KLE Technological University | Creating Value, Leveraging Knowledge

Curriculum Structure and Curriculum Content for the Batch:2022-26
Department: Biotechnology
Program: B.E. Biotechnology

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Vision

KLE Technological University will be a national leader in Higher Education–recognised globally for innovative culture, outstanding student experience, research excellence and social impact.

Mission

KLE Technological University is dedicated to teaching that meets highest standards of excellence, generation and application of new knowledge through research and creative endeavors.

The three-fold mission of the University is:

- To offer undergraduate and post-graduate programs with engaged and experiential learning environment enriched by high quality instruction that prepares students to succeed in their lives and professional careers.

- To enable and grow disciplinary and inter-disciplinary areas of research that build on present strengths and future opportunities aligning with areas of national strategic importance and priority.

- To actively engage in the Socio-economic development of the region by contributing our expertise, experience and leadership, to enhance competitiveness and quality of life.

As a unified community of faculty, staff and students, we work together with the spirit of collaboration and partnership to accomplish our mission.

Vision and Mission Statements of the School / Department

Vision

The KLE Tech – Department of Biotechnology will excel and lead in education, research and innovation in Biotechnology contributing to the evolving needs of the society.

Mission

- To provide an excellent educational experience to undergraduate students of Biotechnology through quality teaching, relevant curriculum and effective research experience that enables students to become leaders in their chosen field.

- To provide scholarly, vibrant learning and research environment that enables to achieve personal and professional development.

- To cater to the societal needs and serve the communities at local, national and international levels combined with a deep awareness of ethical responsibilities to profession and society.

Program Educational Objectives/Program Outcomes and Program-Specific Objectives

Program Educational Objectives -PEO's
Graduates will demonstrate peer- recognized technical competency in the analysis, design and development of solutions for Molecular Biotechnology and Bioprocess Engineering.
Graduates will demonstrate leadership and initiative to advance professional and organizational goals with commitment to ethical standards of profession, teamwork and respect for diverse cultural background
Graduates will be engaged in ongoing learning and professional development through pursuing higher education, and self-study
Graduates will be committed to creative practice of engineering and other professions in a responsible manner contributing to the socio-economic development of the society
Program Outcomes-PO's
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.
Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
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)
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).
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)
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).
Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
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
Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
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)
Program Specific Objectives -PSO's
Demonstrate adequate proficiency of good laboratory practices in terms of accuracy & precision, safety, ethics and reproducibility and able to follow standard operating procedures (SOP).
Demonstrate proficiency of Bioprocess Technology towards development of processes and products in global context.
Apply the knowledge of engineering & applied science to demonstrate research aptitude/skills in frontier areas of biotechnology.

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Curriculum Structure-Overall

Semester :								**Total Program Credits:178**	
Course with course code	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
	Single Variable Calculus 18EMAB101 (4-1-0)	Multivariable Calculus 18EMAB102 (4-1-0)	NMDE 20EMAB205 (4-0-0)	Biostatistics 20EMAB210 (3-1-0)	Genetic Engineering & Applications 24EBTC301 (4-0-0)	Bioprocess Engineering 24EBTC306 (4-0-0)	Downstream Processing Technology 22EBTC401 (4-0-0)	Capstone project 20EBTW402 (0-0-11)	Internship project 20EBTW494 (0-0-11)
	Engineering Physics 15EPHB102 (3-0-0)	Engineering Chemistry 15ECHB101(3-0-0)	Microbiology 15EBTC201 (4-0-0)	Immunology 15EBTC203 (3-0-0)	Bioinformatics 22EBTC301 (4-0-0)	Bioprocess Control & Automation 24EBTC302 (4-0-0)	Bioprocess Equipment Design 24EBTC402 (3-0-0)	**Program Elective - 06** XXEBTE4XX (3-0-0)	Internship training 18EBTI493 (0-0-6)
	C Programming for problem solving 18ECSP101 (0-0-3)	Engineering Mechanics 15ECVF102(4-0-0)	Biochemistry 15EBTC202 (4-0-0)	Enzyme Technology 17EBTC201 (4-0-0)	Reaction Engineering 24EBTC303 (4-0-0)	**Program Elective –01** XXEBTE3XX (3-0-0)	**Program Elective– 03** XXEBTE4XX (3-0-0)		
	Engineering Exploration 15ECRP101 (0-0-3)	Computer Aided Engineering Drawing 15EMEP101(0-0-3)	Bioprocess Calculations 15EBTF201 (4-0-0)	Cell &Molecular Biology 23EBTC205 (4-0-0)	Biological Thermodynamics 24EBTC304 (3-0-0)	**Program Elective – 02** XXEBTE3XX (3-0-0)	**Program Elective - 04** XXEBTE4XX (3-0-0)	**Open Elective** Industrial Waste Management 19EBTO401 (3-0-0)	
	Basic Electronics 18EECF102 (4-0-0)	Problem Solving with Data Structures 18ECSP102 (0-0-3)	Unit operations- 22EBTF201 (3-0-0)	Unit operations-II 22EBTF202 (3-0-0)	Research Methodology 24EBTC305 (3-0-0)	Humanities – 01 **(HSC)** (PALR) 16EHSC301 (3-0-0)	**Program Elective - 05** XXEBTE4XX (3-0-0)		
	Basic Mechanical Engg 15EMEF101 (2-1-0)	Design Thinking for Social Innovation 20EHSP101 (0-1-1)	Corporate Communication 22EHSH201(0.5-0-0)	Problem solving &Analysis 22EHSH202 (0.5-0-0)	Arithmetical Thinking & Analytical reasoning 22EHSH301 (0.5-0-0)	Industry readiness & leadership skills 22EHSH302 (0.5-0-0)	Humanities -02 **(HSC)** CIPE & EVS 15EHSA401 *Audit*		
	Applied Physics Lab 21EPHP102 0-0-1	Engineering Physics Lab 16EPHP102 (0-0-1)	Microbiology Lab 15EBTP201 (0-0-1)	Enzyme Technology Lab 15EBTP204 (0-0-1)	Mini Project 15EBTW301 (0-0-3)	Minor Project 24EBTW302 (0-0-6)	Senior Design Project 20EBTW401 (0-0-6)		
		Professional Communication 15EHSH101 (1-1-0)	Biochemistry Lab 15EBTP202 (0-0-1)	Cell & Molecular Biology Lab15EBTP205 (0-0-1)	Genetic Engineering & Immunotechnology Lab 23EBTP301 (0-0-1)	Bioprocess Engineering Lab 23EBTP303 (0-0-1)	Downstream Processing Technology Lab 23EBTP401 (0-0-1)		
			Unit operations-I Lab 17EBTP201 (0-0-1)	Unit Operations-II Lab 17EBTP202 (0-0-1)	Bioinformatics Lab 22EBTP302 (0-0-1)	Bioprocess Control & Reaction Engineering Lab 23EBTP301 (0-0-1)	Mammalian cell culture techniques Lab 23EBTP402 (0-0-1)		
Credits	**21**	**23**	**22.5**	**21.5**	**23.5**	**25.5**	**24**	**17**	

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Curriculum Structure-Semester wise

Semester - I

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	18EMAB101	Single Variable Calculus	BS	4-1-0	5	6	50	50	100	3 Hours
2	22EPHB102	Engineering Physics	BS	3-0-0	3	3	50	50	100	3 Hours
3	18ECSP101	C Programming for Problem solving	ES	0-0-3	3	6	80	20	100	3 Hours
4	22ECRP101	Engineering Exploration	ES	0-0-3	3	6	80	20	100	3 Hours
5	18EECF102	Basic Electronics	ES	4-0-0	4	4	50	50	100	3 Hours
6	15EMEF101	Basic Mechanical Engg.	ES	2-1-0	3	4	50	50	100	3 Hours
7	21EPHP102	Applied Physics Lab	BS	0-0-1	2	2	50	50	100	3 Hours
TOTAL				**13-2-7**	**22**	**31**				

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Semester - II

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	18EMAB102	Multivariable Calculus	BS	4-1-0	5	6	50	50	100	3 hours
2	22ECHB101	Engineering Chemistry	BS	3-0-0	3	3	50	50	100	3 hours
3	15ECVF102	Engineering Mechanics	ES	4-0-0	4	4	50	50	100	3 hours
4	15EMEP101	Computer Aided Engineering Drawing	ES	0-0-3	3	6	80	20	100	3 hours
5	18ECSP102	Problem Solving with Data Structures	ES	0-0-3	3	6	80	20	100	3 hours
6	20EHSP101	Design Thinking for Social Innovation	HSS	0-1-1	2	4	80	20	100	3 hours
7	15EHSH101	Professional Communication	HSS	1-1-0	2	3	50	50	100	3 hours
TOTAL				**12-2-5**	**22**	**32**				

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Semester- III

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	20EMAB205	Numerical Methods and Differential Equations	BS	4-0-0	4	4	50	50	100	03 Hours
2	15EBTC201	Microbiology	PSC	4-0-0	4	4	50	50	100	03 Hours
3	15EBTC202	Biochemistry	PSC	4-0-0	4	4	50	50	100	03 Hours
4	15EBTF201	Bioprocess Calculations	ES	4-0-0	4	4	50	50	100	03 Hours
5	22EBTF201	Unit Operations-I	ES	3-0-0	3	3	50	50	100	03 Hours
6	22EHSH201	Corporate Communication	HSH	0.5-0-0	0.5	1	100	00	100	NA
7	15EBTP201	Microbiology Lab	PSC	0-0-1	1	2	80	20	100	03 Hours
8	15EBTP202	Biochemistry Lab	PSC	0-0-1	1	2	80	20	100	03 Hours
9	17EBTP201	Unit Operations-I Lab	ES	0-0-1	1	2	80	20	100	03 Hours
		TOTAL		**19.5-0-3**	**22.5**	**26**				

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Semester- IV

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	20EMAB210	Biostatistics	BS	3-1-0	4	5	50	50	100	03 Hours
2	15EBTC203	Immunology	PSC	3-0-0	3	3	50	50	100	03 Hours
3	17EBTC201	Enzyme Technology	PSC	4-0-0	4	4	50	50	100	03 Hours
4	15EBTC205	Cell &Molecular Biology	PSC	4-0-0	4	4	50	50	100	03 Hours
5	22EBTF202	Unit Operations-II	ES	3-0-0	3	3	50	50	100	03 Hours
6	22EHSH202	Problem Solving & Analysis	HSH	0.5-0-0	0.5	1	100	00	100	NA
7	15EBTP204	Enzyme Technology Lab	PSC	0-0-1	1	2	80	20	100	03 Hours
8	15EBTP205	Cell & Molecular Biology Lab	PSC	0-0-1	1	2	80	20	100	03 Hours
9	17EBTP202	Unit Operations-II Lab	PSC	0-0-1	1	2	80	20	100	03 Hours
TOTAL				**17.5-1-3**	**21.5**	**26**				

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Semester- V

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	15EBTC301	Genetic Engineering & Applications	PSC	4-0-0	4	4	50	50	100	03 Hours
2	22EBTC301	Bioinformatics	PSC	4-0-0	4	4	50	50	100	03 Hours
3	15EBTC303	Reaction Engineering	PSC	4-0-0	4	4	50	50	100	03 Hours
4	15EBTC304	Biological Thermodynamics	PSC	3-0-0	3	3	50	50	100	03 Hours
5	15EBTC305	Research Methodology	PSC	3-0-0	3	3	50	50	100	03 Hours
6	22EHSH301	Arithmetical Thinking & Analytical Reasoning	HSH	0.5-0-0	0.5	1	100	00	100	NA
7	15EBTW301	Mini Project	PRJ	0-0-3	3	9	50	50	100	03 Hours
8	23EBTP301	Genetic Engineering & Immunotechnology Lab	PSC	0-0-1	1	2	80	20	100	03 Hours
9	22EBTP302	Bioinformatics Lab	PSC	0-0-1	1	2	80	20	100	03 Hours
TOTAL				**18.5-0-5**	**23.5**	**32**				

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Semester- VI

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	15EBTC306	Bioprocess Engineering	PSC	4-0-0	4	4	50	50	100	03 Hours
2	19EBTC302	Bioprocess Control & Automation	PSC	4-0-0	4	4	50	50	100	03 Hours
3	XXEBTE3XX	Program Elective - 01	PE	3-0-0	3	3	50	50	100	03 Hours
4	XXEBTE3XX	Program Elective - 02	PE	3-0-0	3	3	50	50	100	03 Hours
5	16EHSC301	Humanities – 01 (PALR)	HSC	3-0-0	3	3	50	50	100	03 Hours
6	22EHSH302	Industry Readiness & Leadership Skills	HSH	0.5-0-0	0.5	1	100	00	100	NA
7	15EBTW302	Minor Project	PRJ	0-0-6	6	18	50	50	100	03 Hours
8	22EBTP303	Bioprocess Engineering Lab	PSC	0-0-1.5	1.5	3	80	20	100	03 Hours
9	19EBTP304	Bioprocess Control & Reaction Engineering Lab	PSC	0-0-1.5	1.5	3	80	20	100	03 Hours
		TOTAL		**17.5-0-8**	**25.5**	**40**				

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Semester- VII

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	22EBTC401	Downstream Processing Technology	PSC	4-0-0	4	4	50	50	100	03 Hours
2	15EBTC402	Bioprocess Equipment Design	PSC	3-0-0	3	3	50	50	100	03 Hours
3	XXEBTE4XX	Program Elective - 03	PE	3-0-0	3	3	50	50	100	03 Hours
4	XXEBTE4XX	Program Elective - 04	PE	3-0-0	3	3	50	50	100	03 Hours
5	XXEBTE4XX	Program Elective - 05	PE	3-0-0	3	3	50	50	100	03 Hours
6	15EHSA401	Humanities – 02 (CIPE & EVS)	HSA	*Audit*						
7	20EBTW401	Senior Design Project	PRJ	0-0-6	6	18	50	50	100	03 Hours
8	23EBTP401	Downstream Processing Technology Lab	PSC	0-0-1	1	2	80	20	100	03 Hours
9	23EBTP402	Mammalian Cell Culture Techniques Lab	PSC	0-0-1	1	2	80	20	100	03 Hours
TOTAL				**16-0-8**	**24**	**38**				
9	17EBTE490	Research Experience for Undergraduates (REU)	PE	0-0-6	6	18	50	50	100	03 Hours
TOTAL				**0-0-6**	**6**	**18**				

Semester- VIII

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	XXEBTE4XX	Program Elective -06	PE	3-0-0	3	3	50	50	100	03 Hours
2	19EBTO401	Open Elective	OE	3-0-0	3	3	50	50	100	03 Hours
3	20EBTW402	Capstone Project	PRJ	0-0-11	11	33	50	50	100	03 Hours
TOTAL				**6-0-11**	**17**	**39**				
4	18EBTI493	Internship-Training	--	0-0-6	6	--	50	50	100	03 Hours
5	20EBTW494	Internship-Project	PRJ	0-0-11	11	**33**	50	50	100	03 Hours
TOTAL				**0-0-17**	**17**					

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Semester	I	II	III	IV	V	VI	VII	VIII	**Total**
Credits	21	23	22.5	21.5	23.5	25.5	24	17	**178**

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List of Open Electives

Sr.No	Name of the Course	Course Code
1	Industrial waste management	19EBTO401

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List of Program Electives

Sr.No	Name of the Course	Course Code
1	Bioprocess Plant Design and economics	18EBTE301
2	Bioprocess Modeling and simulation	18EBTE302
3	Insilco Modeling and Drug Design	15EBTE302
4	Bioanalytical Techniques	19EBTE301
5	Structural Biology	22EBTE301
6	Industrial Biotechnology	20EBTE401
7	Food Processing Technology	15EBTE402
8	Environmental Biotechnology	22EBTE401
9	Quality Assurance and regulations	18EBTE403
10	Process Safety and Risk Assessment in industrial biotechnology	22EBTE402
11	Plant and Animal Biotechnology	15EBTE403
12	Biopharmaceuticals	15EBTE404
13	Genomics and Proteomics	15EBTE405
14	Bioethics, safety and IPR	20EBTE403
15	Vaccine Technology	21EBTE401
16	Biological Data Analysis	18EBTE402
17	Genomic data analysis	21EBTE402
18	Bio-business and entrepreneurship	20EBTE402
19	Phytochemicals and Herbal products	22EBTE403
20	Clinical Biotechnology	23EBTE303

Program: Biotechnology		**Semester: I**
Course Title: Single variable Calculus		**Course Code:18EMAB101**
L-T-P:4-1-0	**Credits:05**	**Contact Hours:50**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:04	**Examination Duration:3 Hours**	

Unit I

1.Functions, Graphs and Models

Functions, types of functions, transformations and models (Linear, exponential, trigonometric).

07 Hours

MATLAB: Graphing functions, Domain-Range and Interpreting the models

2. Calculus of functions and models

Limit of a function, Infinite limits- graph, Continuity and discontinuity, Intermediate value theorem statement, Roots of the equation using Bisection Method and Newton- Raphson Method. Interpretation of derivative as a rate of change, All the rules of derivatives (List only), Maxima, Minima and optimization problems. Curvature and Radius of Curvature, Indeterminate forms, L- Hospital's rule-Examples

13 Hours

MATLAB: optimization problems. Curvature problems

Unit II

3. Infinite Series

Definition, Convergence of series, Tests of convergence – p-series, Alternating series. Power series, radius of convergence, Taylor's and Maclaurin's series, Applications of Taylor's and Maclaurin's series

06 Hours

MATLAB: Convergence of series

4. Integral calculus

Tracing of standard curves in Cartesian form ,Parametric form and Polar form; Beta and gamma function, relation between them, evaluation of integrals using Beta and gamma functions;

Applications to find arc length, Area, Volume and surface area (Cartesian, parametric and polar curves). Approximate integration- Trapezoidal rule, Simpson's 1⁄3 rule

14 Hours

MATLAB: problems on arc length, area, volume and surface area

Unit III

5. Ordinary differential equations of first order

(a) Introduction to Initial Value problems. Linear and Bernoulli's equations, Exact equations and reducible to exact form, Numerical solution to Initial Value problems-Euler's method, Modified Euler's method and Runge-Kutta method

(b) Applications of first order differential equations-Orthogonal trajectories growth and decay problems, mixture problems, Electrical circuits, falling bodies.

10 Hours

MATLAB: Solve differential equations

Text Books

1. Early Transcendentals Calculus- James Stewart, Thomson Books, 7ed 2010

Reference Books:

1. Calculus Single and Multivariable, Hughues-Hallett Gleason, Wiley India Ed, 4ed, 2009.
2. Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010
3. Calculus- Early Transcendentals, Anton, Bivens, Davis,10ed, Wiley India, 2012

(Use this template for all courses, semester wise)

BACK

Program: Biotechnology		Semester: I
Course Title: Engineering Physics		Course Code:22EPHB102
L-T-P:3-0-0	Credits:03	Contact Hours:40
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hours	

UNIT-I

1.Concept of Motion- Kinematics in One Dimension: Introduction, motion diagrams, particle model, position and time, linear velocity and acceleration, uniform motion, instantaneous velocity, finding position from velocity, motion with constant acceleration, free fall motion on an inclined plane, instantaneous acceleration, numericals.

06 Hours

2. Kinematics in Two Dimensions: Introduction to vectors, properties of vectors, co-ordinate systems and vector components, vector algebra. Position, velocity and acceleration vectors, projectile motion, relative motion, uniform circular motion, velocity and acceleration in uniform circular motion, non-uniform circular motion and angular acceleration, numericals.

06 Hours

3. Force and Motion: Concept of force, identifying forces, a virtual experiment, Newton's first law, Newton's second law, free-body diagrams, applications.

04 Hours

UNIT – II

4. Dynamics I: Equilibrium using Newton's second law, friction, drag, Newton's third law, analyzing interacting objects, Newton's third law, applications.

05 Hours

5.Dynamics II: Motion in a plane, dynamics in two dimension, velocity and acceleration in uniform circular motion, dynamics of uniform circular motion, fictitious forces, non-uniform circular motion, numericals.

06 Hours

6. Impulse and Momentum: Momentum and impulse, problems, conservation of momentum, inelastic collisions, explosion, momentum in two dimensions, numericals.

05 Hours

UNIT – III

7. Quantum Mechanics: Introduction, dual nature of matter waves, De-Broglie concept of matter waves, Davission and Germer Experiment, Heisenberg's uncertainty principle, 1-D Schrodinger wave equation (qualitative). Physical significance of wave function, particle in a box (qualitative), Eigen functions and Eigen values, discretization of energy.

03 Hours

8. Nanoscience and its applications: Introduction, length scales, scaling effect (surface-volume ratio, quantization, dandling bonds, defects and self-assembly-qualitative), density of states and confinement of electron energy states in 3D, 2D, 1D and 0D systems (qualitative treatment), change in material properties from bulk to nanostructures, variation of physical properties (mechanical, optical, electric, magnetic, chemical) from bulk to thin films to nano-materials, nano-particle examples: metal (magnetic and non-magnetic), Graphene, carbon nanotubes, biological nanoparticles**.**

05 Hours

Text Books:

1. Randall D Knight, Physics for Scientists and Engineers, Pearson publication, 3e (2008)
2. Aurther Beiser, Concepts of Modern Physics, 6e, Tata McgrawHills, (2003)
3. Sulbha Kulkarni, Nanotechnology Principles and practices, 3e, Springer.

Reference Books:

1. John W Jewett and Raymond A Serway, Physics for Scientists and Engineers with modern physics, Cengage publication, India Edition, 9e (2014)
2. Hans C Ohanian & John T Markert, Physics for Engineers and Scientists, W W Norton and Company, Vol-1, 3e (2006)
3. A.K. Bandopadhya, Nanomaterials, New Age Publishers, (2004)
4. S.K. Prasad, Advanced nano technology, Discovery publishing house Pvt. Ltd New Delhi

BACK

Program: Biotechnology		Semester: I
Course Title: C Programming for Problem Solving		Course Code:18ECSP101
L-T-P:0-0-3	Credits:3	Contact Hours: 6
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:78	Examination Duration:3 Hours	

1.Introduction to Problem solving

Introduction to algorithms / flowcharts and its notations, top down design, elementary problems.

03 Hours

2.Basics of C programming language

Characteristics and uses of C, Structure of C program, C Tokens: Keywords, Identifiers, Variables, Constants, Operators, Data-types, Input and Output statements.

15 Hours

3.Decision control statements

Conditional branching statements: if statement, if else statement, else if ladder, switch statement, unconditional branching statements**:** break, continue.
Introduction to Debugging Skills
Introduction to Test Driven Programming.

