductionist approach in biology
2.	Provide the student with an understanding of the methods, tools, and limitations of *modelling and simulation of biological systems.*
3.	Help understand the design principles underlying biological systems
4.	Train students for understanding biology from an engineering perspective

Course Outcomes

At the end of the course the students are capable of:

1.	Understanding the fundamentals of model and its behaviour
2.	Having the knowledge of key concepts of systems biology
3.	Identifying complex biological machineries, their design principles and pathways to analyze and understand them using first principles of basic and applied sciences
4.	Integrative modeling approach towards biological systems will enable them to work in a team and accept technical challenges in other areas and fronts of engineering

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module I Introduction to Systems Biology: Biology in Time and Space, Models and Modeling, Purpose and Adequateness of Models, Advantages of Computational Modeling, Model Scope , Model Statements , System State, Variables, Parameters, and Constants, Model Behavior, Model Classification, Steady States, Data Integration	**8**
Module II Key concepts of systems biology: Dynamic systems, network, selforganization, emergent properties, homeostasis, robustness, modularity, optimality, Genetic Switches	**8**
Module III Kinetics:	**8**

Equilibrium Binding and Co-operativity, Michaelis-Menten Kinetics, identical and independent binding sites, Identical and interacting binding sites, non-interacting binding sites.Genetic switch in Lambda Phage -Noise-based Switches and Amplifiers for Gene Expression, *E.coli* chemotaxis, oscillators, Noise in gene expression.	
Module IV Gene expression networks: Transcription Networks, network motifs, coherent Feed Forward Loop (FFL) and delay gate, The incoherent FFL, Temporal order, Signaling networks and neuron circuits, Aspects of multi-stability in gene networks.	**8**
Module V Databases and tools: Microarray gene expression database, protein-protein interaction database, pathway database, network visualization tools, modelling and simulation tools, Different Markup languages used in systems biology, NGS technology.	**8**

TEXT BOOKS

1. Systems Biology: A Textbook (2016) by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald
2. System Biology: Computational Systems Biology (Hardcover) by Andres Kriete (Editor), Roland Eils (Editor)
3. An Introduction to Systems Biology: Design Principles of Biological Circuits (Chapman & Hall/CRC Mathematical and Computational Biology)
4. Stochastic Modelling for Systems Biology. ISBN-10 1-58488-540-8 and ISBN-13 978-158488-540-5
5. Microarray Data Analysis: Gene Expression Data Analysis. A Beginner's Guide By: Helen Causton (Imperial College), J Quackenbush and AlvisBrazma (The European Bioinformatics Institute)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	**% Distribution**

Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1:	3	2	1	3	3		1	2				1	1	3
CO2:	3	2	1	3	3		1	2				1	1	3
CO3:	3	3	3	3	3		1	3		1	2	3	3	3
CO4:	3	3	3	3	3	3	2	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1
CO3	CD1, CD2
CO4	CD1, CD2

COURSE INFORMATION SHEET

Course Code:	**BE24449**
Course Title:	**Advanced Biocomputing Lab**
Pre-requisite(s):	**NIL**
Co- requisite(s):	
Credits:	**1** L: 0 T: 0 P: 2
Class schedule per week:	**2**
Class:	**B. Tech.**
Semester / Level:	**VII**
Branch:	**Biotechnology**
Name of Teacher:	

COURSE OBJECTIVES

This course enables the students to:

1.	Understand the principles of molecular modeling, simulation, and structure-based analysis of biological macromolecules.
2.	Gain hands-on experience in performing molecular dynamics simulations and interpreting the resulting data.
3.	Explore biological networks and pathways using systems biology approaches.
4.	Learn to analyze and interpret large-scale biological data through computational techniques.
5.	Develop and apply basic scripting skills to automate bioinformatics workflows and virtual screening processes.

COURSE OUTCOMES (COs)

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

CO1	Apply computational approaches to study and analyze molecular structures and their dynamic behavior.
CO2	Design and execute simulation-based experiments to investigate biomolecular interactions.
CO3	Analyze biological systems using network modeling and pathway simulation techniques.
CO4	Interpret and integrate large-scale biological data for functional and mechanistic insights.
CO5	Demonstrate proficiency in automating computational workflows for structure- and systems-level analysis.