12 Hours

4.Iterative statements

while, do while, for, nested statements

10 Hours

5.Functions

Introduction, Function declaration, definition, call, returns statement, passing parameters to functions, introduction to macros.
Introduction to Coding Standards

10 Hours

6.Arrays and Strings

Introduction, Declaration, Accessing elements, Storing values in arrays, Operations on one dimensional array, Operations on two dimensional arrays, Introduction to Code Optimization and refactoring

15 Hours

7.Pointers

Introduction, declaring pointer, pointer variables, pointer expression and arithmetic, passing arguments to functions using pointers, pointers and arrays, passing an array to a function.

08 Hours

8.Structures and Unions

Introduction, passing structures to functions, Array of structures, Unions

05 Hours

Text Books:

1. R.G.Dromey, How to Solve it by Computer, 1ed, PHI, 2008.
2. Yashvant Kanetkar, Let us C, 15th ed, BPS Publication, 2016.

Reference Books:

1. B W Kernighan, D M Ritchie, The Programming language C, 2ed, PHI, 2004.
2. B S Gottfried, Programming with C, 2ed, TMH, 2006.
3. B.A. Forouzan, R.F. Gilberg, A Structured Program Approach Using C, 3ed, CENGAGE Learning, 2008.
4. C Programming: A Modern Approach, 2nd Edition, K. N. King, 2008
5. Head First C, David Griffiths, Dawn Griffiths, O'Reilly Media Publications, 2012

BACK

Program: Biotechnology		Semester: I
Course Title: Engineering Exploration		**Course Code:15ECRP101**
L-T-P:0-0-3	**Credits:3**	**Contact Hours:78**
ISA Marks:80	**ESA Marks:20**	**Total Marks:100**
Teaching Hours:78	**Examination Duration:3 Hours**	

1.Introduction to Engineering and Engineering Study **01 Hours**

2.Role of Analysis in Engineering, Analysis Methodology **02 Hours**

3.Data Analysis Graphing **02 Hours**

4.Basics of Engineering Design, Multidisciplinary Nature of Engineering Design **05 Hours**

5.Project Management **01 Hours**

6.Sustainability in Engineering **02 Hours**

7.Ethics **01 Hours**

8.Modeling, Simulation and Data Acquisition using Software Tool **01 Hours**

9.Platform based development : Arduino **03 Hours**

10.Course Project **03 Hours**

Reference Books:

1. Engineering Fundamentals & Problem Solving by ArvidEide, Roland Jenison, Larry Northup, Steven, McGrawHill Higher Education, 6th Edition (2011)
2. Engineering Exploration (Edited Book, 2008) by Pearson Publication.

BACK

Program: Biotechnology		Semester: I
Course Title: Basic Electronics		Course Code:18EECF102
L-T-P:4-0-0	Credits:4	Contact Hours:4
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50 Hrs	Examination Duration:3 Hours	

Unit I

Chapter 1: Overview of Electronics in Mechanical Engineering

Definition & overview of Mechatronics, Mechatronics and Design Innovation, Mechatronics and Manufacturing, Mechatronics and Education; Typical Mechatronics Components; Sensors and Transducers.

03 Hours

Chapter 2: Semiconductor Devices and Applications:

PN junction diode, characteristics and parameters, diode approximations, half wave rectifier, full wave bridge rectifier, full wave bridge rectifier capacitor filter, Zener diode, Voltage regulator design, BJT, Darlington Pair, JFET, MOSFET, UJT, SCR.

10 Hours

Chapter 3: Operational Amplifiers:

Ideal op-amp characteristics, op-amp applications: Comparator, Inverting amplifier, Non-inverting amplifier, Voltage follower, Integration, Differentiation, Adder, Subtractor and numerical as applicable.

08 Hours

Unit II

Chapter 4: Digital Logic:

Digital Number system: Binary & Hexadecimal number systems, Conversion, BCD Number system, Gray code, Data word representation , Binary Arithmetic, Boolean Algebra, Logic gates, Combinational & Sequential circuits, Adders, Flip-Flops, Registers, Counters, Multiplexer.

Introduction to Digital Electronics (Text-2):

Introduction, Switching and Logic Levels using circuits, Digital Waveform (Sections 9.1to 9.3).Number system: Binary, Octal Decimal and Hexadecimal, Inter Conversion, BCD Number system, Gray code, Data word representation , Binary Arithmetic, Boolean Algebra: Laws, rules & theorems of Boolean algebra, Sum of products form (SOP), products of sum form (POS) of Boolean functions. Study of Karnaugh Maps (K-maps) for 2, 3 & 4 variables only. Logic gates, Adders, Encoder, Decoder, Multiplexer and Demultiplexer. Combinational & Sequential circuits, Latches and Flip-Flops(SR, JK, D, T),

13 Hours

Chapter 5: Sensors and Transducers :

Introduction, Classification of sensors and transducers, Contact type – Mechanical switches, Non-contact type - proximity sensors & Hall sensors, principle of working of light sensors, Future Challenges.

06 Hours

Unit III

Chapter 6: Signal Conditioning:

Analog & Digital signals, Digital to Analog Conversion, R-2R DAC, Analog to Digital Conversion, SAR ADC, Data Acquisition.

06 Hours

Chapter 7: Case Studies of Mechatronic Systems:

Automatic Camera, Drilling Machine, Bar code reader.

06 Hours

Text Books

1. David A Bell, “Electronic devices and Circuits” , PHI New Delhi, 2004.
2. Morris Mano, “Digital logic and Computer design” 21st Indian print Prentice Hall India, 2000.
3. W.Bolton, "Mechatronics - Electronic Control Systems in Mechanical and Electrical

Engineering", 3rd edition Pearson Education, 2005.

4. David Bradley and David W., “Mechatronics in Action”, 2nd edition, Springer, 2010

Reference Books:

1. David G Alciatore, Michael B Histand, “Introduction to Mechatronics and Measurement Systems”, TMH 3rd edition, 2007.
2. K.A Krishnamurthy and M.R.Raghuveer, “Electrical, Electronics and Computer Engineering for Scientist and Engineers”, Second Edition New Age International Publishers, Wiley Eastern, 2001.
3. P. Malvino, “Electronic Principles” Sixth edition Tata McGraw Hill, 1999.
4. Floyd, “Digital fundamentals” Third Edition Prentice Hall India, 2001
5. BoylesteadNashelsky, “Electronic devices & Circuit theory” Sixth Edition Prentice Hall India, 2000.
6. RamakantGayekawad “Operational Amplifiers & applications” 3rd Edition, PHI, 2000.

BACK

Program: Biotechnology				**Semester: I**
Course Title: Basic Mechanical Engineering				**Course Code:15EECF101**
L-T-P:2-1-0	**Credits:3**			**Contact Hours:4**
ISA Marks:50	**ESA Marks:50**			**Total Marks:100**
Teaching Hours:50	**Examination Duration:3 Hours**			

Chapter	Contents	Hours	Tutorial	Sessions
	Unit I			
1	**Introduction to Mechanical Engineering:** Definition of engineering, Mechanical Engineering, Branches of Mechanical Engineering, Who are Mechanical Engineers?, Mechanical Engineers' top ten achievements.	2	Visit to Workshop and Machine Shop, Tools, Safety Precautions Video presentations	1
2	**Manufacturing Engineering: Basics of Manufacturing** What is manufacturing?, The main manufacturing sectors, The importance of the main manufacturing sectors to the Indian economy, Scales of production Classification of manufacturing Processes. Advances in Manufacturing: CNC machines, Mechatronics and applications	8	Demonstration on working of Lathe, milling, drilling, grinding machines Demonstration on Welding (Electric Arc Welding, Gas Welding, Soldering) Demonstration and Exercises on Sheet metal work. Visit to Learning Factory	5

	Unit II			
3	**Design Engineering: Power Transmission Elements** Overview Design Application: • Belt Drives. Types, Length of Belt. Velocity Ratio, Initial Tension. Ratio of Tensions. Power Transmitted, Numerical Problems. • Gears. Spur Gear, Rack and Pinion, Worm Gear, Bevel Gear, Helical Gears. Speed, Torque, and Power in Gear pair. Simple and Compound Gear trains. Numerical Problems. • Ball and Roller Bearings, Types, Applications.	6	Design Problems like a moving experience, aluminium can crusher Video presentations	5
4	**Thermal Engineering 1: Prime Movers.** Internal Combustion Engines: Classification, IC engine parts, 2 stroke SI and CI engine, 4 Stroke SI and CI Engine, PV diagrams of Otto and Diesel cycles, Comparison of 2 stroke and 4 stroke engine, comparison of CI and SI engine, Problems on Engine Performance, Future trends in IC engines.	4	Case study on power requirement of a bike, car or any machine Video presentations	1
	Unit III			
5	**Thermal Engineering 2: Thermal Systems' Applications** Refrigeration system, Air conditioning system, Pumps, Blowers and Compressors,	5	Case study on selection of various thermal systems Video presentations	1

	Turbines, and their working principle and specifications.			

Text Books:

1. Jonathan Wickert and Kemper Lewis, An Introduction to Mechanical Engineering, Third Edition, 2013- Cengage Learning.
2. K.R.Gopalkrishna, SudhirGopalkrishna, S.C. Sharma. A Text Book of Elements of Mechanical Engineering, 30th Edition, Oct 2010,–Subhash Publishers, Bangalore.

Reference Books:

1. Course Material developed by the Department of Mechanical Engineering.
2. SKH Chowdhary, AKH Chowdhary, Nirjhar Roy, The Elements of Workshop Technology - Vol I & II , 11th edition 2001, Media Promoters and Publishers.
3. Basic Manufacturing, Roger Timings, Third edition, Newnes, An imprint of Elsevier.

BACK

Program: Biotechnology		Semester: I
Course Title: Applied Physics lab (ES)		Course Code:21EPHP102
L-T-P:0-0-1	Credits:01	Contact Hours:02
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:20	Examination Duration:3 Hours	

LIST OF EXPERIMENTS:

1. Experimental data error analysis.
2. Centripetal force.
3. Young's modulus.
4. Coefficient of friction.
5. V-I Characteristics of pn- Junction diode and plotting DC load line.
6. Hysteresis loss.
7. Verification of Kirchoff's KVL and KCL (DC Circuits)
8. Use of measuring instruments (RPS & FG) and calibration of oscilloscope
9. Realization of basic gates (Using IC's)
10. Zener diode characteristics and voltage regulation (line and load regulation).

OPEN ENDED EXPERIMENT

1. Realization of a ±5⁄12V regulated power supply
2. Stepper motor dive

BACK

Program: Biotechnology		Semester: II
Course Title: Multivariable calculus		Course Code:18EMAB102
L-T-P:4-1-0	Credits:05	Contact Hours:50
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:05	Examination Duration:3 Hours	

Unit I

1.Partial differentiation

Function of several variables, Partial derivatives, Level curves, Chain rule, Errors and Approximations. Extreme value problems. Lagrange's multipliers.

12 Hours

2. Double integrals Double integrals- Rectangular and polar coordinates, Change the order of integration. Change of variables, Jacobian. Application of double integrals

08 Hours

MATLAB: optimization problems, application of double integrals.

Unit II

1.Triple integrals

Triple integrals, Cartesian, change to Cylindrical and Spherical coordinates Application of Triple integrals

07 Hours

2.Calculus of Vector Fields

Vector fields, Gradient and directional derivatives. Line and Surface integrals. Independence of path and potential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem.

13 Hours

MATLAB: application of Triple integrals, Vector calculus problems

Unit III

1.Differential equations of higher orders

(a)Linear differential equations of second and higher order with constant coeffiISAnts the method of Variation of parameters. Initial and boundary value problems. (b) Applications of second order differential equations-Newton's 2nd law, electrical circuits, Simple Harmonic motion. Series solution of differential equations. Validity of Series solution of

Differential equations.

(5+5) Hours

MATLAB: application of differential equations

Text Books

1. Early Transcendental Calculus- James Stewart, Thomson Books, 7ed 2010.

Reference Books:

1. Calculus Single and Multivariable, Hughues-Hallett Gleason, Wiley India Ed, 4ed, 2009.
2. Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010.

BACK

Program: Biotechnology		Semester: II
Course Title: Engineering Chemistry		Course Code:22ECHB102
L-T-P:3-0-0	Credits:03	Contact Hours: 40
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hours	

Unit-I

1. Chemical Bonding and Molecular Structure

Chemical bonding – Types, Ionic bond: Formation of NaCl molecule, factors influencing the formation of ionic bond – ionization energy, electron affinity and lattice energy, Born–Haber's cycle, calculation of lattice energy of NaCl molecule and properties of ionic compounds; Covalent bond: atomic orbital theory – formation of H_2 molecule, polar and nonpolar covalent bonds – H_2 and HCl molecules, dipole moment, calculation of percentage of ionic character and properties of covalent compounds. Hybridization: sp, sp^2 and sp^3 hybridization - geometry of BeF_2, BF_3 and CH_4 molecules. VSEPR Theory: regular and irregular geometry, geometry of $SnCl_2$, NH_3 and H_2O molecules.

06 Hours

2. Electrochemical Energy Systems

Electrode potential, Nernst equation; Formation of a cell; Reference electrodes: Calomel electrode - determination of electrode potential; Numerical problems on E, E_{cell} and E^0_{cell}. Batteries: classification, characteristics, Lead - acid battery and Lithium ion battery. Fuel cells: Types of fuel cells; Methanol - Oxygen fuel cell.

06 Hours

3. Polymer Chemistry

Polymers, properties, classification, free radical mechanism of addition polymerization by taking ethylene as an example. Commercial polymers: plexi glass and polyurethane. Polymer composites: carbon fibre and epoxy resin – synthesis, properties and applications. Conducting polymers: Polyaniline – synthesis, mechanism of conduction in doped polyaniline and its applications.

04 Hours

Unit – II

4. Plating Techniques

Technological importance of plating techniques, Types of plating, Electroplating: Definition, electroplating of Gold by acid cyanide bath, determination of Throwing Power of plating bath by Haring Blum cell and numerical problems. Electroless plating: advantages of electroless plating over electroplating, electroless plating of Copper and its application in the manufacture of printed circuit board (PCB).

03 Hours

5. Wafer Technology

Introduction, physical and chemical properties of silicon, metallurgical grade silicon, purification of silicon; chemical vapor deposition (CVD) process, zone refining process. Crystal growth: preparation of single crystal silicon by Czhochralski crystal pulling technique and numerical problems. Crystal slicing and wafer preparation; Fabrication process: thermal oxidation, diffusion, ion implantation, numerical problems, epitaxial growth, masking, photolithography; wet etching and dry etching.

10 Hours

6. Material Chemistry

Liquid crystals: classification of liquid crystals, applications of liquid crystals in display systems. Glass: properties, smart glass: electrochromic, thermochromic and photochromic smart glass - properties and applications. Thermoelectric and Piezoelectric materials - meaning, properties and applications.

03 Hours

Unit – III

7. Water Chemistry

Water: sources, impurities in water, potable water: meaning and specifications (as per WHO standards). Hardness: determination of total hardness of water by EDTA method and numerical problems. Purification of water: Flash distillation, Reverse Osmosis, Electrodialysis - principle, process and applications.

04 Hours

8. Instrumental Methods of Measurement

Advantages over conventional methods. Electro analytical methods: Potentiometer - principle, methodology and applications. Optoanalytical methods: Colorimeter - Principle, methodology and applications. Spectral methods of analysis: UV Spectrophotometer - Instrumentation and applications.

04 Hours

Text Books:

1. A text Book of Engineering Chemistry, 1st edition, Dara. S. S, S. Chand and Co. Ltd., 2009, New Delhi.
2. A text Book of Engineering Chemistry, 16th edition, Jain P.C and Jain M, Dhanpat Rai Publications, 2006, New Delhi.
3. Engineering Chemistry, 3rd Edition, Krishnamurthy. N., Vallinayaga. P. and Madhavan. D., PHI/E- Books Premium, 2014.

Reference Books:

1. Text book of Inorganic Chemistry, P. L. Soni, Sultan Chand, 1999, New Delhi.
2. Inorganic chemistry: Principles of structure and reactivity, , 4th Edition, James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Dorling Kindersley (India) Pvt. Ltd., 2006, New Delhi.
3. Concise Inorganic Chemistry ELBS, 5th Edition, J.D. Lee, Wiley, 2008, New York.
4. Hand book of batteries, 3rd edition, David Linden, Thomas B Reddy, McGraw Hill publications, 2001, New York.
5. Polymer Science, 6th edition, Gowariker V.R, Viswanatan N.V, Sreedhar J., New Age International (P) ltd., 2007, New Delhi.
6. Text Book of Polymer Science, 3rd edition, Fred W. Billmeyer, John Wiley and Son's, 1984, New York.
7. VLSI Technology, 2nd Edition, S. M. Sze, McGraw-Hill Series in Electrical and Computer Engineering, 1998, New York.

8. Solid State Devices & Technology, 4th Edition, V. Suresh Babu, Sanguine Technical Publishers, 2005, Bangalore.
9. Materials Science and Engineering: An introduction, 9th Edition, Callister William D, John Wiley and Sons, 2007, New York.
10. Instrumental Methods of Chemical Analysis, 5th edition, Gurdeep R Chatwal, Sham K Anand, Himalaya Publishing House, Pvt. Ltd, 2010, Mumbai.

BACK

Program: Biotechnology		Semester: II
Course Title: Engineering Mechanics		Course Code:15EPHB102
L-T-P:4-0-0	Credits:03	Contact Hours: 4
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration:3 Hours	

Unit I

Chapter No. 1. Overview of Civil Engineering

Civil engineering and its Specializations. role of the civil engineer as regards the health of the environment and society, water resource managers, transportation Engineers, Structural Engineers, and construction project managers.

04 Hours

Chapter No. 2. Coplanar concurrent force system

Introduction to Engineering Mechanics: Basic idealizations – Particle, Continuum, Body, Rigid body, Deformable body, Definition of force and its elements; Laws of Mechanics – Parallelogram law of forces, Principle of transmissibility, Law of Superposition, Newton's laws of motion. Classification of force systems Resultant of coplanar concurrent force system: Definitions – Resultant, composition & Resolution of a force, Equilibrium, Equilibrant, Formulae for resultant of forces and resolution of a force. Numerical problems on resultant of forces. Equilibrium of coplanar concurrent force system: Conditions of equilibrium, Action & Reaction, Free body diagram, Lami's theorem. Numerical problems on equilibrium of forces.

12 Hours

Chapter No. 3. Coplanar non-concurrent force system (resultant)

Resultant of a force system: Moment, moment of a force, couple, moment of a couple, Characteristics of couple, Equivalent force-couple system, Numerical problems on moment of forces and couples, on equivalent force-couple system. Varignons principle of moments, Resultant of coplanar- non-concurrent force systems and numerical problems.

05 Hours

Chapter 3:Coplanar non-concurrent force system

Resultant of a force system: Moment, moment of a force, couple, moment of a couple, Characteristics of couple, Equivalent force-couple system, Numerical problems on moment of forces and couples, on equivalent force-couple system. Varignons principle of moments, Resultant of coplanar- non-concurrent force systems and numerical problems.5 hrs.

05 Hours

Unit - II

Chapter No. 4 Coplanar Non - Concurrent force System (Equilibrium)

Conditions of equilibrium, types of support and loading for a statically determinate beam, Reactions at support connections, Numerical problems on equilibrium of force systems and support reactions for a statically determinate beam.

05 Hours

Chapter No. 5. Friction

Introduction, types of friction, definition, limiting friction, coefficient of friction, laws of Coulomb friction, angle of friction and angle of repose, cone of friction. Wedge theory. Numerical problems on, impending motion on horizontal and inclined planes (including connected bodies); wedge friction and Ladder friction.

08 Hours

Chapter No. 6. Simple Stress and Strain

Introduction, Properties of Materials, Stress, Strain, Elasticity, Elastic limit, Hooke's law & Young's modulus, Stress – Strain Diagram for structural steel, working stress and Factor of safety. Deformation of a bar due to force acting on it. Law of super position. Stresses in bars of uniform & varying cross sections. Composite sections. Problems connected to above topics.

06 Hours

Unit - III

Chapter No. 7. Centroid of Plane Figures

Introduction, Definition, Methods of determining the centroid, axis of reference, axis of symmetry, Locating the centroid of simple plane figures (triangle, semicircle, quadrant of a circle and sector of a circle etc.,) using method of integration, Numerical problems on Centroid of simple built-up sections.

05 Hours

Chapter No. 8. Second moment of area (Plane figures)

Introduction, Definition, Method of determining the second moment of area, Section Modulus, Radius of gyration, perpendicular and Parallel axis theorems, Polar second moment of area, second moment of area of simple plane figures (triangle, rectangle, semicircle, circle etc.,.) using method of integration, Numerical problems on MI of simple built-up sections.

05 Hours

Text Books:

1. Bhavikatti, S.S., Engineering Mechanics, 6th., New Age International Pub. Pvt. Ltd., New Delhi, 2018
2. Kumar, K.L., Veenu Kumar., Engineering Mechanics, 4th, Tata McGraw Hill Publishing Company, New Delhi, 2017
3. Jagadeesh, T.R. and Jayaram, Elements of Civil Engineering, 1ed, Sapna Book House, Bangalore, 2006

Reference Books:

1. Beer, F.P. and Johnston, R., Vector Mechanics for Engineers: Statics and dynamics, 12Ed., McGraw Hill Company, New York, 2019
2. Singer, F.L., Engineering Mechanics, 3Ed., Harper Collins, 1994
3. Timoshenko, S.P. and Young D.H., Engineering Mechanics (In SI Units), 5Ed., McGraw Hill Publishing Company, New Delhi, 2017
4. Irving H Shames, G Krishna Mohana Rao, Engineering Mechanics Statics and dynamics, 4Ed., Prentice-Hall of India Pvt. Ltd, New Delhi, 2005
5. Ramamrutham, S., Engineering Mechanics, Dhanpat Rai Publishing Co., New Delhi, 2016

BACK

Program: Biotechnology		Semester: II
Course Title: Computer Aided Engineering Drawing Equations		Course Code:15EMEP101
L-T-P:0-0-3	Credits:3	Contact Hours:6
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:72	Examination Duration: 2 Hours	

1.Projections of Points and Lines :

Introduction to Engineering Drawing, BIS conventions, drawing sheets and instruments. Types of lines, method of dimensioning. Introduction to projection. Principal of orthographic projection, 1st angle and 3rd angle method of projections, their symbolic representation. Projection of the points located in different quadrants. Introduction to projections of lines, lines perpendicular to one plane, lines parallel to both HP & VP, lines parallel to one plane and inclined to the other. Projections of straight lines inclined to both HP and VP.

12 Hours

2. Projections of Plane surfaces and Solids :

Introduction to projections of plane surfaces, plane surfaces parallel to one plane and perpendicular to other. Plane surfaces perpendicular to one plane and inclined to other plane. Introduction to various types of solids, projections of prisms and cylinders in simple position where the axis is perpendicular to either HP or VP or parallel to both HP and VP. Projections of pyramids and cones in simple position where the axis is perpendicular to either HP or VP or parallel to both HP and VP. Introduction to frustum and truncated solids, projections of frustum of pyramids and cones.

15 Hours

3. Development of lateral Surfaces :

Introduction to development of lateral surfaces, parallel line development method, development of prisms and their truncations. Introduction to radial line development, development of pyramids and truncations. Development of cylinders and cones and their truncations**.** Development of transition pieces by triangulation method.

12 Hours

4. Conversion of Pictorial views into Orthographic projections :

Introduction to Isometric drawings. Conversion of pictorial or isometric views into orthographic projections by manual mode of drawings. Introduction to CAD Software and practice. Conversion of pictorial or isometric views into orthographic projections using CAD software.

18 Hours

5. Conversion of Orthographic projections into isometric views :

Conversion of orthographic projections into isometric views using CAD software.

15 Hours

Text Books

1. Engineering Drawing - N.D. Bhatt & V.M. Panchal, 48th edition, 2005-Charotar Publishing House, Gujarat.
2. Engineering Graphics - K.R. Gopalakrishna, 32nd edition, 2000- Subash Publishers Bangalore.
3. AutoCAD 2014 – Sham Tikku, Perdue University
4. A Primer on Computer Aided Engineering Drawing Published by V T U Belgaum, 2006.
5. Machine Drawing - K.R. Gopalakrishna, 12nd edition, 2007- Subash Publishers Bangalore.

Reference Books:

1. Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production-Luzadder Warren J., Duff John M., Eastern Economy Edition, 2005-Prentice-Hall of India Pvt. Ltd., New Delhi.

BACK

Program: Biotechnology		Semester: II
Course Title: Problem Solving with Data Structures		Course Code:18ECSP102
L-T-P:0-0-3	Credits:3	Contact Hours:78
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:78	Examination Duration: 3 Hours	

1.Chapter No. 1 Introduction to Data Structures

Review of C: Structures, Pointers, Dynamic Memory Allocation and File Manipulation Operations, Introduction to Data Structures, Data structure Operations.

15 Hours

2.Chapter No 2 :Lists

Concept of lists: Abstract data type, Definition, Representation of linked lists in Memory,

Variants of Lists: Singly Linked List, Doubly Linked lists, Circular linked lists

Operations: Traversing, Searching, Insertion and Deletion. Applications of Linked lists – Polynomials, long integer addition and other applications.

18 Hours

3.Chapter No. 3 : Stacks and Recursion

Stack: Definition, Operations, Stack ADT Implementation of stack operations. Polish notation:Infix to postfix conversion, evaluation of postfix expression, parenthesis matching and otherapplications. Recursion

18 Hours

4.Chapter No. 4 : Queues

Queue: Definitions, Queue ADT, Variants of Queues: Linear queue, circular queue, priority queue, double ended queue and multiple queues. Applications of queue.

15 Hours

5.Chapter No. 5 : Binary trees

BinaryTree: Definition, Terminology and representation, Binary Search Tree:Traversals and its applications.

12 Hours

Text Books

1. Data Structures Using C and C++ - Y. Langsam, M. Augenstein And A. M. Tenenbaum, Prentice - Hall of India Pvt. Ltd. Edition- 2, 2006
2. Data Structures with C -- Seymour Lipschutz, Tata McGraw Hill India LTD, EdItion-1, 2011

Reference Books:

1. Data Structures and Algorithms Made Easy – Narshiman Karumunchi, Career Monk Publications, Edition-2, 2017.
2. Data Structure Through C - Yashavant P Kanetkar, BPB Publication, Edition-2.
3. Problem Solving in Data structures and Algorithms Using C – Hemath Jain, Taran Technologies Private Limited, Edition-1, 2016
4. Introduction to Algorithms - Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. The MIT Press, Edition-3, 2009.
5. Data Structures through C in Depth, S.K. Srivastava, Deepali Srivastava, BPB Publications, 2004
6. Online platform: www.Hackerrank.com
7. https://www.geeksforgeeks.org/

BACK

Program: Biotechnology		Semester: II
Course Title: Design Thinking for Social Innovation		Course Code:20EHSP101
L-T-P:0-1-1	Credits:02	Contact Hours: 28
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:28	Examination Duration:3 Hours	

Module		Topics	Assignments	Support activities / Tools
KNOWLEDGE, TOOLS & DEVELOPMENT	Course sensitization	1.**Introduction to Social Innovation:** • Awakening social consciousness **(www.yourstory.com)** • Social Innovation and Leadership • Engineering& Social innovation (EPICS) **(Connecting SI Course to Mini Project, Capstone Project, Campus Placements)** • Course Overview • Students' Self Introduction Activity • Group formation Activity	**Reading assignments** • Read the handout on "The Process of Social Innovation" by Geoff Mulgan • Design thinking for Social Innovation **Written Assignments** • Writing about AkshayaPatra in class. (Background information about Akshayapatra and the Social Cuase it is addressing) • Brainstorming Session on Social Innovators in Class	• Class activity on Behavioural Blocks to Innovation Discussion on the behavioural blocks. • Introducing oneself with three Adjectives- Appreciating diversity and discovering self • Group Formation Activity **(Forming square)** (Making four equilateral triangles out of popsicle sticks to enhance group cohesiveness amongst the group mates)

KNOWLEDGE, TOOLS & DEVELOPMENT		**Seven Mindsets:** **1. Empathy** (Example of The Boy and the Puppies) **2. Optimism** (Person Paralyzed waist down / Glass Halh full Half Empty) **3. Iteration** (Thomas Alva Edison) **4. Creative Confidence** (Origamy – Josef Albers) **5. Making it** **6. Embracing Ambiguity** (Confusion is the Welcome doormat at the door of Creativity) **7. Learning from Failure** (Designing Website first and then asking the stakeholders about the website) (Spending one lakh for the business which is never launched)	**<u>Reading assignments</u>** • Handout on " Create Mindsets"	• (How to train the Dragon? Common Video for all the mindsets) • Watching in Class TED Talk on "How to build youir Creative Confidence by David Kelley – IDEO Founder)

KNOWLEDGE, TOOLS & DEVELOPMENT	**Process of Social Innovation**	Engage Community study and Issue Identification	<u>Reading assignments</u> • Handout on Community Study and Issue Identification • Case Study on "EGramSeva" • Case Study on "JananiAgri Serve" <u>Class Presentations</u> • Initial observations being made by the group (Literature Survey of Places of Hubli-Dharwad)www.readwhere.com • Detailed interaction / engagements with the society and finalize the social issue for intervention **Use template 1: Frame your Design Challenge**	• Activity on Observation skills To know how to use one's observation skills in understanding the social conditions • Experience sharing by senior students • Brainstorming Deliberations on the initial observations and arrive at the "Social Issue" • Familiarization of the respective templates with the help of sample case study
		PEER REVIEW		

		Inspiration • Plan for the Research • Development of Interview guide • Capture your Learnings	**<u>Reading assignments</u>** • Handout on Overview of Inspiration **<u>Class Presentations</u>** • Entirety of the Social Issue • Identification of the Stake Holders **(Examples on Fluoroscent Curtain and Students' Punctuality for Class)** • Interview Questions **(Role Play on Interview with Stakeholders)** • Category wise Learnings capture **Use template 2: Plan your Research** **Template 3. Development of Interview Guide** **Template 4. Capture your Learning**	• Familiarization of the respective templates with the help of sample case study

		Ideation **3.1 Synthesis** • Search for meaning • Create "How might we" question	**Reading assignments** • Handout on Overview of Ideation-Synthesis **Class Presentations** • Create insights • "How might we" questions **Use template 5: Create Insights** **Template 6: Create "How Might We' Questions**	• Familiarization of the respective templates with the help of sample case study
		PEER REVIEW		

		Implementation • Create an action plan • Community Partners (if any) • Budgeting & Fundraising **1. Peer to Peer** **2. Crowd Funding** **3. Giving Kiosks** **4. Donation** **5. Envelop Funding** **6. Marathons/ Walkathons** **7. Conducting Yoga Classes** **(www.causevox.com / www.blog.fundly.com)** • Duration • Ethical concerns • Launch your solution • Feedback (Impact**)**	**<u>Reading assignments</u>** • Handout on Overview of Implementation **<u>Class Presentations</u>** • Pilot implementation plan with required resources and Budget indicating stake holders & their enagement	• Familiarization of the respective templates with the help of sample case study

		5.0 Reflect Reflection of the overall learning by the students	**Reading assignments** • Handout on Overview of students Reflection **Use template 9: Reflection on the Process** **Class Presentations** Final Presentation- After Implementation	• Familiarization of the respective templates with the help of sample case study

BACK

Program: Biotechnology		Semester: II
Course Title: Professional Communication		**Course Code:15EHSH101**
L-T-P:1-1-0-0	**Credits:2**	**Contact Hours:42**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:42	**Examination Duration: 3 Hours**	

Chapter No. 1. Basics- English Communication

Course Introduction, Explanation of template mix-ups with correct usages & necessity of grammar in error detection, Usage of tenses

09 Hours

Chapter No. 2. Vocabulary and grammar

Vocabulary, Word Formation and Active and Passive Voice

06 Hours

Chapter No. 3. Bouncing Practice

Definition and types of bouncing and its practice with examples, reading skills, free style speech. Individual presentation.

06 Hours

Chapter No. 4. Rephrasing and Structures

Comprehension and Rephrasing, PNQ Paradigm and Structural practice

08 Hours

Chapter No. 5. Dialogues

Introduction of dialogues, Situational Role plays,

03 Hours

Chapter No. 6. Business Communication

Covering letter, formal letters, Construction of paragraphs on any given general topic.

09 Hours

Reference Books:

1. Collins Cobuild Advanced Learner's English Dictionary
2. Raymond Murphy - Intermediate English Grammar, Cambridge University Press Martin Hewings- Advanced English Grammar, Cambridge University Press.

BACK

Program: Biotechnology		Semester: III
Course Title: Numerical Methods and Differential Equations		Course Code:20EMAB205
L-T-P:4-0-0	Credits:4.0	Contact Hours:4
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Interpolation techniques

Finite differences, Forward, Backward and central difference Operators. Newton Gregory forward and backward interpolation formulae. Stirling's formula for central difference. Newton's divided difference formula for unequal intervals.

08 Hours

2. Numerical Solution of Partial Differential Equations

Introduction, Classification of PDE, Parabolic, Elliptic and Hyperbolic Partial differential equations, Introduction to finite difference approximations to derivatives, finite difference solution of parabolic PDE, explicit and implicit methods, finite difference method to Elliptic PDE-initial –boundary vale problems, Hyperbolic PDE-explicit method. Engineering problems: Temperature distribution in a heated plate, steady-state heat flow and vibration of a stretched string.

12 Hours

Unit II

3. Matrices and System of linear equations

Introduction to system of linear equations, Elementary row transformations, Rank of a matrix, Consistency of system of linear equations, solution of system by (i) Direct methods-Gauss elimination, Gauss Jordon method (ii) Iterative method - Gauss-Seidel method. Eigen values and Eigenvectors of a matrix. Largest Eigen value and the corresponding Eigenvector by power method. Engineering problems.

08 Hours

4. Introduction to Statistics

Introduction, Scope of biostatistics, Variables, Measurement scales, Ordered array, Graphical representation of data: Bar Chart, Line chart, histogram, frequency curve, Ogive curves. Descriptive statistics: Measure of central tendency (arithmetic mean, median, mode, quartiles); Measures of dispersion (Quartile deviation, Standard deviation, coefficient of variation), Measure of skewness (Pearson and Bowley's)

12 Hours

Unit III

5. Introduction to Laplace transform and Solution of Differential Equations

Definition, transforms of elementary functions- transforms of derivatives and integrals- Properties. Periodic functions, Unit step functions and Unit impulse functions. Inverse Transforms- properties- Convolution Theorem. Applications to differential equations

10 Hours

Text Books:

1. Numerical methods for Engineers, Chapra S C and Canale R P, 5ed, TATA McGraw-Hill, 2007
2. Advanced Engineering Methods, Kreyszig E. 8Ed, John Wiley & sons, 2003.Applied Statistics and Probability for Engineers, Douglas Montgomery, George Runger, 6Ed, John Wiley, 2014

Reference Books:

1. Introduction to Probability and Statistics: Principles and Applications for Engineering and Computing, J.Susan Milton, Jesse C Arnold, , 4, TATA Mc-Graw Hill Edition, 2007
2. Fundamentals of Mathematical Statistics, Gupta S.C and Kapoor V.K, 11Ed, Sultan Chand & Sons, New Delhi, 2002
3. Higher Engineering Mathematics, Grewal B S, 38ed, Khanna Publication, New Delhi, 2001.

BACK

Program: Biotechnology		Semester: III
Course Title: Microbiology		Course Code: 15EBTC201
L-T-P:4-0-0	Credits:4.0	Contact Hours:04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit I

1. Introduction

The scope of Microbiology, Historical Foundations, Taxonomy and classification of microorganisms, Bergey's Manual of Systematic Bacteriology, prokaryotic and eukaryotic cells, Eubacteria and Archaebacteria, study of different types of microorganisms: bacteria, yeasts, viruses, fungi, protozoa (structure, classification, modes of reproduction & growth). Microbes and human society: Microbial applications in agriculture, veterinary, healthcare, industry and environment.

05 Hours

2. Functional anatomy of Prokaryotic and Eukaryotic cells:

Size, shape and arrangement of bacterial cells, structures external to cell wall, cell wall and structures internal to cell wall including endospores. Structure and functions of eukaryotic cell. Genome structure in prokaryotic and Eukaryotic cells, Genotype & Phenotype, Genetic transfer and recombination (Transformation, Conjugation & Transduction), Genes and evolution.

07 Hours

3. Microscopic Examination

Bright-field Microscopy, Dark-field Microscopy, Phase-contrast Microscopy, Fluorescence Microscopy and Electron Microscopy. Preparation of specimen for light and electron microscopy. Advances in Scanned Probe Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy.

04 Hours

4. Microbial Growth

The requirements for growth (Physical & Chemical requirements), Culture media & their classification, Effect of different factors on growth, Growth of bacterial culture: bacterial division, generation time, phases of growth. Fundamentals of microbial growth Kinetics.Chemostat & Turbidostat, Measurement of growth: Direct and Indirect methods.

04 Hours

Unit II

5. Microbial Techniques

Pure culture techniques (streak plate, spread plate, pour plate), Staining techniques (simple and differential staining techniques), Enumeration techniques (Direct Microscopic Count, plating techniques, membrane filtration, Electronic enumeration, etc). Characterization: Phenotypic and Biochemical characterization. 16S rRNA gene homology.

10 Hours

6. Microbial Metabolism

Catabolic and Anabolic reactions, Energy production, Carbohydrate catabolism: Glycolysis, Alternatives to Glycolysis, Cellular respiration, Energy production by aerobic process, Energy production by anaerobic process, Energy production by photosynthesis, Mechanism of ATP synthesis. Lipid and Protein catabolism, Photosynthesis: Light dependent and light independent reactions. Metabolic diversity among microorganisms: autotrophs and heterotrophs. Metabolic pathways of energy use: Polysaccharide biosynthesis, lipid biosynthesis, amino acid and protein biosynthesis. The integration of metabolism. Utilization of Energy and Biosynthesis: Utilization of energy for biosynthetic and non-biosynthetic processes.

10 Hours

Unit III

7. Control & Preservation of Microorganisms

Control of microorganisms by physical methods (heat, filtration, radiation). Microbial death kinetics, Thermal death point, Thermal death time, Decimal reduction time. Control of microorganisms by chemical methods (phenols, alcohols, halogens, dyes, detergents, heavy metals, etc), Common preservation techniques for microbes.

05 Hours

8. Applied and Industrial Microbiology

Food Microbiology, role of microorganisms in food production, Industrial Microbiology: Introduction to Fermenter & fermentation processes, Media for industrial application, Industrial Products: amino acids, vitamins, enzymes, pharmaceuticals, organic acids (discussion of case study), r-DNA technology & therapeutic products from microbes. Biosynthetic pathways and Introduction to Metabolic Engineering.

05 Hours

Text Books:

1. Chan & Pelzar, Microbiology, Publisher: Tata McGraw Hill 5th Edition 2008.
2. Tortora, Microbiology: An Introduction, Publisher: Pearson Education, 8th Edition, 2004

Reference Books:

1. Stanier Ingraham & Wheeler, General Microbiology, Pub: Mac Millan 5th edition. 2007.
2. Heritage, Introductory Microbiology Pub: Cambridge, 1st edition, 2007

BACK

Program: Biotechnology		Semester: III
Course Title: Biochemistry		Course Code: 15EBTC202
L-T-P:4-0-0	Credits:4.0	Contact Hours:04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit I

1. Biochemical Foundation & Carbohydrates

Types of chemical reactions, Solution chemistry. pH (Henderson-hesselbatch equation) Buffers and their Biological importance, carbohydrates- chemical structure and properties classification- Monosaccharide's, Disaccharides, Sugar derivatives, deoxy sugars, amino sugars, and sugar acids, phosphorylated sugars, structure and properties of polysaccharides, Homopolysaccharides, Heteropolysaccharides - Peptidoglycan, Glycosaminoglycans, Glycoconjugates, Glycobiology . Biological importance of carbohydrates.

07 Hours

2. Lipids

Definition and classification of lipid – simple, compound and derived lipids. Structure, classification and properties of fatty acids, Essential and non-essential fatty acid with physiological importance. Structure and physiogical functions of phospholipids, Sphingolipids, cerebrosides and gangliosides. Steroids- Structure and functions of cholesterol,. Eicosanoids, lipoproteins and terpenes. Vitamins-classifications and functions

05 Hours

3. Amino acids and Proteins

Definition, Classification and properties of amino acids, reactions, rare amino acids, essential and nonessential amino acids with physiological importance. Peptides - Definition of peptide bond, Biologically important peptides. Proteins – Classification- primary, secondary- Alpha helix, Beta sheets, tertiary and quaternary proteins-hemoglobin. Ramachandran plot, polypeptide sequencing- Edman degradation, Chemical synthesis of Peptides.

05 Hours

4. Nucleic acids

Structure and properties of purines, pyrimidines, nucleosides and nucleotides. Nucleic acids- Structure of DNA, RNA -Types,

03 Hours

Unit II

5. Carbohydrate metabolism

Glycolysis-aerobic and in anaerobic pathway, Energy yield of glycolysis Regulation of glycolysis-metabolic and hormonal. Fates of pyruvate. Glycogen - synthesis and degradation. Regulation

of glycogen metabolism. Gluconeogenesis, Pentose phosphate pathway. Significance of pentose phosphate pathway and regulation. Production of Acetyl-CoA, Reactions of Citric acid cycle, Anaplerotic reactions, regulation of citric acid cycle. Glyoxylate cycle, Electron transport chain, ATP synthesis, shuttle systems and Oxidative phosphorylation. Cyclic and Non-cyclic Photophosphorylation and Calvin Cycle (C3) in plants Disorders of carbohydrate metabolism. Production of microbial polysaccharides; industrial and Medical application of exopolysaccharides.

10 Hours

6. Metabolism of Amino acids

General reactions of amino acid metabolism, urea cycle, amino acid biosynthesis-aspartate and glutamate family and degradation of aromatic amino acid - phenylalanine and tyrosine, metabolic disorders of amino acid metabolism, biosynthesis of plant substances and neurotransmitters, Environmental and Industrial Significance of Amino acid metabolism.

05 Hours

7. Metabolism of Fatty acids

Fatty acid oxidation, biosynthesis of fatty acids, Ketone bodies, phospholipids and spingolipids cholesterol biosynthesis, Regulation, metabolic disorders of lipid metabolism. Environmental and Industrial Significance of lipid metabolism

05 Hours

Unit III

8. Metabolism of Nucleic acids

Biosynthesis and degradation of purines and pyrimidines, salvage pathway, uric acid production, regulation, metabolic disorders of nucleic acid metabolism.

05 Hours

9. Biological Membranes And Transport Mechanism

Composition and functions of biological membranes (fluid mosaic model) – Proteins, Carbohydrates, Glycoprotein and glycolipids, Membrane transport - Passive transport and Active transport. Mechanism of Na+ and K+, glucose and amino acid transport. Role of transport in signal transduction processes.

05 Hours

Text Books

1. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, Sixth Edition, W.H. Freeman, 2012.
2. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. , Biochemistry, 7th revised International edition, Palgrave MacMillan, 2011.

Reference Books

1. Donald Voet and Judith G. Voet. , Biochemistry, 4th edition, Wiley; , 2010
2. Geoffrey L. Zubay, Principles of Biochemistry , Edition: 4th, William C Brown Pub, 1999.

BACK

Program: Biotechnology		Semester: III
Course Title: Bioprocess Calculations		Course Code: 15EBTF201
L-T-P:4-0-0	Credits:4.0	Contact Hours:04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit I

1.Units and dimensions

Introduction to Fundamental and derived Units. FPS, MKS, CGS and SI system. Conversion from one system to another system with examples.

04 Hours

2.Basics of chemical calculation

Introduction, concept of mole, Atomic mass and molar mass, composition of mixtures of solids, liquids and gaseous. Ideal gas law, Amagats law and Dalton's law. Varification of Vol %=Mol %. Physical properties of solution, normality, morality and molality. Solving problems for normality, morality and molality.

08 Hours

3.Material balances without chemical reaction

General material balance equation, simplification for steady state without chemical reaction. Material balances of unsteady-state operation. Problems on mixing of streams, Distillation, Drying, Absorption, evaporation, Filtration, Extraction & Crystallization.

08 Hours

Unit II

4.Material balances with chemical reaction

Introduction, Concept of limiting, excess reactant and inerts. Conversion, yield and selectivity. Fuels and combustion-Definition of ultimate and proximate analysis of coal, air fuel ratio calculation. Problems.

10 Hours

5.Energy Balance

General steady state energy balance Equation. Thermopysics-Enthalpy, Heat capacities of solids, liquids and gases. Heat capacities of mixture, Thermo chemistry-Heat of combustion, formation and reaction. Effect of temperature on heat of reaction. Definition and significances of NCV and GCV and problems.