SYLLABUS (List of experiments)

Experiment 1:	Input file preparation for MD simulation.
Experiment 2:	Energy minimization of protein structure and its analysis.
Experiment 3:	Simulation run for a given time scale.
Experiment 4:	Trajectory analysis and plotting of RMSD, Rg, RMSF, etc.
Experiment 5:	Creating a pathway model of cellular apoptosis in CellDesigner/JDesigner.
Experiment 6:	Mathematical modeling and simulation of metabolic pathway using MATLAB
Experiment 7:	Establishing crosstalk among networks using different database (KEGG, REACTOME etc.)
Experiment 8:	Learn different network visualization tools (BioUML, CADLIVE, Edinburgh Pathway Editor, Cytoscape etc.)

Text Books:

2. Molecular Modeling: Basic Principles and Applications, 3rd Edition by Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers
3. Systems Biology in Practice: Concepts, Implementation and Application. by Edda Klipp, Ralf Herwig, Axel Kowald, Christoph Wierling
4. An Introduction to Systems Biology: Design Principles of Biological Circuits Second Edition by Uri Alon
5. Foundations of Systems Biology by Hiroaki Kitano

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2		2	3				2		1	2	2	1
CO2	3	3	2	2	3				2		1	2	2	2
CO3	3	3	2	2	3	1			2		2	2	3	2
CO4	2	2	2	2	3	2			2		2	2	3	2
CO5	2	2	2	2	3	2			2	2	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

MINOR IN BIOTECHNOLOGY

COURSE INFORMATION SHEET

Course code: BE24355
Course title: Cellular and Molecular Dynamics
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives:

This course enables the students to:

1.	To provide the knowledge on cell structure of prokaryotic and eukaryotic cells.
2.	To provide detailed overview of cell organelles functions and regulation of various cellular processes and signaling network
3.	To acquaint the molecular mechanism of cell cycle regulation and genetic mechanism of action occurring in eukaryotic cell
4.	To be familiar about the complexity and harmony of the cellular and molecular dynamics showing biological activities happening within a living system.

Course Outcomes

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

CO1	To integrate the different levels of biological complexities from molecules to cells to organisms.
CO2	To assess and utilize scientific literature to do research on cell-cell interaction and signaling network.
CO3	To gain the knowledge of common and advanced mechanisms of cell and molecular dynamics.
CO4	To explain the clear and concise information related to biological activities happening within a living system

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-I: Cell Basics Structure of prokaryotic and eukaryotic cell, cell wall, cell membranes, structural and functional complexities of cell organelles.	**8**
Module-II: Cell-cell Interaction and Signaling Cell communication, Cell signaling, G-Protein linked cell-surface Receptor and enzyme- linked cell-surface receptor based signaling, importance of signal transduction pathways in a living system.	**8**
Module-III: Cell Cycle and its Regulation Cell cycle and its regulation, Intracellular control of the cell cycle events, Extracellular control of cell division, Cell growth in living system, carcinogenesis and regulation.	**8**
Module-IV: Molecular Biology Basics DNA replication, Transcription, Translation, DNA repair, DNA methylation, Chromatin packing, Genetic recombination, RNA splicing, Gene expression and its regulation, Protein synthesis and Manipulations in living systems.	**8**
Module-V: Protein Dynamics: Protein targeting, co-translational transport of protein, post-translational transport of protein into organelles, Protein stability and modification in living systems.	**8**

Textbooks:

1. Molecular Biology of the Cell, 4th Edition, Alberts et al. 2002, New York,
2. Molecular Cell Biology, 5th Edition. Lodish et al., 2003
3. The Cell: A Molecular Approach, 6th Edition, Geoffrey M. Cooper & Robert E. Hausman 2013
4. Channarayappa: Molecular Biology
5. U. Satyanarayana: Biotechnology

Reference Books:

1. DeRobertis EDP 2010, Cell and Molecular Biology, 8th Edition
2. Principles of Molecular Biology, 1st Edition, Burton E. Tropp, 2012
3. Recent review articles (Nature Reviews, Molecular Cell Biology, Trends in Cell Biology)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	1	1	1	1	2	2	2	2	2	2
CO2	3	3	3	3	2	3	2	2	2	1	2	3	2	2
CO3	3	2	2	3	2	1	2	3	2	2	2	3	2	3
CO4	3	2	2	1	2	1	2	2	2	2	2	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24356
Course title: Biochemistry & Microbiology
Pre-requisite(s):
Co- requisite(s): None
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B. Tech
Semester / Level: V/3
Branch: Biotechnology Minor to BTech (other than Biotechnology)
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Learn the basic concept of biomolecules, associated metabolic processes and bioenergetics
2.	Gain knowledge about the various microbial process, microbial culture maintenance and propagation techniques
3.	Extend comprehensive knowledge about microbial process, media constituents, formulations and microbial growth in different fermentation mode
4.	Familiarized with the use of microorganism in environmental process, agriculture and medical field

Course Outcomes

At the end of the course, a student should be able to:

1.	Describe the biochemistry of cells and importance of biomolecules in various anabolic and catabolic processes as well can explain the morphological features of microbes
2.	Acquainted with various metabolic processes of cells and microbial culture techniques
3.	Manipulate the microbial growth and process to produce the desired product and role of microbes in management of waste plant biomass and apply the knowledge in designing microbe based industrial processes
4.	Develop the interdisciplinary capacity for application of microbial cells and products in human welfare

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: Biomolecules: Structure of nucleic acids, DNA Organization, Basic organization of Gene- lac operon, structure of m-RNA and t-RNA; Classification, Structure and function of carbohydrates; Classification and structure of standard amino acids, Physicochemical properties of amino acids; Structure of proteins, Classification and functions of lipids,	**8**

Essential fatty acids. Energy rich compounds like Phosphoenolpyruvate, 1,3-Bisphosphoglycerate, Thioesters, ATP	
Module-2: Metabolic Process: Bioenergetics, Glycolysis, Gluconeogenesis, Kreb's Cycle, Electron transport chain, Oxidative phosphorylation; Photosynthesis; Beta oxidation pathway; Enzymes, Mechanism of enzyme action, Enzyme kinetics; Replication, transcription and Translation	**8**
Module-3: Microbial diversity: Cell structure and major characteristics of bacteria, fungi, algae, protozoa, viruses, Archaebacteria, Growth of Microorganisms: Nutritional and physical requirements - typical composition of medium, Growth curve	**8**
Module-4: Microbiological techniques and Growth: Basics of microscopy; Pure culture isolation, cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria; Staining techniques for microorganisms; Introduction to Batch culture, Continuous culture, Synchronous growth, Fed-batch culture	**8**
Module-5: Microbes in human welfare: Industrially important microorganism and their products; Microbes mediated environmental process, Bioleaching, Bioremediation, Biofiltration; Microbes in agriculture; Medical microbiology, Diseases caused by bacteria, virus, fungi and protozoans; defense mechanism.	**8**

Text Books:

1. D.L. Nelson and M.M. Cox Lehninger Principles of Biochemistry, 3rd Edition (2002) McMillan North Publication.
2. Lubert Stryer, Jeremy M. Berg, John L. Tymoczko: Biochemistry Prescott, Harley, and Klein, Microbiology, 7th Ed., Tata McGraw-Hill, 2008
3. Pelczar, Chan and Krieg, Microbiology, 5th Edition, Tata McGraw-Hill, 1986
4. Frazier and Westhoff, Food Microbiology, 4th Edition, Tata McGraw-Hill, 1995

Reference Books:

1. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10

Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	Program Outcomes													
	PO1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
1	3	3	3	2	2	1	2	1	1	1	1	2	2	2
2	3	3	3	2	3	3	2	1	1	2	2	2	2	2
3	3	3	3	2	3	3	2	1	1	2	2	2	2	3
4	3	3	3	2	2	3	2	1	1	3	1	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: BE24372
Course title: Introductory Pharmaceutical Biotechnology
Pre-requisite(s): Co- requisite(s): Nil
Credits: 3 L: 03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: All, Only for Minor in Biotechnology
Name of Teacher:

Course Objectives This course enables the students:

1.	Understand the basic concepts involved in biopharmaceutical drug production, genomics and gene therapy
2.	Knowledge about therapeutic effects and side effects of biopharmaceuticals. Knowledge about new drug development procedures, drug approval
3.	Appreciate and understand the manufacturing and quality control of drugs and legal steps involved in progressing a new drug to market
4.	Demonstrate knowledge and understanding of currently relevant and newly emerging aspects of pharmaceutical biotechnology