10 Hours

Unit III

6a .Stoichiometry of microbial growth and product formation kinetics

Introduction and definition of various yield coeffiISAnts. Elemental balances and Degree of reduction. Problems.

05 Hours

6b .Stoichiometry of microbial growth and product formation kinetics

Introduction and Basic cell kinetic models, Strutured,unstructured and mixed growth kinetic models

05 Hours

Text Books

1. B.I Bhatt and S.M.Vora, Stoichiometry,Tata McGraw Hill publications,4th edn,2007.
2. David Himmelblau, Basic principles and calculation in chemical engineering, Pearson Education Limited,6th edn,2005

Reference Books

1. Hougen, Watson and Rigatz, Chemical Process principles Pati-I , CBS Publishers & Distributors,2nd edn,2004.
2. J E Bailey and D F Ollis, Biochemical engineering Fundamentals, Mc Grew Hill Publication,2nd edn,1986.

BACK

Program: Biotechnology		**Semester: III**
Course Title: Unit Operations-I		**Course Code: 17EBTF201**
L-T-P:: 3-0-0	**Credits:3.0**	**Contact Hours: 03**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:40	**Examination Duration: 3 Hours**	

Unit I

1. Basics of mass transfer

Introduction to Mass Transfer, Classification of mass transfer operations, Diffusion, Fick's law of diffusion, Vapour Liquid Equilibrium (Txy & xy plots),Raoult's law, Relative volatility and its importance. Prediction of VLE data for binary mixture (Ideal system).

05 Hours

2. Distillation

Types of distillation: simple/Batch distillation, Multi stage tray tower distillation, Packed column distillation & steam distillation. Determination of theoretical stages in multistage tray tower distillation column: Construction of equilibrium curve, Equations for operating lines of rectifying section & stripping section, Equation for feed line (q-line).Concept of Reflux ratio, Types of Refluxes: Total reflux, Minimum reflux & Optimum reflux. Conceptual numerical Problems on determination of number of theoretical stages.

10 Hours

Unit II

3. Drying & Crystillation:

Importance of Drying, Terminologies and definitions, Drying rate curves under constant drying conditions, Drying Equipments: Tray dryer, Freeze dryer/Lyophilizer,spray dryer etc.*Crystallization:*Concept of Crystlallation, Principle and Applications

05 Hours

4. Extraction

Introduction, Liquid-Liquid & Solid-Liquid Extraction Principles, selection of solvents. Batch and Continuous Extraction.Extraction Processes:Aqueous two phase Extraction, Super critical Fluid extraction.

04 Hours

5. Adsorption

Concept of Adsorption, Types of Adsorption, Adsorption Isotherms, Applications of Adsorption in Chromatography.

03 Hours

6. Heat transfer

Heat transfer: Introduction, Modes of heat transfer: conduction, convection and radiation. Conduction: Fourior's law of heat conduction, Thermal conductivity. Steady state heat conduction through unilayer and multilayer plain wall, Unilayer & multilayer Cylindrical pipe. Conceptual problems.

04 Hours

Unit III

7. Convective heat transfer & Heat transfer equipment's

Forced and natural convection, individual and overall heat transfer coeffiISAnt, Correlation for h and U for the flow in circular tubes and annulus. Calculation of h (film heat transfer coeffiISAnt) based on dimensionless number, Concept of Log Mean Temperature Difference (LMTD). Typical heat transfer equipments: Double pipe heat exchanger, Shell and tube heat exchanger. (Line diagram and operation).

05 Hours

8. Condensation & Boiling

Condensation: Drop wise & Film wise condensation. Boiling: Phenomenon, different regimes of Boiling (descriptive only). Insulation, Critical thickness of Insulation.

05 Hours

Text Books

1. McCabe W. L. and Smith J. C, Unit operations of chemical engineering, 7th, McGraw-Hill, 2005
2. 2. C. J. Geankoplis, Transport Processes and unit operations, 4th, Prentice Hall of India,2004

Reference Books

1. George Granger Brown, Unit Operations, 1st , CBS Publishers &Distributors, 2004
2. Alan S Foust, Principles of Unit operations, 2nd, John Wiley & Sons, 1980

BACK

Program: Biotechnology		Semester: III
Course Title: Microbiology Lab		Course Code: 15EBTP201
L-T-P:: 0-0-1	Credits:1.0	Contact Hours: 03
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration: 3 Hours	

List of Experiments:

1. Laboratory safety precautions, material safety guidelines, cleaning & storage practices, culture disposal practices.
2. Study of Laboratory equipments: Microscope, Autoclave, Laminar Air Flow Bench, Hot Air Oven, Bacteriological Incubator and Freeze Drier. SOP and Calibration.
3. Media preparation: Nutrient broth/Agar, Mac-Conkey's medium and Potato-Dextrose broth/Agar.
4. Micrometry: Bacterial Cell measurement
5. Pure culture techniques: Streak plate Method, Spread plate Method, Pour plate Method.
6. Isolation and enumeration of microorganisms from environmental sources. (Open-ended experiment)
7. Simple and Differential Staining Techniques (Gram staining technique).
8. Hanging drop technique for motility and Endospore staining.
9. Study of bacterial growth curve (difference between non spore former and spore former) Sterilization by Filtration and antibiotic susceptibility testing.

Text Books/Reference Books:

1. Microbiology: A Lab Manual Seventh Edition by Cappuccino J G and Sherman N 2012 Pearson education Inc, 2012 (ISBN 978-81-317-1437-9).
2. Laboratory experiments in Microbiology, Ninth Edition by Ted R. Johnson and Christine Case. Pearson Education (ISBN 978-0-321-56028-5)
3. Techniques in Microbiology: A Student Handbook by John M. Lammert. Pearson Education (ISBN 978-0-13-224011-6)

BACK

Program: Biotechnology		Semester: III
Course Title: Biochemistry Lab		Course Code: 15EBTP202
L-T-P:: 0-0-1	Credits:1.0	Contact Hours: 02
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration: 3 Hours	

List of Experiments:

1. Biochemical Measurements: Molarity, Normality, Molality, Moles, weight/volume measurements, percent solution, concentration Units. pH measurements and Buffer preparation, SOP's, Instrument calibrations.
2. Qualitative analysis of carbohydrates and Lipids
3. Qualitative analysis of amino acids and proteins.
4. Estimation of reducing sugar by Folin – Wu method.
5. Estimation of reducing sugar by Nelson –Somogyi/DNS method.
6. Estimation of Amino acids by ninhydrin method.
7. Estimation of Proteins by Lowry's method.
8. Estimation of Inorganic Phosphate by Fiske-Subbarao method.
9. Estimation of Urea by DAMO method
10. Estimation of DNA by Diphenylamine method.
11. Estimation of RNA by Orcinol method.

Text Books/Reference Books:

1. David Plummer An introduction to Practical biochemistry.Third edition,McGraw-Hill,1987.
2. Sadasivam S and Manickam A.,Biochemical methods.Second edition,New Age International,2005.

BACK

Program: Biotechnology		Semester: III
Course Title: Unit Operations-I Lab		Course Code: 17EBTP201
L-T-P:: 0-0-1	Credits:1.0	Contact Hours: 02
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration: 3 Hours	

List of Experiments:

1. Diffusivity measurements
2. Drying characteristics.
3. Liquid Extraction
4. Convective mass transfer
5. Simple distillation
6. Steam distillation
7. Heat transfer in packed bed
8. Vertical condenser
9. Adsorption studies
10. Leaching

Text Books/Reference Books:

1. McCabe W. L. and Smith J. C, Unit operations of chemical engineering, 7th, McGraw-Hill, 2005
2. C. J. Geankoplis, Transport Processes and unit operations, 4th, Prentice Hall of India,2004

BACK

Program: Biotechnology		Semester: IV
Course Title: Biostatistics		Course Code: 20EMAB210
L-T-P:: 3-0-0	Credits:4.0	Contact Hours: 04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit I

1. Bivariate Distribution Fitting of curves

Introduction to biostatistics, Review of Central tendency and Dispersion, Correlation, linear regression, Curve fitting (Nonlinear and Exponential curves)

05 Hours

2. Probability

Definition of probability, addition rule, conditional probability, multiplication rule, Baye's rule, sensitivity, specificity, predictive value positive and negative, Probability in Genetics: Punnett square, Hardy - Weinberg law, Wahlund's Principle

05 Hours

3. Probability distributions

Discrete probability distributions - Binomial, Poisson, Continuous Probability Distribution – Normal, Exponential, Gamma distribution

05 Hours

Unit II

4. Sampling and Statistical Inference

Introduction, Sampling, Sampling distribution, sample size determination, Confidence intervals, Tests of hypothesis, p-value, t-test for single mean, difference of mean (with equal variance and unequal variance), paired t-test, Chi Square test for goodness of fit and independence of attributes, analysis of variance (one-way and two-way classifications). Case studies of statistical designs of biological experiments (RCBD, RBD)

08 Hours

5. Design of Experiments-1

Introduction, OFAT, 2^2 and 2^3 factorial experiments: Data table, Graphical representation, Main and interaction effects, ANOVA Table

07 Hours

Unit III

6. Design of Experiments -2

Fractional factorial design, Placket-Burman design, Response Surface Methods-Central Composite Design

05 Hours

7. Population Growth Models

Introduction, Discrete time and continuous growth, Density Independent growth model: Geometric and Exponential growth model, Density dependent growth: Logistic growth model

05 Hours

Text Books

1. Applied Statistics and Probability for Engineers,Douglas Montgomery, George Runger, 6Ed, John Wiley, 2014
2. Introduction to Probability and Statistics: Principles and Applications for Engineering and Computing,J.Susan Milton, Jesse C Arnold, , 4, TATA Mc-Graw Hill Edition, 2007
3. Mathematical Models in Biology and Medicine, Kapoor J.N, EWP New Delhi, 2000

Reference Books

1. Fundamentals of Mathematical Statistics, Gupta S.C and Kapoor V.K, 11Ed, Sultan Chand & Sons, New Delhi, 2002

BACK

Program: Biotechnology		Semester: IV
Course Title: Immunology		Course Code: 15EBTC203
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Immune system

History and Scope of Immunology and Immune system, Classification of Immune system, Types of Immune responses, Molecules ,Cells and Organs of Immune system and Anatomy of immune response.

06 Hours

2. Humoral Immunity

Overview of Humoral immunity, B- Lymphocytes – Development and their activation, Antibody response, Structure and functions of Immunoglobulins, Classes and sub-classes of immunoglobulins, genetic control of antibody production, Monoclonal and Polyclonal antibodies, Production of Monoclonal antibodies and quality screening processes in large scale monoclonal antibody production

05 Hours

3. Cell Mediated Immunity

Overview of cell mediated immunity and its significance, T-Lymphocytes – Development, Types and their activation, Major Histocompatibility (MHC) Complex, Antigen Presenting Cells (APC) and antigen processing and presentation, Mechanism of Phagocytosis- Oxygen dependent and Oxygen independent.

04 Hours

Unit II

4. Regulation of Immune Response and Immune tolerance

Immune response – Nature and necessity of its regulation, Complement System- Types, activation and types and their biological applications, Cytokines – types and their role in immune response, Immune Tolerance and their types, Hypersensitivity reactions – Types and Treatments. **Food allergy,** Case study on mechanism of immunity booster.

05 Hours

5. Immunological disorders

Auto immune disorders – Features, important types and Experimental models of auto immune diseases ImmunodefiISAncy Disorders – Types and features.

04 Hours

6. Transplantation immunology

Transplantation antigens – Types and functions, Types of Transplantations, Immunological basis of Graft rejection , and their disease association**,** Role of HLA in graft rejection, Tumor specific antigens, Tissue typing, Immune suppression and immune suppressive drugs.

06 Hours

Unit III

7. Molecular Immunology

Vaccines – Types and their development, Production of Recombinant DNA vaccines, Application of PCR technology to produce antibodies, Immune Therapy with genetically engineered antibodies, Catalytic antibodies, immunotherapeutic applications of hematopoietic stem cells, Purification and preparation of antigens in vaccine development and Immunoinformatics.

06 Hours

8. Immunodiagnosis

Immunization and Antiserum, Antigen-Antibody interactions – Precipitation reactions and Agglutination reactions Immuno-electrophoresis and Immunoflurescence assay, Principle and applications of ELISA and RIA and Western blotting analysis.

04 Hours

Text Books

1. Janis. Kuby, Immunology, V, WH Freeman and Company, 2003
2. Pandian and Senthil Kumar, Immunology and Immunotechnology , Panima Publishing Corporation, 2007

Reference Books

1. P.M. Ladyard, Immunology , Bios SISAntific Publishers Ltd , 2000
2. Roitt I, Essential Immunology, Blackwell sISAntific Publications.

BACK

Program: Biotechnology		Semester: IV
Course Title: Enzyme Technology		Course Code: 17EBTC201
L-T-P:: 4-0-0	Credits:4.0	Contact Hours: 04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit I

1. Introduction to enzymes

History, nomenclature, classification of enzymes, sources of enzymes, properties of enzyme, Types of specificities, mechanism of enzyme action-Lock and Key model and Induced fit model, Enzyme catalysis -Acid base catalysis, covalent catalysis, metal ion catalysis, Proximity and orientation effects. Mechanism of coenzymes (NAD/NADP,FAD/$FADH_2$,PLP, Coenzyme A, TPP, Biotin)

07 Hours

2. Purification of enzymes

Objectives and strategies in enzyme purification, choice of source-plant, animal and microbial, purification of intracellular and extracellular enzymes (Comprehensive flow sheet for enzyme purification),methods of homogenization, methods of separation-Enzyme fractionation by precipitation (using Temperature, salt, solvent, pH, etc.), liquid-liquid extraction, ionic exchange, gel chromatography, affinity chromatography and other special purification methods., Methods of characterization of enzymes; Analysis of yield, purity and activity of enzymes. Molecular weight determination-SDS-PAGE, MALDI-TOF

08 Hours

3. Enzymatic techniques

Enzyme assay, Enzyme and isoenzyme measurement methods with examples(fixed incubation and kinetic methods) Methods for investigating the kinetics of Enzyme catalyzed reactions-Initial velocity studies, rapid-reaction techniques, Standardization and optimization methods, stability and activity of enzymes

05 Hours

Unit II

4. Enzyme Kinetics and Enzyme Inhibitions.

Kinetics of single substrate reactions; Derivation of Michaelis -Menten equation, turnover number; K_{cat} value, determination of Km and Vmax, Line Weaver Burk plot, Eadie Hofstee plot, Hanes woolf plot, Importance of Km & Vmax; Enzyme inhibitions- reversible, competitive, uncompetitive and non-competitive inhibitions and kinetics, allosteric and irreversible inhibition. Substrate inhibitions, Multi-substrate reactions-ordered mechanisms, random

mechanisms, Ping-pong mechanism. Allosteric enzymes and regulation - The Monad - Changeux - Wyman model (MCW) and The Koshland - Nemethy - Filmer (KNF) model, Feedback regulation and covalent regulation.

07 Hours

5. Enzymes Of Medical Importance

Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudocholinesterase, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes.Importance of enzymes in diagnostics, Enzyme pattern in diseases like Myocardial infarctions, (SGOT, SGPT & LDH). Isoenzymes (CK, LD, ALP). Enzymes in immunoassay techniques, Therapeutic enzymes.

07 Hours

6. Enzyme Immobilization

Techniques of enzyme immobilization, adsorption - matrix entrapment- encapsulation- cross-linking - covalent binding - examples; whole cell immobilization and their application, kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, uses of immobilized enzymes, Design of Immobilized Enzyme Reactors- Stirred tank reactors(STR), Continuous Flow Stirred Tank Reactors (CSTR), Packed- bed reactors (PBR), Fluidized-bed Reactors (FBR); Membrane reactor

06 Hours

Text Books

1. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry. , 6, W.H. Freeman, 2012
2. Trevor Palmer, 2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, 1, East-West Press Pvt. Ltd, 2004

References

1. Laurence A. Moran, Raymond S. Ochs, J. David Rawn, and K. Gray Scrimgeour. , Principles of biochemistry., 3, Prentice Hall, 2002
2. Faber, Biotransformation in Organic Chemistry , 4, Springer, 2000
3. Aehle W, Enzymes in industry- production and applications, 3, Wiley-VCH, 2007
4. Nicholas .C. Price and Lewis Stevens, Fundamentals of Enzymology , 3, Oxford University Press , 1991

BACK

Program: Biotechnology		Semester: IV
Course Title: Cell and Molecular Biology		Course Code: 15EBTC205
L-T-P:: 4-0-0	Credits:4.0	Contact Hours: 04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit I

1. Cell Biology and Biotechnology

Organization of Prokaryotic and Eukaryotic cells. Structure and functions of membranes, nucleus, endoplasmic reticulum, Golgi complex, mitochondria, chloroplast and vacuoles. Cell division, Cell Cycle regulation and Cancer. Applications of cell biology and its principles in Genetic Engineering and Microbial, Plant & Animal Biotechnology

05 Hours

2. Molecular Biology and Nucleic Acids

Development and scope of Molecular Biology, Central Dogma of Molecular Biology and its updated view, Classical experiments and Nucleic acids as genetic material, Overview of Genome: Viral genome, bacterial genome, Mitochondrial genome, Eukaryotic genome. Organization of Prokaryotic and Eukaryotic genome/Chromosomes. Typical Gene structure in Prokaryotes and Eukaryotes. Structure and forms of nucleic acids, factors determine the structure of DNA. Denaturation and melting curves. Overview of Isolation, Purification, Estimation and Storage of Nucleic acids.

10 Hours

3. Replication of DNA

An overview and Basic rules for DNA Replication, Enzymes and proteins of DNA Replication, DNA Replication is Semi conservative, Origin of DNA Replication, Replicon and Replication fork, Unidirectional and Bidirectional replication of DNA, Mechanism of DNA replication in prokaryotes and in Eukaryotes.

05 Hours

Unit II

4. Transcription

General features of Transcription process, Types of RNA molecules, Prokaryotic and eukaryotic RNA polymerases, Promoter structure and Mechanism of transcription in prokaryotes and eukaryotes, Post transcriptional modifications of mRNA, tRNA and rRNA, Transcription inhibitors. **05 Hours**

5. Translation

Features of Genetic code and Wobble hypothesis, Overview of protein synthesis, Components required for protein synthesis, Mechanism of protein synthesis in prokaryotes and eukaryotes, Post-translational modifications and Protein targeting, Inhibitors in translation

04 Hours

6. Regulation of Gene Expression in Prokaryotes and Eukaryotes.

Regulation of gene activity, Gene regulation in Prokaryotes: Constitutive, Inducible and repressible gene expression systems, Operon model for gene expression regulation in prokaryotes, Positive and Negative regulation of – Lac Operon – Regulation, Catabolic repression and Gratuitous inducers etc, Trp Operon and Gal Operon. Gene regulation in Eukaryotes, Regulation of Gene expression at Genome level, Transcriptional level –Acetylation of Histones, Chromatin remodeling, DNA Methylation, DNA elements, Transcription factors, Insulators, Regulatory proteins and Hormones. Gene regulation at Post transcriptional level – Splicing, RNA interference, Transport of mRNA and by regulating mRNA stability.

07 Hours

7. Mutations and DNA Repair

Mutation – Source of genetic variability, basic features of Mutation process, Molecular basis of Mutation, Conditional lethal mutations as a powerful tool for genetic studies and Ames test of Mutagenecity testing. DNA damage and different types of DNA repair systems and Human diseases. **04 Hours**

Unit III

8. Polymerase Chain Reaction

Principle of polymerase chain reaction (PCR) - Components of PCR reaction and optimization of PCR. Primer design and types of PCR– Inverse PCR, Hot-start PCR, Loop mediated PCR -, Reverse transcription PCR and Real time PCR. Chemistry of primer synthesis.

05 Hours

9. Analysis of Gene Expression

Analyzing Transcription – Northern Blots, RNase protection assay, Reverse Transcription (RT) PCR and Primer extension assay. Transcriptome Analysis – Differential screening and Array based methods. Promoter activity study – Reporter genes and Run-On assays. Translational Analysis – Western Blots and 2-D Analysis.

05 Hours

Text Books

1. Cell and Molecular Biology – S C Rastogi, New Age International Publishers, New Delhi (1996).
2. Fundamentals of Molecular Biology Ane's Student Edition. - Veer Bala Rastogi, Ane Books India, New Delhi (2008)

Reference Books:

1. Instant Notes in Molecular Biology – P.C. Turner, Viva Series Publishing, New Delhi
2. Essentials of Molecular Biology – V Malathi, Dorling Kindersley (India) Pvt Ltd, New Delhi (2013).

BACK

Program: Biotechnology		Semester: IV
Course Title: Unit Operations-II		Course Code: 17EBTF202
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 40
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Basic concepts

Fluid definition, Properties of biological fluids, Classification of biological fluids, Types of fluid flow, Reynolds number, pressure measurement devices: manometers, Bourdon gauge, bellow gauge, capsule gauge, Hydrostatic equilibrium, Newton's law of viscosity.

04 Hours

2. Fluid dynamics

Basic equations of fluid flow: Mass balance, Continuity equation, Bernoulli's equation, Laminar Flow through Circular pipe, Velocity and shear stress distribution, Boundary layer, Boundary layer separation, minor loss and major loss.

05 Hours

3. Flow past immersed bodies

Drag, lift, Drag coefficient, Kozney- Carman equation, Ergun's Equation. Motion of particles through fluids, Settling, Types of settling, Stoke's law, Newton's law, Criteria for settling regime, Numerical problems.

06 Hours

Unit II

4. Transportation and metering of liquids

Pipe and tube, joints and fittings, valves—Diaphragm/pneumatic valve, pinch valve, ball valve, plug valve. Pumps: peristaltic pumps, sinusoidal pumps, single use diaphragm pumps. Characteristic curves of a pump, Measurement of fluid flow rates, venturimeter, rotameter, pitot tube, vortex-shedding meter, turbine meter, magnetic meters, ultrasonic meters, thermal meters. Numerical problems

08 Hours

5. Mechanical separations

Filtration, Filter media, Filter aids, factors affecting rate of filtration, specific cake resistance, media resistance. Types of filters, Membrane processes—ultra filtration and microfiltration, Filtration equipment: rotary drum filter, leaf filter. Sedimentation, Kynch theory of sedimentation, Thickener, Numerical problems. **07 Hours**

Unit III

6. Mixing and agitation of liquids

Mixing and Agitation, Flow patterns in agitated tanks, Mechanism of mixing, Estimation of mixing time, Types of Impellers & propellers, Standard turbine design, Numerical problems.

05 Hours

7. Dimensional Analysis and similitude

Units and dimensions, Dimensionless number, Rayleigh and Buckingham π theorem. Model and prototype. Similitude. Problems on Rayleigh and Buckingham π theorem.

05 Hours

Text Books:

1. Unit operations of chemical engineering by McCabe W. L., Smith J. C, and Peter Harriott, 7th edition, McGraw-Hill, 2005.
2. Transport Processes and Separation Process Principles by C. J. Geankoplis, 4th edition, Prentice Hall of India, 2004.

Reference Books:

1. Fluid Mechanics by John F. Douglas, Janusz M. Gasiorek, John A. Swaffield, 4th edition, Pearson Education limited 2007.
2. Principles of Unit operations by Alan S Foust, 2nd edition, John Wiley & Sons, 2005.
3. Engineering Fluid Mechanics by K. L. Kumar, 7th edition, Eurasia Publishing house (P) Ltd, 2007.

BACK

Program: Biotechnology		**Semester: IV**
Course Title: Enzyme Technology Lab		**Course Code: 15EBTP204**
L-T-P:: 3-0-0	**Credits:3.0**	**Contact Hours: 40**
ISA Marks:80	**ESA Marks:20**	**Total Marks:100**
Teaching Hours:24	**Examination Duration: 3 Hours**	

List of Experiments

1. Biochemical Measurements: Molarity, Normality, Molality, Moles, weight/volume measurements, percent solution, concentration Units. pH measurements and Buffer preparation, SOP's, Instrument calibrations.
2. Determination of activity of amylase enzyme
3. Estimation of protein content of amylase and specific activity
4. Effect of temperature on enzyme activity
5. Effect of pH on enzyme activity
6. Effect of substrate concentration on enzyme activity
7. Effect of enzyme concentration on enzyme activity
8. Effect of inhibitor on enzyme activity
9. Enzyme immobilization and kinetics of immobilized enzyme
10. Molecular weight determination by SDS PAGE
11. Staining the gel using CBB and silver staining

Text Books/ Reference Books:

1. Introduction to Practical biochemistry – David Plummer, McGraw-Hill Publishing Co,3rd edition,pp:332.
2. Biochemical methods- Sadasivam and Manickam(1996), New Age International Publishers, 2nd edition, pp256.
3. Experimental Biochemistry – A Student Companion by Beedu Shashidhar Rao and Vijay Deshpande.(2005) I.K International Pvt. Ltd,New Delhi. pp301

BACK

Program: Biotechnology		Semester: IV
Course Title: Cell and Molecular Biology Lab		Course Code: 15EBTP205
L-T-P:: 0-0-1	Credits:1.0	Contact Hours: 02
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration: 3 Hours	

List of Experiments

1. Basic Calculations and Solutions preparation skills and Good Lab Practices(GLPs)for the Molecular biology lab
2. Study **SOPs** of Cell and Molecular Biology laboratory equipments – Table top cooling Centrifuge, UV – Visible Spectrophotometer, PCR machine and Gel Documentation system.
3. Staining and microscopic observation of plant/animal cells and chromosomes
4. Study of Mitosis and Meiosis Cell Divisions
5. Isolation of genomic DNA from Bacteria/ Plant/ Animal cells
6. UV Spectrophotometric analysis of DNA and RNA
7. Calculation of Tm value of isolated DNA sample
8. Agarose gel electrophoresis and gel elution method.
9. Isolation and agarose gel electrophoresis estimation of Plasmid DNA
10. Extraction of Total RNA from different biological sources

Text Books/ Reference Books

1. Cell and Molecular Biology – A Lab Manual K V Chaitanya PHI Learning Private Limited Delhi – 110092, 2013.
2. Molecular Cloning Volumes I, II and III – Sambrook J *et al* (2000) Cold Spring Harbour Laboratory Press, 2000

BACK

Program: Biotechnology		Semester: IV
Course Title: Unit Operations-II Lab		Course Code: 17EBTP202
L-T-P:: 0-0-1	Credits:1.0	Contact Hours: 02
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration: 3 Hours	

List of Experiments

1. Pressure drop correlations through packed bed.
2. Studies on sedimentation.
3. Studies on agitation and mixing
4. Constant pressure filtration using leaf filter
5. Pressure drop correlations through circular pipes
6. Study of fluid flow patterns
7. Terminal settling velocity
8. Studies on Bernoulli's equation
9. Studies on flowmeter

Text Books/ Reference Books:

1. Unit operations of chemical engineering by McCabe W. L., Smith J. C, and Peter Harriott, 7th edition, McGraw-Hill, 2005.
2. Transport Processes and Separation Process Principles by C. J. Geankoplis, 4th edition, Prentice Hall of India, 2004.

BACK

Program: Biotechnology		Semester: V
Course Title: Genetic Engineering and Applications		Course Code: 24EBTC301
L-T-P:: 4-0-0	Credits:4.0	Contact Hours: 4
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit I

1. Basics of Recombinant DNA technology

Development and Scope of Recombinant DNA Technology and Genetic Engineering. Emergence and commercialization of Molecular Biotechnology. Ethical, Social, Economical and Political issues related to Gene modification and Genetic Engineering. Gene Cloning: Introduction and Steps involved in gene cloning. Subcloning and its applications. Vectors in GE - biology, features, types, cloning & expression vectors

06 Hours

2. Enzymes in Genetic Engineering

DNA modifying enzymes and necessity of DNA modification in gene cloning. Enzymes used for DNA modification. Restriction Endonucleases, classification & mode of action, Role and applications of different DNA modifying enzymes in gene cloning process - DNA Polymerases, Reverse Transcriptase, RNA Polymerase, Alkaline Phosphatases, Polynucleotide Kinase and DNA Ligases etc.

05 Hours

3. Molecular Cloning Strategies and Genetic Transformation

Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification on and storage of nucleic acids, Construction of cDNA library , Construction of Genomic library ,Screening and preservation of DNA libraries. DNA Cloning – Methods and applications. Genetic Transformation of prokaryotes and DNA Transfection in Eukaryotic hosts. Biological and Non-biological methods of gene transfer in hosts. Chloroplast transformation.

09 Hours

Unit II

4. Selection, Screening and Analysis of Recombinants

Introduction to screening and analysis of recombinants. Genetic selection and screening methods - Selectable Marker genes, Reporter genes. Screening using Nucleic acid hybridization methods - Preparation of probes for hybridization experiments and different blotting techniques. Screening by PCR based methods. Screening by Immunological methods and Analysis of cloned genes.

07 Hours

5. Production of Proteins from Cloned Genes

Introduction to recombinant gene expression, scope and applications of recombinant gene expression. Special vectors for expression of foreign genes in E coli. General problems with the production of recombinant protein in E coli. Production of recombinant proteins by Eukaryotic cells.

07 Hours

6. Directed Mutagenesis and Protein Engineering

Oligonucleotide – Directed Mutagenesis with M13 DNA, Plasmid DNA, PCR Amplification etc. Protein Engineering – Meaning and Scope, Protein Engineering for adding disulphide bonds, increasing enzymatic activity, decreasing protease sensitivity, modifying protein specificity, Increasing enzyme stability and specificity etc.

06 Hours

Unit III

7. Genetic Engineering and Microbial Biotechnology

Genetic manipulation of Microorganisms – Introduction and scope. Applications of Recombinant Microorganism – Production of recombinant therapeutic proteins, Production of Antibiotics, Combating Human diseases, Microbial pesticides, EffiISAnt utilization of Carbohydrates and Bioremediation or Environmental cleanup.

05 Hours

8. Plant and Animal Transgenic Technology and Applications

Applications of Transgenic Plant Technology – Development of Insect resistant plants, Herbicide resistant plants, Pathogens resistant plants, and Abiotic stress tolerant plants. Plants as Bioreactors for large scale production. Applications of Animal cloning and Transgenic technology - Cloning in Domestic animals. Applications of Transgenic Animals - as research models, and as bioreactors for large scale production of substances for Human welfare.

05 Hours

Text Books:

1. Genetic Engineering by Smitha Rastogi and Neelam Pathak, Oxford University Press, USA (2009)
2. Molecular Biotechnology – Principles and applications of Recombinant DNA by Bernard r Glick and Jack J Pasternak, ASM Press, American SoISAty for Microbiology, Washington DC 2003

Reference Books:

1. Gene Cloning and DNA Analysis by T A Brown,7th edition, Wiley-Blackwell 2016
2. An Introduction to Genetic Engineering – By Desmond S T Nicholl, 4th edition, Cambridge University Press, Singapore 2023.

BACK

Program: Biotechnology		Semester: V
Course Title: Bioinformatics		Course Code: 22EBTC301
L-T-P:: 4-0-0	Credits:4.0	Contact Hours: 04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit - I

1.Database

Bioinformatics: Definition, components, multidisciplinary nature, and applications of bioinformatics; Databases: Introduction, meaning, types and characteristics of databases, types of databases, Biological database: Classification, Primary Database: NCBI, Genbank, DDBJ, EMBL. File formats, Secondary Database: PROSITE, PIR, UNIPROT, BLOCKS, Pfam; metabolic pathway database: KEGG, Structure Database: PDB, MMBD, CATH, SCOP; Ligand Database, Enzyme database, human disease database, microbial and viral genome database, structure visualization tools.

07 Hours

2.Pairwise Sequence Alignment

Pairwise sequence alignment: Definition, significance, and applications; Types of pairwise sequence alignment: Local and Global alignment; Methods of pairwise sequence alignment: Dot matrix, Dynamic programming: features of dynamic programming, Global Alignment: Needleman & Wunsch Algorithm, Local Alignment: Smith – Waterman Algorithm, and Word method: BLAST, PSI-BLAST, PHI-BLAST and FASTA; Substitution matrices: PAM and BLOSUM; gap penalties.

08 Hours

3.Multiple Sequence Alignment

Multiple Sequence Alignment: Meaning, significance, and applications; Methods of MSA: Progressive Alignment methods, Iterative methods, Local Multiple sequence Alignment: Profile Analysis, BLOCK analysis, Pattern searching and Motif analysis, Statistical methods or Probabilistic models; Multiple Sequence Alignment editors. **05 Hours**

Unit - II

4.Phylogenetics analysis

Phylogenetic analysis: Meaning and significance; Concepts of evolutionary trees: Tree terminology, types of phylogenetic trees; fundamentals of phylogenetic models, Phylogenetic Data Analysis: Alignment: Building the data model, and extraction of phylogenetic data set; Determining substitution models: Models of Substitution Rates Between Bases, Models of Among-Site Substitution Rate Heterogeneity, Models of Substitution Rates Between Amino Acids; Tree Building methods: Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method; Character based methods: Maximum parsimony, Maximum Likelihood; Tree Evaluation methods, Phylogenetic Softwares

07 Hours

5.Gene Prediction

Gene structure, Prokaryote and Eukaryote gene prediction, Prokaryote and Eukaryote promoter site prediction Gene Prediction tools, Genomic database, Next Generation Sequencing.

05 Hours

6.Protein Prediction

Protein structures: Secondary Structure: Alpha helix, beta Sheets, phi & psi angles, Ramachandran plots. Protein Structure Prediction: Use of sequence patterns and Amino acid; Protein Secondary Structure Prediction methods: Chou-Fasman, neural network, and nearest neighbor method; Tertiary Structure Predictions: Homology modeling; Protein sequence and structure analysis: Physicochemical parameters, binding site, sub-cellular location, protein stability, and patterns.

.

08 Hours

Unit - III

7.In-silico Drug Designing-I

Introduction to traditional drug designing, Introduction in-silico drug designing approach, Methodology for in-silico drug designing: Structure based and Ligand based drug designing; De novo drug designing, pharmacophore modeling in drug designing, Ligand screening, drug designing based on template, Steps in drug designing: Target identification, target validation,

lead identification and validation; different tools used for drug designing.

05 Hours

8.In-silico Drug Designing-II

Molecular Modeling, Lipinski's rule, Virtual Screening, Process of Docking, Quantitative structure-activity relationship (QSAR), Physical and Chemical basis of receptor ligand interactions, ADMET property analysis, Molecular dynamics simulation of protein and protein-drug interaction.

05 Hours

Text Books

1. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd, Wiley-Inte, 2005
2. David Mount, Bioinformatics: Sequence and Genome Analysis , 2nd, Cold Sprin, 2004

Reference Books:

1. P. Rastogi, N. Mendiritta, S. C. Rastogi, Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, 4th, Prentice-H, 2013.
2. Anand Solomon K, Molecular Modelling and Drug Design , 1st, MJP Publis, 2015

BACK

Program: Biotechnology		Semester: V
Course Title: Reaction Engineering		Course Code: 24EBTC303
L-T-P:: 4-0-0	Credits:4.0	Contact Hours: 50
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit-I

1: **Introduction**

Introduction to homogeneous and heterogeneous reaction in ideal reactors. Elementary and Non-elementary reactions kinetics of homogeneous and heterogeneous reaction system.

06 Hours

2: **Interpretation of Batch Reactor data**

Introduction to analysis of experimental reactor data, evaluation of rate equation, integral and differential analysis of kinetic data's, constant volume system and variable volume System. Total pressure technique of analyzing the kinetic data of gaseous reaction system.

08 Hours

3. **Introduction to Bioreactor Design.**

General discussion on basics bioreactor design. General material balance equation for various conditions. Ideal reactors for a single reaction. Design equations for homogeneous system: batch, stirred tank and tubular flow reactor, size comparison of reactor systems.

08 Hours

Unit-II

4 Design for Multiple Reactions

Introduction, general design approach to multiple reactions. Quantitative and qualitative analysis of product distribution. Effect of temperature and pressure on single reaction. General graphical procedure, optimum temperature progression. Factors affecting choice of reactors: optimum yield, conversion, selectivity and reactivity.

08 Hours

5 Non-Ideal Reactors

Non-ideal reactors, residence time distribution studies, Stimulus Response Technique, pulse and step input response of reactors, RTD's for CSTR and PFR, Relationship between C, E and F-curve. Kinetic models for non-Ideal reaction system, Axial Dispersion Model

04 Hours

6 Microbial kinetics:

Introduction to microbial kinetics, Yield coefficient, Simple kinetic models for microbial growth, transient growth kinetics Factors affecting the kinetics of Monod model; Growth of Filamentous Organisms. kinetic Models for product formation and substrate degradation

08 Hours

Unit-III

7 Heterogeneous Reactor System:

Heterogeneous reactions in Bioprocessing. The rate equation for surface for kinetics, Pore diffusion kinetics with combined with surface kinetics. Porous catalyst particle Performance equation for reactor containing Porous catalyst particles. External and internal mass transfer effects.

04 Hours

8 Reactor Engineering

Bioreactor configurations: Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed,

04 Hours

Text Books:

1. Chemical Reaction Engineering by Octave and Levenspiel., John Wiley, 3rd Edition, 2006.
2. Elements of Chemical Reaction Engineering by Fogler, H.S., 6th edition, Prentice Hall, 2020.

Reference Books:

1. Bioprocess Engineering Principles by Pouline M Doran Academic Press , 2003
2. Biochemical Engineering Fundamentals By Bailey and Ollies, 2nd Edition, McGraw Hill, 2017
3. Chemical Reactor Analysis and Design by Forment G F and Bischoff K B. John wiley, 3rd edition 2011
4. Chemical engineering, By J.F Richardson and J.M Coulson, volume 6, 4th edition, Elsevier Butterworth-Heinemann 2005

BACK

Program: Biotechnology		Semester: V
Course Title: Biological Thermodynamics		Course Code: 24EBTC304
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 40
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Basic concepts

System, Surrounding, State and Properties, Intensive and extensive properties, State and path functions, Heat reservoir, Hess Law, energy and biological world, energy flow transformation, energy conversions, energy, nutritional requirements of living systems, Flow of electrons in organism, energy flow in metabolic process, division of labor in cells, Numerical problems

06 Hours

2. Basic laws of thermodynamics

Zeroth law, First law of Thermodynamics, cyclic process, non-flow process, flow Process, internal energy, Heat capacity, second law of thermodynamics, Concept of entropy, Calculation of entropy changes, Third law of thermodynamics. Numerical problems.

09 Hours

Unit II

3. PVT behavior

P-V-T Behavior of pure fluid, Processes involving ideal gases, Equation of state for real gases: Vander Waals equation, Redlich-Kwong equation, Peng-Robinson equation, Virial equation. Compressibility charts: Principle of corresponding states, Numerical problems.

07 Hours

4. Thermodynamic properties of Biological fluids

Classification of thermodynamic properties, Work function, Gibbs free energy, Gibbs-Helmholtz equation, ATP Synthesis in cell and Protein Folding, Metabolic reactions in cells. Entropy - heat capacity relationships, Relationships between C_p and $C_{v,}$, Activity of molecule, Chemical potential, Oxidation-Reduction reaction, Cell Membrane Transportation & Protein Extraction, Osmosis, Nernst equation in membrane transportation, Numerical problems.

08 Hours

Unit III

5. Statistical Thermodynamics

Boltzmann distribution & partition function, Protein folding and helix-coil transition, Binding equilibria, Oxygen biding to myoglobin & Hemoglobin.

04 Hours

6. Reaction Equilibria

Reaction Stoichiometry, Effect of temperature on standard heat of reaction. energy coupling reactions, activation energy, Criteria of chemical reaction equilibrium, Relationship between Equilibrium constant and standard free energy change, Effect of temperature, pH and pressure on equilibrium constants and other factors affecting equilibrium conversion, Numerical problems**.**

06 Hours

Text Books

1. Biological Thermodynamics by Donald T. Haynie, 2nd edition, Cambridge University Press,2008
2. Introduction to chemical engineering thermodynamics by J.M.Smith, H. C. VanNess, M.M. Abbott, 7th edition, Tata McGraw-Hill, NewDelhi, 2005.

Reference Books

1. Thermodynamics. An engineering approach, by Yunus A. Cengel, Michael A. Boles, 8th edition, McGraw- Hill, 2014.
2. Chemical Engineering Thermodynamics by Y.V.C. Rao. 2nd edition, Universities Press, 1997.
3. Chemical and Process Thermodynamics by B.G.Kyle. 3rd edition, Prentice Hall of India Private limited, 2015.

BACK

Program: Biotechnology		Semester: V
Course Title: Research Methodology		Course Code: 24EBTC305
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 40
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Introduction to Research and Research Methodology

Introduction, Objectives and scope of research, Research methods and Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical Concept of Translatory research.

04 Hours

2. Research Philosophy and Formulation of Research Problem

Concept of Research Philosophy- (Ontology, Logic, Method and Epistemeology) Formulation of Research Problem- Necessity of defining the research problem and framing the problem statement.

03 Hours

3. Sources and Review of Literature

Introduction and need for Literature Review., Search Procedures and Gap analysis. Sources of Literature - Research articles, review articles, Research communications, Book chapters. Bibliometrics- Citation index, Impact factor, author h-index and i10-index, awareness on predatory journals and its identification, grants and funding agencies for biotechnology research

08 Hours

Unit II

4. Sampling & Data Collection

Explain sampling and its significance. Describe different methods of sampling.

03 Hours

5. Statistical Analysis of Data

Measures of Central Tendency, Measures of Dispersion and variance, Correlation and Regression Development of hypothesis and testing : Chi- square test, Student's t-test, ANOVA

07 Hours

6. Design of Experiments

Introduction and significance of DOE, Types - Factorial Design, Plackett Burman Design, Central Composite Design, Response Surface Methodology, Design of matrix and analysis, Contour

plots and response surface plots, QBD principles, Introduction to Artificial Intelligence and its application in biotechnology

05 Hours

Unit III

7. Environment, Ethics and IPR in Research

Impacts of Research on Environment, - Ethical issues, ethical committees, Research Generated Intellectual Property Rights- Copy-right & royalty, Patent law, Trade mark, Trade secret, Geographical Indicator, Industrial Design. Concept of Plagiarism

05 Hours

8. Research Communication

Written Communication- Introduction, Structure and components of scientific reports – Bibliography, referencing and footnotes. Oral Presentation – Developing and delivering presentation

05 Hours

Text Books

1. C.R. Kothari and Guarav Garg, Research Methodology, III Edition, New Age International Publisher, New Delhi, 2014
2. N. Gurumani, Research Methodology for Biological SISAnces, I Edition, MJP Publishers, Chennai, 2007

Reference Books

1. Design and Analysis of Experiments by Montgomery D. C. John Wiley Publishers
2. An Introduction to Research Methodology by Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. RBSA Publishers

BACK

Program: Biotechnology		**Semester: V**
Course Title: Mini Project		**Course Code: 15EBTW301**
L-T-P:: 0-0-3	**Credits:3.0**	**Contact Hours: 09**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours: NA	**Examination Duration: 3 Hours**	

Preamble:

The Mini project is an essential part of the curriculum structure which integrates all the skills acquired from all the theory and laboratory courses of 3rd and 4th semester. The mini project work is based on the theme: "Isolation and preliminary characterization of metabolites producing microorganisms". Mini project emphasizes on basic skill development like isolation, screening, and characterization of the microorganisms. Students gain hands on experience during their mini Project implementation. Mini project facilitates the students to present their work on different platforms likes seminars and national conferences. Mini project help students in their job, higher studies as well in higher research careers.

Guidelines:

1. Mini project has to be carried out in teams of four students.
2. Every team needs to maintain laboratory work book which contains details of all the work carried out in the laboratory.
3. Make entries in log books for instrument usage.
4. Adhere on timely report submission to the coordinator.
5. Provide requisitions beforehand for any project work

Review committee:

Review committee is formed by the mini project coordinator taking into consideration each review committee has faculty experts from all the domains. Review committee also consists of the guide of the respective project group.