Course Outcomes

After the completion of this course, students will be:

1.	Students will have a basic understanding of the scientific method. explain the strategies and various steps of new drug discovery process
2.	Able to explain the basic concepts of genomics, gene therapy, pharmacogenomics and pharmacodynamics
3.	Able to understand the applied the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals
4.	Able to understand the quality control procedures in the production of various biopharmaceuticals. Explain the economics and regulatory aspects in the development of pharmaceuticals.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: Introduction to Molecular Biotechnology: Central dogma of molecular biology, Genomics and its impact on medicine. Molecular medicine, Rational drug design.	**8**
Module-2: Gene Testing & Diagnostics: Gene testing, Molecular diagnostics. Pharmacogenomics.	**8**
Module-3: Cancer Biology & Gene therapy: Genetic diseases and DNA based diagnosis of genetic diseases, Oncogenes, tumor suppressor genes, growth factors, Gene therapy.	**8**
Module-4: Formulation of Biotech Products: Microbiological consideration, use of excipients, Drug delivery methods, Shelf life of biopharmaceuticals, pharmacodynamics of protein therapeutics.	**8**

Module-5: Genetically Engineered Pharmaceuticals: Insulins, Growth Hormones, Vaccines- Hepatitis B & Corona, Interferons & interleukins, Economic aspects in pharmaceutical biotechnology.	**8**

Text Books:

1 Molecular Biotechnology - Therapeutic Applications and Strategies by SUNIL Maulik and Salil D. Patel , Wiley-Liss

2 Pharmaceutical Biotechnology: A Programmed Text 1st Edition by Steven Strauss, Santo William Zito, S. William Zito, CRC Press

3 Pharmaceutical Biotechnology. Fundamentals and Applications, Third Edition. Edited By Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm, Springer

4 Pharmaceutical Biotechnology. Vyas S.P , V.K. Dixit; CBS Publishers & Distributors

Reference Books:

1. Kar, A., Pharmacognosy and pharmacobiotechnology. 2^{nd} Edition, New Age International (P) Ltd., 2007.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1.Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	Program Outcomes													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
1	3	3	3									2	2	2
2	3	3		3	3	3						2	2	2
3			3	3	3	3	2					2	2	3
4							2				3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **BE24373**
Course title: **Basic Biotechnology Lab**
Pre-requisite(s): BE24355
Co- requisite(s): NIL
Credits: 1.0 L: 0 T: 0 P: 2
Class schedule per week: **02**
Class: **BTech**
Semester Level: III
Branch: Bioengineering and Biotechnology
Name of Teacher:

Course objectives
This course enables the students to:

1	Understand the concepts underlying techniques & instrumentation in biotechnology.
2	Operate instruments to do biological, chemical, and analytical analysis of biomolecules like DNA, RNA, Proteins and carbohydrate from the living organisms
3	Develop critical thinking and analytical abilities to perform small and big biotechnology related projects.

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

1.	Apply knowledge of biotechnology to analyze various events in livings system.
2.	Identify, formulate, design, conduct experiments, analyze and interpret the biotechnology related data to solve problems in life sciences.
3.	Use the techniques and modern tools necessary for detecting the changes of biomolecules in living system
4.	Independently execute the experimental work by utilizing biotechnology related techniques towards life science problems

BE24373 Basic Biotechnology Lab Experiments	
Experiment-1	Demonstration of various instruments related to Biotechnology lab
Experiment-2	Preparation of various solutions and buffers.
Experiment-3	Aseptic techniques for microbial culture;
Experiment-4	Isolation of pure microbial culture and quantification of viable cell
Experiment-5	DNA isolation and its concentration measurement
Experiment-6	RNA isolation and its concentration measurement
Experiment-7	Amplification of nucleic acid using Polymerase Chain Reaction and electrophoresis
Experiment-8	Analysis of the recombinant plasmid using Restriction enzymes
Experiment-9	Isolation of carbohydrates and estimation
Experiment-10	Protein isolation and Separation

Text Books

1. J.G.Chirikjian, Biotechnology: Theory and Techniques (Plant Biotechnology, Animal Cell Culture and Immunobiotechnology), Jones & Bartlett Publishers, U.K., 1996.

2. Priyanka Siwach and Namita Singh: Molecular Biology (Principles and Practices), University Science Press, New Delhi
3. Gerczei Fernandez, Timea / Pattison, Scott: Biochemistry laboratory manual for undergraduates: An inquiry-based approach
4. K. Wilson and J. Walker (ed.), Practical Biochemistry, Principles and Techniques, Cambridge University Press, 1995.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	2	2	2	1	1	2	2	1	2	2	3	3
CO2	3	3	3	3	2	2	2	3	2	1	2	3	2	3

CO3	2	3	2	2	2	1	2	2	2	3	1	3	2	2
CO4	3	2	3	2	3	3	2	2	2	3	2	2	3	3

Grading: No correlation – 0, Low correlation- 1, Moderate correlation – 2, High Correlation- 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: **BE24453**
Course title: **Fundamental of Process Biotechnology**
Pre-requisite(s): **Nil**
Co- requisite(s): **Nil**
Credits: **4 L: 3 T: 1 P: 0**
Class schedule per week: 3
Class: **B. Tech**
Semester / Level: **IV**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To Understand the basic mechanism of bacterial growth
2.	To Understand the mechanism of action of enzyme
3.	To Sterilize liquid medium and air
4.	To Understand the operation of bioreactors and process of production of different metabolites

Course Outcomes

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

1.	Calculation of kinetic parameters and yield from bacterial growth curve
2.	Determining the effect of parameters on enzyme kinetics
3.	Sterilization of air and liquid medium
4.	For operation of culture of microorganisms and Production of different primary and secondary metabolites

Syllabus

MODULE	**(NO. OF LECTURE HOURS)**
Module-1: **Cell growth and kinetics**: Pattern of growth behaviour in batch culture, factors affecting the process of growth and model for Product formation, Mass balance, Yield prediction.	**8**
Module-2: **Enzyme kinetics:** Introduction to enzymes, Michaelis–Menten kinetics, Linear plots. Determining rate parameters, Effect of pH and temperature, Enzyme immobilization.	**8**
Module-3: **Sterilization:** Importance of Sterilization, Introduction and the kinetics of death, various type of sterilization equipment, role of oxygen transfer rate.	**8**
Module-4: **Production of primary and secondary metabolites:** Bioprocesses for production of organic acids; solvents; antibiotics, proteins; polysaccharides; lipids etc.	**8**
Module-5:	**8**

Bioreactors, **Mode of bioreactor operation:** Batch, Fed-batch and Continuous bioreactors, Operation and control of bioreactors.	

Text Books:

1 Michael L. Shuler, Fikret Kargi, Bioprocess Engineering – Basic Concepts, 2nd Ed., Pearson Education India, 2015

2. James Bailey, David Ollis, Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill Education, 2017

Reference Books:

1. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, 2nd Ed., Oxford University Press, 2003.
2. Pauline M. Doran, Bioprocess Engineering Principles, 2nd Ed., Academic Press, 2012

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) NIL

POS MET THROUGH GAPS IN THE SYLLABUS NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN NIL

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminar
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	Program Outcomes													
	PO1	**PO 2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
1.	3	2	1		3	2			1			2	2	2
2.	3	2	1		3	2			1			2	2	2
3.	3	2	1		3	2			1			2	2	2
4.	3	1		1		2	1	1	1	1	1	2		2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **24454**
Course title: **Process Biotechnology lab**
Pre-requisite(s):
Co- requisite(s): **Nil**
Credits: **1.5: L: 0 T: 0 P: 3**
Class schedule per week: 2
Class: **B. Tech**
Semester / Level: **VI**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Establish an understanding of the bacteria growth in liquid culturing conditions.
2.	To familiarize students with different parts of fermenter and fermentation process.
3.	To give them knowledge about preparation of standard plots for estimation of desired product and residual components.
4.	To expose students for mass balance calculation related with kinetics of enzyme/ cells.

Course Outcomes

After the completion of this course, students will be:

1.	Able to understand the role of media for growth.
2.	Able to know batch mode cultivation and mass balance analysis
3.	Capable of knowing the role of calibration process like pH, DO etc in fermentation systems
4.	Able to design experiments for enzyme catalysis both for free state and immobilized state.