Project evaluation:

Sl. No	Phase	Marks	Review
1	Concept generation phase	15	Committee
2	Preliminary design phase	10	Guide/s
3	Definitive design phase	10	Guide/s
4	Final submission	15	Committee
3	End Semester Assessment	50	External/Internal
Total Marks		100	

BACK

Program: Biotechnology		Semester: V
Course Title: Genetic Engineering & Immunotechnology Lab		Course Code: 23EBTP301
L-T-P:: 0-0-1	Credits:1.0	Contact Hours: 02
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration: 3 Hours	

List of Experiments:

1. Preparation of Competent *E coli* cells (**Structured Inquiry**)
2. Ligation of DNA fragment with vector and Transformation (Demonstration)
3. Restriction digestion analysis of plasmid DNA (Structured Inquiry)
4. Introduction to PCR –Programming, and amplification of DNA (Exercise)
5. Screening of Transformants by Colony PCR (Demonstration)
6. TA Cloning method for cloning of PCR product. (**Structured Inquiry**)
7. Demonstration of Southern blotting (Demonstration)
8. Agglutination techniques – Heam agglutination techniques and Bacterial agglutination techniques (Exercise)
9. Radial diffusion and Rocket Immunoelectrophoresis (Exercise)
10. Dot-ELISA(Enzyme Linked Immuno Sorbent Assay) (Exercise)

Text Books/Reference Books:

1. Principles of Gene Manipulations- Introduction to Genetic Engineering, by R.W. Old and S.D. Primrose(2007), Blackwell SISAntific Publications.
2. Molecular Cloning- By T.Maniatis, E.F. Fritsch and J. Sambrook, Cold spring Harbour (2009)

BACK

Program: Biotechnology		Semester: V
Course Title: Bioinformatics Lab		Course Code: 22EBTP302
L-T-P:: 0-0-1	Credits:1.0	Contact Hours: 02
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration: 3 Hours	

List of Experiments:

1. Biological Databases: Searching bibliographic database for relevant information and retrieve from nucleic acid and Protein sequence database
2. PDB: Protein Data Bank and structure visualization
3. Searching sequence database using BLAST algorithm & Pair wise alignment of the sequences (nucleic acid and protein).
4. Multiple Sequence (nucleic acid and protein) Alignment & Phylogenetic Analysis: CLUSTALW/Phylogeny
5. Gene structure Prediction from genomes.
6. Nucleic acid analysis: Restriction digestion, primer design and in-silico PCR.
7. Protein 2D & 3D structure Prediction
8. Protein Sequence and Structure analysis: Physicochemical parameters, binding site, sub-cellular location, protein stability, patterns and conserve domain.
9. Identification of ligands/Virtual Screening
10. Molecular Docking and interaction analysis.
11. Identification of Ligand for protein involved in pathogenesis.

Text Books/Reference Books:

1. Mohammed Iftekhar and Mohammed Rukunuddin Ghalib; Bioinformatics Practical Manual; Createspace Independent Pub; Large Print edition (28 September 2015).
2. K Kasturi, K Sri Lakshmi; Bioinformatics: A Practical Manual; Pharmamed Press; St ed. edition (2 July 2018).
3. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd, Wiley-Inte, 2005.

BACK

Program: Biotechnology		Semester: VI
Course Title: Bioprocess Engineering		Course Code: 24EBTC306
L-T-P:: 4-0-0	Credits:4.0	Contact Hours: 04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit - I

1.Media and Inoculum development for industrial fermentations

Bioprocess development: An interdisciplinary challenge, Biotechnology & Bioprocess Engineering, steps in bioprocess development, Media ingredients, medium formulation, oxygen requirements, antifoams, medium optimization, Ingredients for mammalian cell culture and plant cell culture. Introduction, Criteria for transfer of inoculum, development of inocula for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant Fermenter.

08 Hours

2.Sterilization

Media sterilization, Design of sterilization process: Batch Process (Dell factor, holding time, and thermal death kinetics), continuous sterilization process; sterilization of fermenter and other ancillaries. Scale up of sterilization, filter sterilization of air and media.

05 Hours

3.Design of bioreactors

Basic objective of fermenter design, aseptic operation & containment regulation, achievement and maintenance of aseptic conditions, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Animal cell bioreactors. Single use bioreactor, perfusion system, Data analysis software for fermenter Ex:simca software.

07 Hours

Unit - II

4.Scale Up of Bioreactor

Scale up of bioreactors: Introduction, Scale-Up methods: Geometric and Dynamic Similarity, Criteria for scale-up: Constant power consumption/volume, constant KLa, constant mixing time, constant tip speed, Regime analysis: Time constant for transport phenomena, time constant for conversion. Scale down approach.

05 Hours

5.Heat Transfer

Heat transfer in Bioprocess: Design equation for heat transfer process, Energy balance, Logarithmic and arithmetic mean temperature difference, Calculation for heat transfer coeffiISAnt, applications of design equations, Relationship in between heat transfer, cell concentrations and stirring conditions, Numerical based examples on above.

04 Hours

6.Mass Transfer

Mass transfer in Bioprocess: Role of diffusion in bioprocessing, Different equations in mass transfer (liquid-solid, liquid-liquid and gas-liquid) , Oxygen uptake in cell culture: Factors affecting cellular oxygen demand, Oxygen transfer from gas bubble to cells, Oxygen transfer in fermenter, measuring dissolved oxygen concentrations, Measurement of KLa: Oxygen balance method, Gassing out techniques (static method of Gassing out and dynamic method of Gassing out) Sulphite oxidation, Factors affecting KLa, Oxygen transfer in large vessels, Numerical based examples on above.

05 Hours

7.Fermenter fluid rheology

Fermentation broth: Viscosity, Viscosity measurement, Rheological properties of fermentation broths, Factors affecting broth viscosity , Mixing in Fermenters: Mechanism of mixing, Assessing mixing effectiveness, estimation of mixing time, Power requirement for mixing: Ungassed Newtonian fluids, ungassed non-Newtonian fluids, Gassed fluids, Calculation of power requirements, Scaleupof mixing systems, Improving mixing in Fermenters, Effect of rheological properties on mixing, Role of shear in stirred fementers: Interaction between cells and turbulent eddies, Bubble shear, operating conditions for shear damage. Numericals

06 Hours

Unit - III

8.Bioreactor kinetics

Batch reactor kinetics, CSTR kinetics, Fedbatch kinetics and plug flow kinetics, Numericals

05 Hours

9.Solid State fermentation:

Introduction, SSF v/s SMF, Types of SSF reactors, Microbial growth kinetics in SSF, Heat & Mass Transfer in SSF

05 Hours

Text Books

1. Pauline M. Doran, Bioprocess Engineering Principles, 2, Academic Press, 2003
2. Stanbury & Whittaker, Principles of Fermentation Technology, 2, Pergamum Press, 2000

Reference Books

1. Michael L. Shuler & Fikret Kargi, Bioprocess Engineering, 2, Prentice Hall, 2001
2. Bailey, James E.; Ollis, David F., Biochemical Engineering Fundamentals, McGraw-Hill Education, 1986

BACK

Program: Biotechnology		Semester: VI
Course Title: Bioprocess Control and Automation		Course Code: 24EBTC302
L-T-P:: 4-0-0	Credits:4.0	Contact Hours: 04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit I

1 Instrumentation & Process Dynamics: Introduction to Measurement of important physicochemical and biochemical parameters in bioprocess. Methods of on line and off line estimation of biomass, substrates and products. Brief introduction to typical automatic control system and its components. Open loop and closed loop control systems.

05 Hours

2 First & Second Order Systems: Mathematical representation of physical systems. Transfer function representation of linear first order systems, Examples: mercury in glass thermometer & Liquid level system. Mathematical forms of standard Input function/Forcing Functions such as Step input, Impulse Input, Linearly increasing Input and Sinusoidal Input. Response of first order system for step input, Features of step response, Response of linearly increasing input. Conceptual numerical. First Order Systems in Series: Interacting and Non-Interacting systems & their Transfer function representation. Second Order Systems: Transfer function representation of Second order systems, Example: Pneumatic Control Valve.

10 Hours

Unit II

3 Controller and Final Control Elements: Different types of controllers-P (Special case of P-controller i.e ON-OFF controller), PI, PD, PID controllers. Derivation of Transfer Functions of different types of controllers. Final control element: The role of Final control Element in control system. Example: Pneumatic Control Valve: Working of Pneumatic control valve, Types of Pneumatic Control Valves i.e. Air to close & air to open.

10 Hours

4 Block Diagram Reduction: Block diagram representation of control systems, Block diagram reduction in case of Servo and Regulatory control systems. Reduction of block diagrams for single input & Single output systems (SISO) & Multiple Input & Multiple Output Systems (MIMO), Problems on block diagram reduction.

05 Hours

5 Block Diagram Reduction (MIMO systems): Analysis of Multiple Input Multiple Output Systems: Introduction to Multiple Input & Multiple Output Systems (MIMO), Examples of MIMO systems. Analysis of MIMO systems considering only one Input at a time while other Inputs are Suppressed. Considering only one output at a time while other outputs are Suppressed. Problems on block diagram reduction considering MIMO systems.

10 Hours

Unit III

6 Transient response of different controllers for Servo & Regulatory control Problems: Transient response of P, PI, PD & PID controllers for servo and regulatory problems. The determination of offset in all cases.

05 Hours

7 Analysis of Stability: Concept of stability, stability criterion. Routh test for stability. Theorems of Routh Array test, Conceptual numerical on Routh test for stability.

05 Hours

Text Books:

1. Donald R Coughnowr, Process System analysis and control, 3rd Edn., Mc Graw Hill, 2017.
2. George Stephanopoulos, Chemical Process Control, 1st Edn, Prentice Hall of India, 2015.

Reference Books:

3. Peter Harriott, Process Control, 2nd Edn, Tata McGraw-Hill Publishing Company Limited, 2017.

BACK

Program: Biotechnology		**Semester: VI**
Course Title: Minor Project		**Course Code: 15EBTW302**
L-T-P:: 0-0-6	**Credits:6.0**	**Contact Hours: 18**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:NA	**Examination Duration: 3 Hours**	

Preamble:

The Minor project is an essential part of the curriculum structure which integrates all the skills acquired from theory and laboratory courses of 3rd, 4th and 5th semester. The minor project work is based on the theme: "Production of metabolites and study of effect of physic-chemical parameters by isolates". Minor project emphasizes on studies on fermentation process, design of experiments, and partial purification of metabolites. Students gain hands on experience during their minor project implementation. Minor project facilitates the students to present their work on different platforms likes seminars and national conferences. Minor project help students in their job, higher studies as well in higher research careers.

Guidelines:

1. Minor project has to be carried out in teams of four students.
2. Every team needs to maintain laboratory work book which contains details of all the work carried out in the laboratory.
3. Make entries in log books for instrument usage.
4. Adhere on timely report submission to the coordinator.
5. Provide requisitions before hand for any project work

Review committee:

Review committee is formed by the minor project coordinator taking into consideration each review committee has faculty experts from all the domains. Review committee also consists of the guide of the respective project group.

Project evaluation:

Sl. No	Phase	Marks	Review
1	Concept generation phase	15	Committee
2	Preliminary design phase	10	Guide/s
3	Definitive design phase	10	Guide/s
4	Final submission	15	Committee
5	End Semester Assessment	50	External/Internal
Total Marks		100	

BACK

Program: Biotechnology		Semester: VI
Course Title: Bioprocess Engineering Lab		Course Code: 23EBTP303
L-T-P:: 0-0-1.5	Credits:1.5	Contact Hours: 03
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:36	Examination Duration: 3 Hours	

List of Experiments:

1. Laboratory Fermenter: Design principles, components, and process control.
2. Pilot scale Fermenter: Design principles, components, and process control.
3. Differentiate different aseptic operation and containment regulation between lab & pilot scale fermenter.
4. Sterilization-in-place: Calculation of dell factor for Sterilization of media in lab fermenter.
5. Clean-in-place: Identify and execute different procedure involved in maintenance and cleaning of lab & pilot scale fermenter.
6. Monitoring and control of Operation parameters: Execute the process of calibration, control & Maintenance of fermenter sensors.
7. Fermentation methods: Demonstrate aseptic operation and containment regulation of fermenter like inoculation, aeration and sampling procedures.
8. Determination of kinetic parameters of microorganism using batch mode.
9. Design an experiment to determine mixing time, power requirement, and K_{La} of fermenter.
10. Design batch reactor using modeling and simulation software super pro.

Text Books/Reference Books

1. Debabrata Das and Debayan Das; Biochemical Engineering: A Laboratory Manual; Jenny Stanford Publishing; 1st edition (11 January 2021).
2. S. N. Mukhopadhyay; Process Biotechnology: Theory and Practice; The Energy and Resources Institute, TERI.
3. Pauline M. Doran, Bioprocess Engineering Principles, 2, Academic Press, 2013.
4. Stanbury & Whittaker, Principles of Fermentation Technology, Butterworth-Heinemann; 3rd edition (14 September 2016)

BACK

Program: Biotechnology		Semester: VI
Course Title: Bioprocess Control & Reaction Engineering Lab		Course Code: 23EBTP301
L-T-P:: 0-0-1.5	Credits:1.5	Contact Hours: 02
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration: 3 Hours	

List of Experiments:

1. Study of characteristics of Transducers (such as Resistance Temperature Detector (RTD) sensor, Thermister, Thermocouple).
2. Determination of Time constant of given first order system (such as mercury in glass thermometer, bimetallic thermometer, RTD sensor using step response).
3. Response of first order system for step & Impulse inputs.
4. Response of first order systems arranged in Non-interacting mode for standard inputs (like step input, Impulse Input).
5. Response of first order systems arranged in Interacting mode for standard inputs (like step input, Impulse Input).
6. Transient response of change in set point/load variable on different control systems (such as Temperature, Pressure and Flow control systems) using different controllers (such as P-controller, PI-Controller, ON-Off controller etc).
7. Linearization of Non Linear Systems (such as control Valve).
8. Analyze the characteristics of different types of reactors (PFR & MFR)
9. Determination of Vessel dispersion number
10. Determination of rate constant for first order reaction.

Text Books/Reference Books:

1. Process System analysis and control by Donald R Coughnowr, 3rd Edn. Mc Graw Hill,2017
2. Chemical Process Control by George Stephanopoulos, 1st edition,Prentice Hall of India,2015

BACK

Program: Biotechnology		Semester: VI
Course Title: Bio Analytical Techniques		Course Code: 19EBTE301
L-T-P:3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Introduction to Bio-analysis

Introduction to instrumentation, Functional elements of an instrumentation system, static and dynamic characteristics, calibration of instrumental methods, Types of errors, Methods of expressing precision and accuracy, Confidence limits, Uncertainties in Instrumental measurements – Sensitivity and detection, preparation & storage of solutions, usage of laboratory glasswares, statistical analysis of experimental data, Electrodes and Biochemical preparation.

05 Hours

2. Spectroscopy

General principles–Radiation, energy and atomic structure- types of spectra and their biochemical usefulness basic laws of light absorption. Electromagnetic radiation & Spectrum, Beer – Lambert's Law and apparent deviations; UV – VIS Spectrophotometer

05 Hours

3. Advanced Spectroscopy

Spectroflourimetry, Atomic absorption spectroscopy, IR spectroscopy, FTIR, Nuclear Magnetic Resonance, Mass spectroscopy, ORD, CD, X-ray diffraction.

05 Hours

Unit II

4. Chromatographic techniques

Analytical techniques for biomolecules purification, Paper chromatography, thin layer chromatography, Column chromatography, Gas chromatography, Ion-exchange chromatography, molecular exclusion chromatography, affinity chromatography, High performance liquid chromatography & UPLC- Principles, Methods, Instrumentation, Detectors, Analysis of data.

08 Hours

5. Electrophoretic techniques

Theory & application of polyacrylamide & Agarose gel electrophoresis for protein & nucleic acids, capillary electrophoresis, pulsed field gel electrophoresis, Iso-electric focusing, 2D-gel electrophoresis and Immunoelectrophoresis

06 Hours

Unit III

6. Centrifugation techniques

Basic principles of sedimentation, centrifuges and their uses, preparative ultracentrifuges, density gradient ,analytical ultra-centrifuges, applications

06 Hours

7. Advanced Instrumental methods

LC-MS, GC-MS, HPTLC, SEM, Atomic Force Microscopy, transmission electron microscopy (TEM)

04 Hours

Text Books

1. Wilson K & Walker J., Principles and Techniques of Practical Biochemistry, 5th edition, Cambridge Univ. Press., 2000.
2. Rodney Boyer, Modern Experimental Biochemistry, 3rd edition, Pearson Education, 2002
3. Chatwal and Anand, Spectroscopy, Himalaya Publishing house-New Delhi, 2016

Reference Books

1. Willard H. W. & Meritt L. L, Instrumental methods for chemical analysis, 7th edition. CBS Publishers & Distributors, 2004
2. Chatwal and Anand, Instrumental methods for chemical analysis, Himalaya Publishing house, 2012

BACK

Program: Biotechnology		Semester: VI
Course Title: Bioprocess Plant Design and Economics		Course Code: 18EBTE301
L-T-P:3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Introduction to Process Design Development

Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design, and comparison of different processes, Equipment design and specialization, factors affecting the investment.

06 Hours

2. General Design Considerations

Marketability of the product, availability of technology, Health and safety hazards, raw materials, human resources, loss prevention Environmental protection and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, structural design, storage, materials handling, materials and fabrication Selection, optimum design and design strategy. Waste disposal, physical treatment, chemical treatment and biological treatment, govt. regulations and other legal restrictions, community factors. Safety and hazard control measures.

10 Hours

Unit II

3. Cost Analysis and Manufacturing Cost

Cost Analysis: Factors involved in project cost estimation. Cash flow diagrams for the industrial operation, Cumulative cash position, factors affecting the Investment and production cost, Different methods employed for the estimation of the capital investment. Estimation of equipment cost by sixth tenth rule, Cost index. Marshall and swift installed – equipment indexes, Engineers News-Record construction index, Nelson –Farrar refinery construction index. and Chemical Engineering plant cost index Manufacturing Costs: Direct Production costs, indirect cost and fixed charges (including depreciation, taxes, insurance, rental costs etc.)

10 Hours

4. Bioprocess Economics:

Economic analysis for the production of following Products.(Historical Perspective, Fermentation Technology, Recovery of product and process economics of following

products)

- High volume, low value products. (Citric acid, Ethanol and Amino acids etc)
- Medium volume, medium value products.(Antibiotics, Crude Enzymes and Vitamins etc)
- Low volume, high value products. (MAb, purified Enzymes and Therapeutic proteins etc)

06 Hours

Unit III

5. Profitability Analysis and Optimization Technique

i) Importance of profitability analysis in investment decision making. Different Methods for calculating the profitability. Minimum Acceptable Rate of return. Methods that Do not consider Time value of money.

04 Hours

ii) General procedure to find the optimum conditions, factors affecting the optimization, comparison of analytical and graphical methods. Linear programming, Simultaneous Equations and dynamic programming

04 Hours

Text Books:

1. Peters and Timmerhaus, Plant Design and Economics for Chemical Engineers, McGraw Hill 5th edition, 2004.
2. Chemical Engineering plant design, Frank C Vilbrandt and Charles E Dryden , McGraw Hill 4th edition, 1959

Reference Books:

1. Rudd and Watson, Strategy of Process Engineering, Wiley, 1987.
2. Backhurst, J.R And Harker, J. H - Process Plant Design, Heieman Educational Books, (1973
3. Biochemical Engineering Fundamentals, James E Baily David F Oillis. McGraw-Hil International Edition

BACK

Program: Biotechnology		Semester: VI
Course Title: Insilco Modeling and Drug Design		Course Code: 15EBTE302
L-T-P:3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Insilico Drug Design

Generation of rational Approaches in Drug Design Molecular modeling: The second generation, Conception frame and methodology of molecular modeling, Importance of the " Bioactive Confirmation", Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural similarities and Superimposition Techniques, Rational Drug design and Chemical Intuition

08 Hours

2. Molecular Modeling :

Constructing and Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure generation or Retrivel, structure visualization, Confirmation generation, Deriving Bioactive Confirmations Molecule Superposition and Alignment Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking Calculation of Molecular Properties, Energy Calculations (no derivation), Example of Small Molecular Modeling Work,

08 Hours

Unit II

3. Computer Assisted New LEAD Design.
Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Confirmation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure

03 Hours

4. Docking Methods
Program GREEN Grid: Three-Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three Dimensional Database Search Approaches, Automated Structure Construction Methods with known Three Dimensional Structure of the Receptor, Structure construction in the case of Unknown Receptor Structure. Scope and Limitation Points for Consideration in Structure Methods, Handling of X Ray Structure of Protein, Future Perspectives, Types of programs available for molecular modeling scope and limitations-interpretation of results

11 Hours

Unit III

5. Computer Assisted Drug Discovery-Part-I.

The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD),

05 Hours

6. Computer Assisted Drug Discovery-Part-II.

Current Practice of CADD in the Pharmaceutical Industry, Management Structure of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware Constraints.

05 Hours

Text Books:

1. Moody P.C.E. and A.J.Wilkinson Protein Engineering,IRL Press Oxford 1990.
2. The molecular modeling perspective in drug design by N Claude Cohen,1996,Academic Press

Reference Books:

1. M.Michael Gromiha, Protein Bioinformatics- From Sequence to Function. Academic press 2010
2. Branden C.and Tooze R.Introcuction of Protein structure, Garland 1993

BACK

Program: Biotechnology		Semester: VI
Course Title: Bioprocess Modeling and Simulation		Course Code: : 18EBTE302
L-T-P:3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1.Introduction to modeling:

Introduction, Mathematical Modeling of Bioprocess Engineering System, General Aspects of the Modeling Approach, General Modeling Procedure: Fundamentals uses of mathematical model, scope of coverage, principles of formulation; Fundamental Laws of Modeling: continuity equation, energy equation with examples

05 Hours

2.Fundamental Laws of Modeling:

Equation of motion, transport equation, equation of state, phase and chemical equilibrium, chemical kinetics; Lumped and distributor parameters with examples

05 Hours

3. Mathematical models of Biochemical Engineering Systems:

Modeling of Batch reactors, modeling of CSTR, Numericals. Plug flow reactor, Fluidized bed reactor, Reactors used in effluent treatments, packed bed reactor.

05 Hours

Unit II

4. Use of MATLAB in Process Simulation:

Basics-Data analysis-curve fittings, Numerical integration, Euler and fourth order RungeKutta method, Input and Output in MATLAB. Solving problems using MATLAB by numerical integration, Euler and fourth order Runge Kutta methods. Simulation of CSTR and Batch Reactor, Simulation of Plug flow reactor.

10 Hours

4.Introduction to Process Design:

Steps involved in process design, Process flow diagram structure and hierarchical approach, importance of Material and Energy balance, selection of unit operations,

05 Hours

Unit III

5.Introduction to process simulation software

Bioprocess design with example: Process Description, Specifying Process Sections, Specifying Equipment Sharing, Initialization of Reaction Operations, Process Analysis, Cost Analysis and Economic Evaluation, Environmental Impact.

05 Hours

6. Use of Super Pro in Process Simulation:

Components and mixtures, Physical and Chemical properties of components, material and energy balance simulation, adding unit operation, scheduling the unit process, process cost estimation, sizing of the unit operation. Case study: Monoclonal antibody production, Enzyme production

05 Hours

Text Books:

1. Luyben W.L., Process Modeling Simulation and Control for Chemical Engineers., McGraw Hill, 1988.
2. Pauline M. Doran, "Bioprocess Engineering Calculation", Blackwell Scientific Publications.

Reference Books:

1. Kenneth J. Beers. "Numerical Methods for Chemical Engineering Applications in MATLAB®", Massachusetts Institute of Technology, Cambridge University press 2007 edition.

2. Bailey and Ollis, "Biochemical Engineering Fundamentals", 2 nd ed.,McGraw Hill, 1986.

BACK

Program: Biotechnology		Semester: VI
Course Title: Structural Biology		Course Code: : 22EBTE301
L-T-P:3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1 Introduction to Protein Structures: Concept of chirality in biological molecules & its significance, Structural significance of biomolecules, Classification & structures of amino acids, Levels of protein structure, Conformational analysis & forces that determine protein structures, Geometries, Potential energy calculations, Main chain torsional angles – ϕ (phi), Ψ (psi), ω (omega) & χ (chi).

06 Hours

2. Protein Structures

Ramachandran plot, allowed chi angles in proteins, hydrogen bonding, disulphide bonds, hydrophobic interactions. Secondary structures : Hélix- Alpha hélix pi hélix, Beta sheets, coils and turns, Helix to coil transition & zipper model. Tertiary structures of proteins, quaternaire structures of proteins. Relationships between primary, secondary tertiary & quaternaire structures of proteins. protein folding- General features & thermodynamic aspects of protein folding, folding kinetics. Ligand interactions, Scatchard plot, co-operative interactions, Hill constant & linked functions. Relationship between the primary, secondary, and tertiary structure of proteins. Structure of Immunoglobulin, fibrous proteins (Examples).

09 Hours

Unit II

3. Structures of Nucleic Acids

Structure and classification of Nucleic acids. Difference between nucleoside and nucleotide. Levels of nucleic acid structure, general characteristics of nucleic structure, glycosidic bond, rotational isomers & ribose puckering forces (C2’ exo & endo, & C3’exo & endo). Polynucleotide chain, main chain & side torsional angles, base pairing (Watson-Crick, Hoogstein, Reverse Hoogstein, etc), base stacking, secondary structure of DNA and tRNA, A, B & Z forms of DNA, intra-molecular interactions in the double helix. Thermodynamics of melting of double helix. Kinetics of unwinding of double helix, interaction with small ions. DNA replication. Tertiary structure of DNA and tRNA.

11 Hours

4. Structures of Biomembranes

Structure and conformational properties of cell membranes, Singer and Nicholson model,

integral proteins in membranes, conformational variations during ion transport, signal transduction and molecular reception (qualitative).

04 Hours

Unit III

5. Biomolecular Interactions and Dynamics-I

Association of macromolecules, molecular conjugates, supramolecular interactions, DNA – Protein interactions, DNA – small molecule interactions, RNA – Protein interactions, Protein – protein interactions, lipid/membrane-protein interactions

05 Hours

6. Biomolecular Interactions and Dynamics-II

Molecular mechanics and dynamics (Newtonian and Monte Carlo simulations), theoretical principles and its importance towards in-silico simulations, results of molecular dynamics calculations and their implications to biological function.

05 Hours

Text Books

1. Biophysics – An Introduction by Cotterill, Wiley Student Edition 2002.
2. Biophysical Chemistry by Cantor R, & Schimmel P.R, W.H Freeman & Co. 2002.
3. A Textbook of Biochemistry and Biophysics by S.M Gopinath, Archers & Elevators International Publishing House, India. 1st Edition, 2014.

Reference Books

1. Principles of protein structure by G Shulz & R H Schrimer (Springer Verlag) 1st edition , 1998
2. Lehninger -Principles of Biochemistry by Nelson & Cox. 4th edition. New York: W.H. Freeman. 2008
3. Introduction to Protein Structure by Carl Branden and John Tooze 2nd edition, Garland publishing Co. 1999.

BACK

Program: Biotechnology		Semester: VI
Course Title Clinical Biotechnology		Course Code: : 23EBTE303
L-T-P:3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Fundamentals of Pharmacology and Toxicology

Pharmacology: Drugs action, general principles - binding of drug molecules to cells, tachyphylaxis and desensitization, molecular aspects- targets for drug, Cellular mechanisms – excitation, contraction, secretion, cell proliferation and apoptosis. Biopharmaceuticals drugs from plants, prokaryote and eukaryote, Bioassay, animal models of disease and drug evaluation. Toxicology: Basic concepts, mechanism of action of toxins, biotransformation of toxins & their clearance from the body, toxic intermediates, side effect, adverse effect, acute toxicity, chronic toxicity, toxicity testing, mutagenesis and carcinogenicity, Teratogenesis and drug-induced fetal damage, allergic reaction to drugs, First-line of treatment, Antidotes.

08 Hours

2. Drug discovery and Development process

Drug discovery pipeline, Hit and lead identification, sources of NCEs, Prototype drug, structure-activity relationship (SAR) and quantitative SAR (QSAR), In-silico drug discovery, Target-structure based drug discovery, Characterization and Bio analytical aspects of recombinant proteins, The preclinical stages, clinical development, commercial aspect, NDE, IND.

07 Hours

Unit II

3. Clinical Research and Bioassay methods

General principles and guide to data sources, types of epidemiology study designs, clinical study designs, ecological (correlation) studies, case reports, prevalence surveys or cross-sectional studies, case control studies, clinical trials-informed consent, Placebo responses, clinical registries, clinical research institutes, Data Management, clinical research from pharmaceutical industry perspective. Bioassay methods and their significance in drug development. Concept of pharmacovigilance.

15 Hours

Unit III

4. Clinical research governance and ethics

Brief History of Clinical Research: Sulphanilamide Tragedy, Thalidomide Disaster, Nazi Experiments, Tuskegee Study, Belmont report, Nuremberg code, Declaration of Helsinki principles. Guidelines in Clinical Research-International Conference on Harmonization (ICH), Guidelines for Good Clinical Practice, ICMR guidelines for Biomedical Research on Human Subjects,. Regulation in Clinical Research- Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities. Clinical Research Regulatory Submission & approval Process- IND, NDA and ANDA submission Procedure. DCGI submission procedure. Other Regulatory authorities- EMEA, MHRA, PhRMA. Overview on regulatory affairs for pharmaceuticals, nutraceuticals and medical devices. Good clinical practices, risk assessment and trail monitoring, legal and ethical issues on biotechnology, medical research and related clinical practice.

10 Hours

Text Books:

1. Biochemistry and biotechnology by Gary Walsh, John Wiley & sons Ltd
2. Principles and practice of clinical research by J. I Gallin and F. P Ognibene, Elsevier publications.
3. Current trends in Pharmacology by Arunabha Ray & Kavitha Gulati, IK Intl.
4. Pharmaceutical Biotechnology by K Sambamurthy & Ashutosh Kar, New Age

Reference Books:

1. Basic & clinical Pharmacology by Bartram G. Katzung, Mc Graw Hill.
2. Biopharmaceuticals, biochemistry and biotechnology by Gary Walsh, Wiley Pub

BACK

Program: Biotechnology		Semester: VII
Course Title: Downstream Processing Technology		Course Code: 22EBTC401
L-T-P:: 4-0-0	Credits:4.0	Contact Hours: 04
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3 Hours	

Unit I

1. Introduction

Role and importance of downstream processing in biotechnological processes. Characteristics of biological mixtures: morphology of cells, concentration of cells, products and by-products, rheological behavior. Process design criteria for various classes of by products (high volume, low value products and low volume, high value products), Steps involved: pretreatment, solid/liquid separation, concentration, purification, formulation. case studies, costing of product and numerical

09 Hours

2. Primary Separation Techniques

Cell disruption methods for intracellular products: mechanical methods, physical methods and chemical methods. Removal of insolubles, Biomass (and particulate debris) heat and photosensitive materials separation techniques; Pretreatment of fermentation broth: heating, coagulation and flocculation, adsorption on filter aids. Theory of centrifugation and methods of centrifugation: tubular bowl centrifuge, disc stag centrifuge, decanter centrifuge. Theory of filtration and methods of filtration: plate and frame filter press, rotary drum filter and types of filter media, numerical.

11 Hours

Unit II

3. Membrane separation processes

Membrane – based separations theory; Design and configuration of membrane separation equipment; Concentration polarization and fouling – causes, consequences and control techniques. Membrane modules: tubular module, flat sheet modules, spiral wound module, hollow fiber membrane. Classification of membrane processes: Based on hydrostatic pressure, concentration and applied electric field

12 Hours

4. Enrichment operations

Precipitation methods with salts (salting-in and salting-out), organic solvents, polymers, isoelectric precipitation. Extraction methods for separation: Reversed micellar extraction and

Aqueous two-phase extraction, Supercritical extraction; In situ product removal / integrated bio-processing, SDS PAGE: determination of molecular weight of unknown protein. Numerical.

08 Hours

Unit III

5. Product recovery-I

Introduction to chromatography: Principle, instrumentation and practices (Van Deemter equation). Derivation of equation for resolution of peaks, Preparative High Performance Liquid Chromatography for recovery of product, Ion Exchange Chromatography for separation of ionic compounds, numericals.

05 Hours

6. Product recovery-II

Gel Filtration Chromatography for molecular weight determination. Affinity Chromatography for purification of protein in cell free extract. Polishing Operations: Crystallization, Drying and Freeze drying or lyophilization

05 Hours

Text Books:

1. B. Sivasankar, Bioseparations: Principles and Techniques , Eastern Economy Edit, Prentice-H, 2005
2. P.A. Belter E.L. Cussler, W.S. Hu, Bioseparations: downstream processing for biotechnology, John-Wiley, New York, 1988

Reference Books:

1. BIOTOL, Product Recovery in Bioprocess Technology, VCH, 1990
2. Shuler and Kargi , Bioprocess Engineering , Prentice Hall, 1992
3. Asenjo J. and Dekker M, Separation Processes in Biotechnology , 1993 CRC Press

BACK

Program: Biotechnology		Semester: VII
Course Title: Bioprocess Equipment Design		Course Code: 24EBTC402
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit – I

1.Notation and terminologies

Pipe Joints: Flanged pipe joint, Hydraulic pipe joint, Gland & stuffing box expansion joint, Union joint, Socket & spigot Joint. Welded joints: Butt, Fillet, lap welded joint. Vessel openings: Manholes, nozzles, drains, sight Glasses. Pipe design: Basic notation and terminologies, Schedule 10 and 40. Introduction to design.

04 Hours

2.Materials of Construction

Material properties: Mechanical & types of Corrosion; Materials used: Stainless steel and their alloys, properties of different metals used in stainless steel, Selection criteria, Different Standards (Indian steel codes, American Society for Mechanical Engineers-Bioprocess Engineer (ASME BPE) standard, AISI (American Iron & Steel Institute) standard), different Stainless steel grade: 304, 316.

08 Hours

Unit – II

1.Design of Bioreactor

Fermenter: Steps involved in the design: Volume of Reactor, H/D ratio, impeller design, baffle design, shaft design, Thickness of the shell, thickness of the top & bottom cover, thickness of jocket, heat transfer area of jacket, power number, power required to drive the Impeller.

09 Hours

2.Design of shell and tube Heat exchanger

Heat exchangers: Steps involved in the design, Energy balance, LMTD, Tubing characteristics, Tube side heat transfer coefficient, baffle spacing, shell side heat transfer coefficient, Fouling, Overall heat transfer coefficient, Tube side & shell side Pressure drop Calculations.

09 Hours

Unit – III

3.Equipment qualification & Validation

Design qualification, FAT (factory acceptance test), Site acceptance test, Commissioning, Installation Qualification, Operational qualification, Performance qualification, Equipment Validation.

05 Hours

4.Bioreactor Accessories

Sterilization by filters, Design criteria for filters, filter housing, Filter Integrity test: Diffusive air flow test, Bubble point test, Pressure drop test, Water intrusion test; Valves: Diaphragm valve, Pneumatic valve, pinch valve, Non-return safety Valve; Aseptic seals in fermenter (Gasket, Lip seal, O rings).

05 Hours

Text Books:

1. Chemical Engineering Design by R K Sinnott, vol-6, 4th edition, Butterworth-Heinemann, 2005.
2. Process Equipment Design by M. V. Joshi & V. V. Mahajani, 5th edition, Macmillan India Ltd, 2016.

Reference Books:

1. Fermentation & Biochemical engineering handbook by H. C. Vogel & C. L. Todaro, 3rd edition, Standard publishers distributors.
2. Introduction to chemical equipment design by B. C. Bhattacharyya, 1st e-book edition, CBS Publishers & distributors, 2018

BACK

Program: Biotechnology		Semester: VII
Course Title: Senior Design Project		Course Code: 20EBTW401
L-T-P:: 0-0-6	Credits:6.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours: NA	Examination Duration: 3 Hours	

Preamble:

The engineering graduate's senior design project work is an essential part of the curriculum structure which integrates all the skills acquired during all the theory and laboratory courses addressing Bioprocess Engineering and Molecular Biotechnology verticals. The senior design project work requires exhaustive literature survey to define the problem statement and research objectives. Various optimization strategies help the student to select the best alternative and feasible solution. Project emphasizes on solving real time problems depicting societal benefits and industrial applications. Students gain hands on experience during their Project implementation. Projects also facilitate students to present their work on different platforms likes seminars, national and international conferences. Project helps students in their higher studies as well in higher research careers.

Themes

Senior design project Themes are open and defined in following areas of research

1. Bioprocess engineering
2. Molecular Biotechnology
3. Environmental Biotechnology
4. Phytochemistry
5. Bioinformatics and In-silico approach
6. Process Optimization

Guidelines:

1. Project has to be carried out in teams (4 members).
2. Every team needs to maintain Project work book which contains details of all the work carried out in the laboratory
3. Make entries in log books for instrument usage.
4. Adhere on timely report submission to the project coordinator.
5. Provide prior requisitions for any project work
6. Every team needs to maintain which contains details of all the work carried out in the laboratory.

Review committee:

Review committee is formed by the project coordinator taking into consideration each review committee has faculty experts of all the domains. Review committee consists of the

guide of the respective project group also.

Review:

- In semester assessment (ISA) will be done by the respective guides/review committee as per the rubrics.
- Total of **4 reviews** per semester will be carried out to evaluate the progress of the projects.
- During each review, team has to present the project work carried out (Viva-Voce or PPT).
- End semester Assessment (ESA) evaluation will be done by appointed examiners.

Project evaluation:

Sl. No	Phase	Marks
1.	Concept generation phase	10
2.	Preliminary design phase	10
3.	Definitive design phase	10
4.	Final submission phase	20
5.	End Semester Assessment- External review	50
TOTAL		100

BACK

Program: Biotechnology		**Semester: VII**
Course Title: Downstream Processing Technology Lab		**Course Code:23EBTP401**
L-T-P:: 0-0-1	**Credits:1.0**	**Contact Hours: 02**
ISA Marks:80	**ESA Marks:20**	**Total Marks:100**
Teaching Hours:24	**Examination Duration: 3 Hours**	

List of Experiments

1. Cell disruption technique: Sonication.
2. Determination of cake and filter medium resistance for separation of biomass by Filtration.
3. Determination of settling velocity and RCF of biomass separation by centrifugation.
4. Determination of percentage recovery of proteins from broth by aqueous Two – Phase Extraction process.
5. Determination of Isoelectric point of protein by isoelectric precipitation.
6. Membrane Separation methods: Tangential Flow Filtration.
7. Extraction of chlorophyll and beta-carotene: Column chromatography
8. Determination of protein molecular weight: SDS-PAGE
9. Estimation of metabolite using high performance liquid chromatography
10. Determination of asymmetry and HETP of Akta Start column chromatography

Text Books/ Reference Books:

1. Bioseparations: Principle & Technique; Shiv Shankar B.; PHI LEARNING PRIVATE LIMITED;2009
2. Bioseparations: Downstream Processing for Biotechnology; Paul A. Belter E. L. Cussler Wei-Shou Hu; WILEY INDIA PVT. LTD.-NEW DELHI; 2011
3. Separation Processes in Biotechnology; Juan A. Asenjo; CRC Press (28 June 1990). Protein Purification : Principles and Practice; Robert K Scopes;Springer; 2010 December

BACK

Program: Biotechnology		Semester: VII
Course Title: Mammalian Cell Culture Techniques Lab		Course Code:23EBTP402
L-T-P:: 0-0-1	Credits:1.0	Contact Hours: 02
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration: 3 Hours	

List of Experiments

1. Study of facilities and equipments of Mammalian cell culture lab
2. Aseptic technique and Good cell culture practice.
3. Preparation of cell culture media and sterilization
4. Study of primary cell cultures
5. Initiation of cell culture by revival of cryopreserved cells
6. Study of Monolayer and Suspension cell line cultures and growth monitoring
7. Subculture of monolayer/suspension cell cultures
8. Typhon Blue staining and Counting of Monolayer and Suspension cell cultures
9. Cell Viability Assay – MTT Assay.
10. Cryopreservation of cell cultures by freezing method.

Text Books:

1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, R. Ian Freshne**,** John Wiley & Sons, 2016, Seventh edition.
2. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD, Third edition, 2000.

BACK

Program: Biotechnology		Semester: VII
Course Title: Research experience for undergraduates (REU)		Course Code: 17EBTE490
L-T-P:: 0-0-6	Credits:6.0	Contact Hours: 18
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours: NA	Examination Duration: 3 Hours	

Preamble:

REU is an initiative being implemented for students of VII semester. It is exclusive course designed to motivate and nurture students aspiring for research at early stage. The course gives a feel of research and has been instrumental for many students to seek admissions to higher studies in engineering, both in India and abroad. It is of six credits and interested students opt for the course in lieu of two courses. The list of REU titles along with the guides (with Ph.D.) and co-guides is displayed prior to commencement of the course. Interested students apply with their academic credentials till VI semester. The students are selected based on their CGPA and individual counselling. Selected candidates undertake REU with their supervisors for VII semester and submit a report. The outcomes are expected in the form of conference/journal publications. Also a REU journal, which is a compilation of all REU papers, is published as internal circulation at the university level every year.

Guidelines:

1. REU has to be carried out individually.
2. Each REU student needs to maintain laboratory work book which contains details of all the work carried out in the laboratory.
3. Make entries in log books for instrument usage.
4. Adhere on timely report submission to the coordinator.
5. Provide requisitions beforehand for any project work

Review committee:

Review committee is formed by the REU coordinator taking into consideration each review

committee has faculty experts from all the domains.

REU Evaluation:

Phase	Review	Marks	Review members
1 (Summer semester)	Review-1	15	Guide/s
	Review-2	15	Guide/s
	Review-3	20	Committee
2 (Seventh Semester)	Review-4	25	Guide/s
	Review-5	25	Committee
ESA	Report	50	Guide/s
	Viva-voce	50	External
Total		200	

BACK

Program: Biotechnology		Semester: VII
Course Title: Industrial Biotechnology		Course Code: 20EBTE401
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1 Introduction

History of fermentation products, Range of fermentation process: Traditional approach: biomass, enzymes, metabolites and biotransformation; Modern fermentation process: rDNA products, animal cell culture: therapeutic proteins, monoclonal antibodies; application of system biology approach; generalized representation of typical fermentation process.

05 Hours

2. Isolation and improvement of industrial microorganisms

Isolation methods: Primary screening and secondary screening; Improvement of industrial microorganism: selection of induced mutants for primary and secondary metabolites, isolation of revertant mutants, use of rDNA systems, and improvement by other properties.

05 Hours

3. Fermentation products

Beverages (beer), Ethanol, Aminoacids, enzymes (lipase/protease), penicillin, therapeutic proteins, monoclonal antibodies and vaccines.

05 Hours

Unit II

4 Bioreactor configuration-I

CSTR with recycle, CSTR in series, Airlift reactor, Fluidized bed bioreactor, bubble column bioreactor, packed bed bioreactor, tickle bed bioreactor, deep jet bioreactor, rotating disc bioreactor.

05 Hours

5. Bioreactor configuration-II

Animal cell bioreactors:- Homogeneous reactor: Solid and macro porous micro carriers bioreactor; Heterogeneous reactor: Hallow fiber bioreactor, Packed glass bed bioreactor, fluidized bed bioreactor, cell encapsulation; Disposable bioreactor: Wave bioreactor and stirred bag bioreactor, Perfusion system- single use reactor and Open raise ponds, photo bioreactor.

05 Hours

6. Advance downstream processing

Process integration in product recovery, large scale refolding of therapeutic proteins, advanced membrane technology, Chromatography: column quantification and validation, AKTA purifier, reversed micellar technique for bio separation Single use technology in purification.

05 Hours

Unit III

7. Fermentation monitoring and control:

On-line and off-line monitoring instruments, Bioprocess modeling for control, Estimation technique: Traditional method, linear black-box model and non-linear model; control strategies for fermentation, real time data analysis: Raman spectroscopy.

05 Hours

8. Fermentation data analysis:

Introduction, classification of fermentation measurement and quantities, calculation of metabolites, estimation of unmeasured variables, calculation of integral and averaged variable, physiological variable and pattern recognition technique, SIMCA software.

05 Hours

Text Books:

1. L.E.Casida,JR ,Industrial Microbiology, New Age International (P) Ltd Publication.
2. Prescot and Dun, Industrial Microbiology, McGraw-Hill Book Company, Inc. New York

Reference Books:

1. D.Lanch,Drew,Wang, Comprehensive Biotechnology-Volume 3,Elsevier Publication.
2. George T. Austin, Nicholas Basta; Shreves Chemical Process Industries Handbook; McGraw Hill Professional, 1998

BACK

Program: Biotechnology		Semester: VII
Course Title: Food Processing Technology		Course Code:24EBTE406
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Fundamentals of Food Processing Technology

Basic concepts about properties of foods: liquid, solid and gases; Introduction to food processing: scope and significance; Principles of food processing and preservation

04 Hours

2. Microbial Food Spoilage

Food as substrate for microorganisms, Primary sources of microorganisms in foods, Microbes induced biochemical changes in foods, Microbiological Examination of foods, Food poisoning, and types. , A brief account of various organisms related with food poisoning- *E. coli, Clostridium, Bacillus, Staphylococcus and Vibrio*

. **07 Hours**

3. Food biotechnology and Applications

Enzymes, organic acids, antibiotics, baker's yeast, single cell protein and Mushrooms. Biocolours, Concept of fermented foods and beverages, Probiotics, Prebiotics & Symbiotics, Genetically Modified Foods

04 Hours

Unit II

4. Unit Operations in Food Processing

Introduction, Food Engineering operations- raw material preparation, cleaning, sorting, grading and peeling. Food conversion operations- size reduction, emulsification, filtration, membrane

separation, centrifugation and extraction. Pulsed Electric Field processing, High-Pressure Processing,

04 Hours

5. Thermal Processing of Foods

Heat processing using steam or water, Blanching, Pasteurization, Heat Sterilization, Evaporation, Distillation, Extrusion and Canning. dielectric heating, ohmic and infrared heating. Dehydration, Intermediate Moisture Foods, Baking and Roasting, Heat processing using hot oils- Frying.