<u>BE24454 Process Biotechnology Lab</u>

Experiment 1:	To study different parts of bioreactor and other accessories required during cultivation
Experiment 2:	To calibrate pH and DO sensors
Experiment 3:	To prepare a standard plot of protein
Experiment 4:	To prepare a standard plot of ammonia
Experiment 5:	To prepare a standard plot of sugar
Experiment 6:	To monitor growth of provided bacteria and mass balance
Experiment 7:	Immobilization of whole cells by entrapment
Experiment 8:	To perform kinetic study of hydrolyzing enzyme

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes	Program outcomes											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	1	1		1				1	2				2	3
2	3	2	3		2	2	3			3	1	1		3
3	1	3		2	2		2	2	3	3	2	1	2	

4	2	3	3		3	3			3		3		2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

VOCATIONAL COUSES

COURSE INFORMATION SHEET

Course code:	**BE24163**
Course title:	**Clinical Electrophysiology**
Pre-requisite(s):	**NA**
Co- requisite(s):	**NA**
Credits:	**3 L: 1 T: 0 P: 4**
Class schedule per week:	**03**
Class:	**B. Tech**
Semester / Level:	**II/1**
Branch:	**All**
Name of Teacher:	**Dr. Rakesh Kumar Sinha**

Course Objectives

This course enables the students:

1.	To introduce the concept of generation of body electricity.
2.	To understand the components of electrophysiological signal and its recorder.
3.	To record and analyze the different electrophysiological characteristics of human body.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the generation of cell potentials.
CO2	Learn and characteristics of human electrophysiological signals.
CO3	Record and evaluate the electrophysiological characteristics of living system.
CO4	Understand the application of electrophysiological signals in real life clinical applications.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module-1: General Physiology of Excitable System Action potential; Physiology of muscle, heart, lungs and neurons	**8**
Module-2: Electrodes and Transducers Types and characteristics of electrodes; electrodes for biosignal recording; Disposable electrodes; Important transducers in biomedical measurements.	**8**
Module-3: Biomedical Signals Electrocardiogram (ECG); Electromyogram (EMG); Electroencephalogram (EMG); Electrode arrangement for ECG, EMG and EEG recording.	**8**
Module-4: Recording and Processing of Signals Universal amplifier for biosignal recording; Concept and importance of unipolar and bipolar signal recording; Types of noises in biosignal recording and their removal.	**8**
Module-5: Biomedical Signal Applications Human-computer interface; Pacemakers; Defibrillators; Biosignal based rehabilitation system; Diagnostic and psychological application of biosignals.	**8**

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Text Books:

- Guyton, A.C. Medical Physiology, 8th/9th Intnl Edn., Philadelphia, W.B. Saunders, 2001/2006.
- Handbook for Biomedical Instrumentation by R. S. Khandpur, 3rd edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014.

Reference Books:

- E.R. Kandel & J. Shwartz (ed.): Principles of Neural Science, 3rd ed., 1991.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Laboratory experiments/ teaching aid
CD5	Seminar
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2				3			2	1					1
CO2	2	3		2	3			1	2			2		1
CO3	2	3	3	2	3			1	3		2	3	1	2
CO4		3	3	3	3				3		3	3	1	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD2, CD3, CD4

COURSE INFORMATION SHEET

Course code: **BE24164**
Course title: **Instrumental Methods of Analysis**
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L:1 T: 0 P: 4
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fifth/ Third
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

1.	Develop the ability to design and conduct experiments, including making measurements and interpreting experimental data from living system and addressing the problems associated with the interaction between living systems and nonliving materials.
2.	An understanding of the use of different instruments, discrimination of analytical data; and functions of different components of the selected instruments and their effects on data analysis.
3.	To develop expertise, an understanding of the range and theories of instrumental methods available in biological research/ biotechnology.
4.	To develop knowledge pertaining to the appropriate selection of instruments for the successful analysis of complex mixture.
5.	To provide an understanding of and skills in advanced methods of separation and analysis.
6.	To expand skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments.
7.	A clear understanding of bioanalytical technique prepares a student for making a career as R&D expert/ analyst/ quality control manager/ product development manager etc.
8.	Students are able to search, select, organize and present information related to bioinstrumentation.

Course Outcomes

After the completion of this course, students will be:

1.	able to apply knowledge of mathematics, science, and engineering and will be able to design and conduct experiments, as well as to analyze and interpret data related to the domain of Bioinstrumentation.
2.	able to design a system, component, or process to perform research in biological systems and address the challenges associated with Centrifugation Techniques and cell fractionation.
3.	able to understand, design and application of the processes of Spectroscopy and Thermal Analysis
4.	able to apply the knowledge of various types of industrially used Chromatographic Techniques
5.	able to understand the principle and design of different techniques in Characterization of proteins and nucleic acids.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module-I: Microscopic techniques Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining	**8**
Module-II: Cell fractionation Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient, analytical centrifugation, ultracentrifugation	**8**
Module-III: Spectroscopic Methods of Analysis Electromagnetic radiation, spectrum, Energy levels of atoms, Atomic Spectroscopy (AAS), Molecular Spectroscopy (UV-Vis), Magnetic Resonance Spectroscopy (NMR)	**8**
Module-IV: Chromatography Principle, Classification of Chromatographic methods, Chromatographic parameters, Paper chromatography, Column chromatography	**8**
Module-V: Characterization of proteins and nucleic acids Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE	**8**

Text Books:

1. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry. 3rd edition, Edward Arnold (Publishers) Ltd.
2. Willard, Merrit and Dean, Instrumental Methods and Analysis, 7th edition, D. Van Nostrand Company, Inc.
3. Ewing GW, Instrumental Methods of Chemical analysis. McGraw Hill Book Company.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS : NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Laboratory experiments/ teaching aid
CD5	Seminar
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	PSO1	PSO2	PSO3
1	3	3	2	3	3	2	3	3	3	3	3	3	3	3
2	3	3	2	3	3	2	3	3	3	3	3	3	3	3
3	3	3	2	3	3	2	3	3	3	3	3	3	3	3
4	3	3	2	3	3	2	3	3	3	3	3	3	3	3
5	3	3	2	3	3	2	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4, CD5
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

BE24263 – Vocational Course-III (Spawn and Mushroom Technology)

Course Code	**BE24263**
Course Title	**Mushroom Science and Technology**
Pre-requisite(s)	**Basic Microbiology or Plant Biology**
Credits	**3 (L:1 T:0 P:4)**
Class Schedule	**3 per week**
Class	**B. Tech. Biotechnology (Lateral Exit)**
Semester/Level	**Fifth**
Branch	**Bioengineering and Biotechnology or Allied Life Sciences**
Name of Teacher	

Course Objectives

This course aims to:

1.	Provide foundational knowledge of mushroom biology and taxonomy.
2.	Train students in spawn preparation, substrate management, and cultivation techniques.
3.	Equip learners with practical knowledge on pest/disease management and post-harvest operations.
4.	Introduce entrepreneurial opportunities and commercial aspects in mushroom farming.

Course Outcomes (COs)

Upon completion, students will be able to:

CO No.	**Course Outcome**
CO1	Understand the taxonomy, life cycle, morphology, and environmental requirements for edible mushrooms.
CO2	Demonstrate knowledge and practical skills in substrate preparation, spawn production, and mushroom cultivation.
CO3	Identify and manage pests and diseases affecting mushroom production using scientific approaches.
CO4	Evaluate post-harvest handling, processing, storage, and business strategies in mushroom-based enterprises.

Syllabus

MODULE	**(NO. OF LECTURE HOURS)**
Module-I: Introduction to Mushroom Science Overview of Mushroom Science and Technology, Classification and Types of Mushrooms, Life Cycle and Morphology of Mushrooms, Environmental Requirements for Mushroom Growth	**8**
Module-II: Substrate Preparation and Spawn Production Techniques Types of Substrates Used in Mushroom Cultivation, Methods of Substrate Preparation, Introduction to Spawn Production, Types of Spawn (Grain, Sawdust, Liquid and synthetic spawn), Quality Control in Spawn Production	**8**

Module-III: Cultivation Techniques for Different Mushrooms Cultivation of *Agaricus bisporus* (Button Mushroom), Cultivation of *Pleurotus spp.* (Oyster Mushroom), Cultivation of *Lentinula edodes* (Shiitake Mushroom)	**8**
Module-IV: Pest and Disease Management in Mushroom Farming Common Pests in Mushroom Cultivation, Common Diseases in Mushroom Cultivation, Prevention and Control Methods	**8**
Module-V: Post-Harvest Handling and Commercial Aspects Harvesting Techniques, Post-Harvest Handling and Storage, Processing and Packaging of Mushrooms, Economic Analysis and Business Planning, Marketing Strategies for Mushroom Products	**8**

Textbooks

1. Singh, R.S. (2009). *Mushroom Cultivation*. CBS Publishers.
2. Chang, S.T. and Miles, P.G. (2004). *Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact*. CRC Press.

Reference Books

1. Kumar, V., Sharma, V. (2015). *Mushroom Production and Processing Technology*. Agrobios.
2. Garcha, H.S. (1997). *Mushroom Growing*. Chandigarh University Press.
3. Zadrazil, F. & Grabbe, K. (1990). *Spawn Preparation and Mushroom Growing*. FAO.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Laboratory experiments/ teaching aid
CD5	Seminar
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1:	3	2	2	1	1	1	1	0	0	1	1	3	2	1
CO2:	3	3	3	2	2	1	1	1	1	2	2	3	3	2
CO3:	3	3	3	2	2	2	1	1	1	2	2	3	3	2
CO4:	2	2	2	2	1	2	2	1	1	1	2	3	2	2

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4, CD5
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: **BE 24264**
Course title: **FUNDAMENTALS OF NANOSCALE TECHNOLOGY**
Pre-requisite(s):
Co- requisite(s):
Credits: **3** L: 01 T:00 P:04
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: ----
Branch: **Biotechnology**
Name of Teacher: **Dr. Sneha Singh**

Course Objectives
This course enables the students:

1.	To gain knowledge about the various concepts and interdisciplinary aspect of nanoscale technology.
2.	To learn the principle and phenomena governing the nanoscale effect on material properties and their applicability
3.	To gain a working knowledge and skills in nanoscale fabrication of materials their in-depth characterization and acquire the ability to use them to solve engineering problems
4.	To correlate the impact of nanoscience and nanotechnology in a global, economic, environmental, and societal context.
5.	To identify career paths at the interface of nanotechnology, biotechnology, environmental and agricultural engineering, medicine and research.

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

1.	Understand the fundamentals of nanoscale phenomena, science at nanoscale.
2.	Acquire the knowledge and skill in various visualization and characterization techniques for nanomaterials
3.	Acquire the in-depth knowledge and skill to fabricate nanomaterials using different nano-fabrication methods, their advantages and disadvantages
4.	Familiarize themselves with nanomaterials potentialities and emerging applications

FUNDAMENTALS OF NANOSCALE TECHNOLOGY

MODULE	(NO. OF LECTURE HOURS)
Module-1: Introduction: Definitions and concept, Historical background, Nanoscale phenomena & Properties, nanomaterials classification, Nano system in nature, biomimetics	**8**
Module-2: Characterization techniques: Spectroscopy (UV-Vis, FT-IR) Electron microscopy, light scattering, Zeta potential, AFM, EDAX	**8**
Module-3: Synthesis of Nanomaterials I: Top-Down approaches, Advantages & Limitation, Applications	**8**
Module-4: Synthesis of Nanomaterials II: Bottom-Up approaches, Advantages & Limitation, Applications	**8**
Module-5: Emerging applications:	**8**

Biosensors & Nanobiosensors, Drug delivery, Nanomedicine, Bioimaging, Environmental remediation, Industrial applications	

Text Books:

1. Murty, B. S., Shankar, P., Raj, B., Rath, B. B., & Murday, J. (2013). Textbook of nanoscience and nanotechnology. Springer Science & Business Media.
2. T. Pradeep (2012). A Textbook of Nanoscience and Nanotechnology. Tata McGraw Hill Education Pvt. Ltd.

Reference Materials:

Class lectures, Laboratory manual, e-resources

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Continuous Internal Assessment	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Laboratory experiments/ teaching aid
CD5	Seminar

CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcome #	**Program Outcomes**											**PSO**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	**PSO1**	**PSO2**	**PSO3**
1	3	3			3	2	2	1	1		1	**3**	**3**	**2**
2	3	3	3	3	3	2	2	1	1		1	3	3	3
3	3	2	3	3	3	2	2	1	1		1	3	3	3
4			3		3	2	2	1	1		1	3	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4, CD5
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3