06 Hours

6.Non-Thermal Processing of Foods

Chilling, Freezing, Freeze-drying, Vacuum Concentration, Processing by chemical methods- sugar, salt, curing, smoking, acid and chemicals. Irradiation of foods. Controlled and Modified–Atmosphere Packaging. Concept of hurdle technology.

05 Hours

Unit III

7. Food Product Development

Concept and need of new product development, testing and sensory evaluation, Development of product formulation and development,, Role of food ingredients in human health Packaging and shelf life of food products. Concept of Functional Foods and Nutraceuticals.

05 Hours

8. Food laws, Labeling and Regulatory Bodies

Food Laws- General Standards and Regulations as per FSSAI, . Regulatory bodies governing food laws. Certification and labeling of foods. Concept of HACCP and AGMARK

05 Hours

Text Books:

1. P.J.Fellows, Food Processing Technology. Principles and Practices, Second Edition, Woodland Publishing Ltd,Cambridge,England,2002
2. Avantina Sharma, Text Book of Food Science and Technology, International Book Distributing Co, Lucknow, UP, 2006

Reference Books:

1. Ramaswamy H & Marcotte M. Food Processing: Principles and Applications. Taylor & Francis. 2006

BACK

Program: Biotechnology		Semester: VII
Course Title: Environmental Biotechnology		Course Code:22EBTE401
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Introduction

Issues and scope of Environmental Biotechnology, Environment and Biotechnology, Areas of applications for Biotechnology. Microbes and Environment, Genetically modified organisms and Legislation.

03 Hours

2. Waste Water Treatment

Sources of water pollution, Waste water characteristics: Physical, Chemical and Biological characteristics. Chemical Oxygen Demond (COD) and Biochemical Oxygen Demond (BOD). Introduction to physical and chemical waste water treatment methods. Biological wastewater treatment methods: Aerobic suspended growth treatment processes (Activated Sludge Process, aerared lagoons etc), Aerobic attached growth treatment processes (Trickling Filter, Rotating Biological contactors), Anaerobic suspended growth treatment processes- contact digestors, packed column reactors, UASB. Bioelectrochemical systems (BES) including microbial fuel cells (MFCs).

12 Hours

Unit II

3. Solid waste Management

Basic aspects, Generation of solid wastes, general composition of Municipal solid waste, On site handling, storage and processing, Collection of solid wastes. Solid waste processing techniques and equipments. Recovery of biological conversion products from solid waste such as composting, sanitary landfilling, recycling, vermicomposting, incineration. Solid waste management for energy recovery-Biogas production, processing of lignocellulosic waste biomass for ethanol production **08 Hours**

4. Bioremediation and Bioleaching

Uses of bacteria for bioremediation, co-culture and mixed culture biotechnology bioremediation of aromatic and aliphatic hydrocarbons, PCB dechlorination, immobilization techniques for bioremediation, biosorption & bioaccumulation, bioaugmentation and biostimulation genetic engineering of microbes for bioremediation. Phytoremediation-plants capable of assimilating heavy metals. Bioleaching using microbes, role of Thiobacilli, direct & indirect bioleaching, copper extraction by leaching, dump leaching.

07 Hours

Unit III

5. Biofuels

Environmental Biotechnology and biofuels: biogas; bioethanol/biomethane; biodiesel; biohydrogen, bioelectricity; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; phycoremediation- biofuels through algal biotechnology; Microbiologically enhanced oil recovery (MEOR); Production of biosurfactants: bioemulsifiers;

05 Hours

6. Environmental Impact Assessment

Introduction, Scope and history of EIA, Need of Environmental Impact assessment. Stakeholder and public involvement, Identification and quantification of environmental effects and Environmental Impact statement (EIS), Environmental Regulations.

05 Hours

Text Books

1. Pramod Kumar, Vipin Kumar, Pravin Kumar Sachan, Textbook of Environmental Biotechnology, Woodhead Publishing India in Energy, 2019.
2. Indu Shekhar Thakur, Environmental Biotechnology, 2nd edition: Basic Concepts and Applications, Dreamtech Press, 2019.

3. Pradipta Kumar Mohapatra, Textbook of Environmental Biotechnology, I K International Publishing House, 2007.

Reference Books

1. Ozcan Konur, Bioenergy and Biofuels, 1st edition, CRC press, 2018.
2. P. Rajendran, P. Gunasekaran, Microbial Bioremediation, 1st edition, Mjp Publishers, 2011

BACK

Program: Biotechnology		Semester: VII
Course Title: Quality Assurance & Regulations		Course Code:18EBTE403
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Introduction

Introduction to Quality and Quality Regulation, Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP).

06 Hours

2. Quality and Quality Management

Terms Relating to Quality Management System, Quality Policy, Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement, Continual Improvement, Effectiveness, Efficiency; Relating to Process and Product, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Rework, Repair, Scrap, Concession, Deviation Permit, Release; Terms Relating to Documentation.

10 Hours

Unit II

3. Process Validation

Definition and concept of validation, An introduction to process validation, Validation and Qualification, IQ, OQ and PQ. A Review of Prospective, Concurrent, Retrospective Validation Calibration and performance evaluation. Validation of Water & Thermal Systems, including HVAC Facilities & Cleaning Validation. Validation septic Processes, Computer software validation in pharmaceuticals (CSV).

10 Hours

4. Analytical Method Validation

FDA and ICH guidelines. Analytical method validation, Specificity, Linearity, Accuracy, Precision, Limits of detection (LOD) and quantification (LOQ), Minimum detectable amount (MDA), Sample stability and method robustness, System suitability, Statistical process control for HPLC, Troubleshooting out-of-control systems, Case studies, Validation of Analytical Methods.

06 Hours

Unit III

5. Quality Standards

Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Control of Quality Records, Internal Quality Audits, Training, Servicing, Environmental Management System.

04 Hours

6. Implementation and Regulation

Role of QC and QA in Bio/Pharmaceutical organization, Quality System, Contract Review, Design Control, Document and Data Control, Product Identification and Traceability, Process Control, Control of Quality Records, Internal Quality Audits, Training.

04 Hours

Text Books:

1. Pharmaceutical Process Validation by Robert Nash and Alfred Wachter, Marcel Dekker. Publisher: Marcel Dekker Inc. 2011.
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Publisher: Marcel Dekker Inc. 2005.

Reference Books:

1. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker, 2008.
2. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider, Saint Lucie Press, 2004.

BACK

Program: Biotechnology		Semester: VII
Course Title: Process Safety & Risk management in Industrial Biotechnology		Course Code:22EBTE402
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1.Introduction

Introduction to Industrial Hygiene, Basic Laboratory Safety & Personal Protective equipment's (PPE). Risk & Risk Assessment, definition of Hazard and process of hazard identification, frequency and severity of Hazard, Occupational Health and Safety Administration, Safety and loss prevention, scope and outline of risk management. Legislation regarding process safety.

05 Hours

2. Biological Hazards & Containment Levels

Classification of biological hazards, Major pathological mechanisms for health effects associated with hazardous biological agents, Biological Agents, major pathological mechanisms. Biosafety level: The BSL ranges from the lowest biosafety level-1 (BSL-1) to the highest at level-4 (BSL-4) based on the agents. Biohazard risk classification used by the World Health Organization. Bio-waste. Genetically Modified Organisms (GMO): requirements, or other Environmental safety regulations. Containment Levels: Containment requirements based on the assessment of potential biohazard, Biological safety cabinets (Class-I, Class-II& Class-III) to provide personnel & environmental protection, Biological safety cabinets for safety in Research & Manufacturing of Biological products.

10 Hours

Unit II

3.Chemical safety and Fire Safety

Toxicity and safe handling of materials. Identification Material Safety Data Sheet (MSDS), evaluating exposure to volatile toxicants. Industrial hygiene, Industrial Hygiene Regulations. Runaway Reactions. Nature of Accidents and major disasters. Some Case Studies: Bhopal Gas Tragedy, The Flixborough UK, Cyclohexane Disaster, Seveso Accident: July 10, 1976, etc.

Fire and Explosion, Work Place Hazards, Dangerous Substance, Fire triangle, Effective Ignition Source, Fire Extinguishers. Designs to prevent Fire and Explosion. General Design Methods to prevent Fire.

05 Hours

4. Safe Handling Radioactive Materials/Radioactive Isotopes

Introduction to safe handling radioactive materials, Personal Protective Equipment and Clothing, Precautions for Using Radioactive Material, Radioactive Materials Safe Work Practices, Fume Hoods and Biosafety Cabinets, Good Laboratory Practices, Radiation Safety Committee (RSC). **05 Hours**

5. Risk Assessment

Risk Management, evaluating and analyzing risks associated with those hazards, actions to eliminate the hazards, Risk Matrix, Acceptable risks and safety priorities, cost of saving a life, frequency of accidents, safety check lists, assessment of risks from complex plants, Action and Recommendation. Environmental hazards.

05 Hours

Unit III

6. Hazard Identification and evaluation Techniques

Process for identifying hazards, Hazard Identification techniques such as HAZOP (Hazard and Operability Analysis): basic principles, explanation of guide words, procedures, critical examination of flowsheets, FMEA (Failure Modes and Effects Analysis), FTA (Fault Tree Analysis). Event Tree Analysis (ETA), Cause Consequence Analysis & Layer of Protection Analysis. What-If Analysis.

05 Hours

7. Process Safety Audit and Standards

Safety Audit: Key Elements of a Workplace Safety Audit, Safety Audit Checklist, Safety Audit Report, Industrial Process Safety standards: Laws & Regulations. Occupational Health Hazards. Occupational Safety and Health Administration (OSHA) and National Institute of Occupational Safety and Health (NIOSH), Toxic Substance and Control Act (TSCA).

05 Hours

Text Books:

1. Crowl D.A. and Louvar J.F., Chemical Process Safety: Fundamentals with Applications. 3rd Edition. Prentice Hall Publisher.
2. Lees F.P. Lee's Loss Prevention in Process industries: Hazard Identification, Assessment and control. 4th Edition.Sa Mannan Publisher.
3. Chemical Process Safety: Fundamentals with Applications (International Series in the Physical and Chemical Engineering Sciences) Hardcover. 2011 by Daniel Crowl and Joseph Louvar. 3rd Edition. Pearson Prentice Hall Publisher.

Reference Books:

1. Chemical Process Safety: Fundamentals with Applications, 3e Paperback – 1 January 2013 by Daniel A.Crowl and Joseph F. Louvar. 3rd Edition. Pearson Prentice Hall Publisher.
2. What Went Wrong? Case Histories of Process Plant Disasters: How They Could Have Been Avoided. By Kletz T. 5th Edition. Butterworth-Heinemann Publisher.

BACK

Program: Biotechnology		Semester: VII
Course Title: Plant and Animal Biotechnology		Course Code:15EBTE403
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Introduction to plant tissue culture

Introduction and scope of plant tissue culture. Historical events in the development of plant tissue culture method. Practical applications and recent advances. Laboratory organization, Cell culture media and its components. Aseptic manipulation in plant tissue culture laboratory. . Ethical and Social issues related to development and release of transgenic plants with case studies – Bt Cotton.

05 Hours

2. Methods and Techniques in Plant tissue Culture.

Callus and suspension culture, Micropropagation, Protoplast culture & Somatic Hybridization, Anther & Ovary Culture, Somatic Embryogenesis, Embryo & Endosperm culture, Somaclonal variation Germplasm storage by cryopreservation – pretreatment for cryopreservation, freezing, thawing, plant growth and regeneration and applications.

04 Hours

3. Introduction to animal cell and tissue culture

History and Scope of Animal cell and Tissue culture, Advantages and Disadvantages of Cell culture, laboratory facilities for tissue culture. Culture media for cells and tissues. Laboratory layout, Essential equipment's and Consumable items, Aseptic Techniques- elements of aseptic environment and culturing vessels Types of tissue culture – Primary cultures and Cell lines maintenance of cell line cultures

06Hours

Unit II

4.Culture characterization and culture maintenance

Need for characterization, Parameters of Characterization, Cell Morphology, Confocal microscopy, DNA content analysis, Enzyme activity and Antigenic markers. Contamination in cell culture – sources, monitoring and eradication of contamination Cryopreservation and transportation.

04 Hours

5. Animal Cell culture Scale up and Automation

Introduction to scale up and automation. Scale up in suspension culture: Continuous culture, Scale & complexities, Mixing & Aeration. Scale up in Monolayer culture: Multi surface propagators, Roller culture, Microcarriers, and Perfused Monolayer culture. Process control and Automation: Robotic cell culture and High throughput screening.

05 Hours

6. Animal cell culture and Biopharmaceuticals production

Mammalian cells as desired expression systems for protein biopharmaceuticals, Construction and selection of high-producing cell lines, Medium development for mammalian cell culture, and Process development for mammalian cell culture. Single use disposable animal cell culture technologies for biopharmaceutical manufacturing.

06 Hours

Unit III

7. Plant Cell culture and Secondary Metabolite production

Introduction, Selection of high yield cells and Mass cultivation of plant cells: Free cell suspension culture, Immobilized plant cell culture, and Two phase system culture. Elicitor induced accumulation of products. Biotransformation using plant cell cultures, Genetic modification and factors limiting large scale production of useful compounds.

05 Hours

8. Animal cell culture applications and Tissue engineering

Hybridoma Technology and Animal cell culture applications in Monoclonal antibodies production. Products of Animal tissue culture – Erythropoietin, Tissue Plasminogen Activator & Factor VIII etc. Tissue Engineering – Introduction, Cell types, Extracellular matrix and Tissue engineering concepts. Artificial skin development by tissue engineering and its applications.

05 Hours

Text Books:

1. Introduction to Plant tissue culture Second edition. M K Razdan Oxford & IBH Publishing Co Pvt Ltd, New Delhi. 2003
2. Animal Cell Culture – Concept and Application by Sheelendra M Bhatt, Narosa Publishing House, New Delhi ISBN: 978-81-7319-926-4

Reference Books:

1. Introduction to Plant Cell, Tissue and Organ culture Sunil D Purohit PHI Learning Private Ltd, New Delhi 2013. ISBN – 978-81-203-4677-2
2. Culture of Animal Cells - A Manual of Basic Technique by R. Ian Freshney A John Wiley & Sons, Inc., Publication New York (2000)

BACK

Program: Biotechnology		Semester: VII
Course Title: Biopharmaceuticals		Course Code:24EBTE404
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Introduction:

Introduction to pharmaceutical industry, API and pharmaceutical products, Formulation Industry, Introduction to dosage forms, conventional dosage forms, Biopharmaceuticals & Biotechnology, Biopharmaceuticals: Current status & future prospects. Drug discovery & development process, Clinical research, pre-clinical testing in-vitro & in-vivo methods, drug safety & pharmacovigilence, Sources of Biopharmaceuticals, Dosage forms and routes of drug administration.

06 Hours

2. Pharmacokinetic and Pharmacodynamics of Peptide & Protein Drugs:

Introduction to pharmacokinetics and pharmacodynamics, Disease target identification & selection, receptor based apporach, drug as agonist & antagonist, Pharmacokinetics of protein therapeutics, ADME study for small molecules & protein therapeutics, optimization of pharmacokinetic profile, Pharmacodynamics of protein therapeutics, PK/PD Models. Drug metabolism, Phase-I and Phase-II reactions. CYP Families- case study, Drug side effects and adverse effects, drug toxicity, Pharmacogenomics & personalized medicine.

10 Hours

3. The Drug Manufacturing Process:

Pharmacopeias, good manufacturing practices (GMP), good laboratory practices (GLP), manufacturing facilities, clean rooms, water plant & grades of water, production of final product & formulation, analysis of final product (Qualitative & Quantitative), documentation: SOP, specifications & records, batch manufacturing records (BMR), batch packaging records (BPR). Methods to enhance protein based therapeutics, product preservation and packaging techniques.

08 Hours

4. Therapeutic Agents:

The cytokines (Interleukins & Interferons), haemopoetic growth factors (erythropoietin), hormones of therapeutic interest (insulin & glucagon), preservation and clinical use of blood products, therapeutic enzymes, monoclonal & polyclonal antibodies, vaccines and vaccine

technology (with appropriate case studies), gene and cell therapy: recent developments. Sustained drug release, targeted therapy, role of nanotechnology in drug delivery, Novel Drug Delivery Systems.

08 Hours

Unit III

5. Quality in Pharmaceutical Industry:

Quality Assurance & Quality Control, validation & qualification studies, aseptic fill-process validation, cleaning validation, Validation Master Plan, Qualification: IQ, OQ and PQ. Calibration of analytical instruments. Bioassays for protein therapeutics, test for sterility, Bacterial Endotoxin Test, product formulation & stability analysis,

04 Hours

6. Regulatory issues and Drug product approval

Drug approval process (NDA & ANDA), Regulatory framework: Quality, Safety & Efficacy, generic and branded products, Global and Indian sccenario, issues concerned to generics and biosimilars, Biosimilars and follow-on biologics, FDA & its Organizational structure, European regulations, Drug Registration in Japan, World harmonization of drug approvals (The ICH).

04 Hours

Text Books:

1. Biopharmaceuticals: Biochemistry & Biotechnology. Author: Gary Walsh. Second Edition, Pub: John Wiley & Sons, 2011
2. Pharmaceutical Biotechnology: Fundamentals and Applications. Ed: Daan J.A. Crommelin et al. Third Edition. Publisher: Informa Healthcare, 2007

Reference Books:

1. Molecular Biotechnology: Principles & Applications of r-DNA. Author: Bernard Glick & Jack Pasternak.3rd edition, 2002, Pub: Panima Books.
2. Manual of Industrial Microbiology & Biotechnology by Arnold L. Demain. 2nd edition,1999 Pub: ASM Press.
3. Biopharmaceuticals: An Industrial perspective. Authors: Gary Walsh & Brendan Murphy. 2009. Pub: Spring Books.

BACK

Program: Biotechnology		**Semester: VII**
Course Title: Genomics and Proteomics		**Course Code:24EBTE405**
L-T-P:: 3-0-0	**Credits:3.0**	**Contact Hours: 03**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:40	**Examination Duration: 3 Hours**	

Unit I

1. Introductory Genomics

Genomics- Introduction, History and Scope and types, Structure of prokaryotic and eukaryotic genome, Mitochondrial and Chloroplast genome, C- value of genome. Genomics Approaches – traditional and updated, Genome mapping as an approach of genomics and recent approaches of genomics.

04 Hours

2. Genome Analysis and markers

Genome analysis and markers – Introduction, necessity and tools of genome analysis and markers. Genome Sequencing - Whole genome Shot gun, Hierarchial Shotgun, High-throughput sequencing, Chromosome walking, Chromosome jumping, Next Generation Sequencing. Molecular Markers: Concept of Markers, different types of markers and their general applications. Brief introduction to nature and applications of RFLP, RAPD, AFLP, SNP, Micro satellites, Minisatellites, Short Sequence Repeats, VNTR, EST, STS, Marker Assisted Selection

07 Hours

3. Genomics- Recent Advancements and Applications

Microarray analysis, Genomic libraries, Gene-disease associations. Genomics Applications: Nutrigenomics, Toxicogenomics, Pharmacogenomics, Metagenomics, Medical applications, Human Genome Project. Model Organisms for Genomics studies- Yeast and Drosophila

04 Hours

Unit II

4. Introductory Proteomics

Proteomics- Introduction, History, Scope and Types. Protein – Sequence, Structure and function relationship. Different approaches for proteomics studies and their applications.

04 Hours

5. Proteome separation and Purification

Proteome extraction and purification. Separation of Proteins- ion-exchange, size exclusion and affinity chromatography techniques,1-D by Isoelectric focusing, 2-D by SDS-PAGE. Protein

Identification- Edman degradation, Mass Spectrometry, MALDI-TOF, Electrospray ionization, Peptide mass fingerprinting.

08 Hours

6. Proteomics- Recent Advancements and Applications

Applications of proteome analysis to drug; Protein-protein interaction Protein engineering: Protein chips. Clinical and biomedical application of proteomics.

03 Hours

Unit III

7. Bioinformatics tools in Genomics

Raw genome sequences, Major Genomic Databases, Genome Annotation, similarity search, Genome sequence alignment tools.

05 Hours

8. Bioinformatics tools in Proteomics

Proteome Databases, Proteome Annotation, Protein characterization and function, Families, patterns, domains and profiles.

05 Hours

Text Books:

1. Bioinformatics- Methods and Applications. Genomics, Proteomics and Drug Discovery. S.C. Rastogi, N. Mendiratta and P. Rastogi. PHI Learning Private Limited, delhi.
2. GENES IX Benjamn Lewin Oxford University and Cell Press 2010

Reference Books:

1. Introduction to Genomics- Arthur Lesk. Oxford University & Cell Press
2. Principles of Proteomics by R M Twyman BIOS Scientific Publishers 2004

BACK

Program: Biotechnology		**Semester: VII**
Course Title: Bioethics, Safety & IPR		**Course Code:20EBTE403**
L-T-P:: 3-0-0	**Credits:3.0**	**Contact Hours: 03**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:40	**Examination Duration: 3 Hours**	

Unit I

1. Perceptions about Biotechnology: Biotechnology and social responsibility, Positive & negative perceptions of Biotechnology, Public acceptance issues, surveys, areas of public concern for Biotechnology. Socio, ethical, economic and legal aspects of Biotechnology. Public education & Biotechnology.

06 Hours

2. Bioethics: Legality, morality, and ethics, Principles of bioethics: autonomy, human rights, beneficence, justice, equity, etc. Expanding scope of ethics from Biomedical practice to Biotechnology, ethical conflicts in Biotechnology.

05 Hours

3.Biosafety concept and issues : Rational vs. subjective perception of risks and benefits, Hazards of BT , relationship between risk and hazard, Ethical implications of biotechnology products and techniques,

05 Hours

Unit II

4. National and International Regulations: Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI)

10 Hours

5. Biosafety & Management: Laboratory associated Biosafety practices, assessment of biohazard, Biosafety levels,. Risk analysis and assessment, Containment levels-physical, biological containments,. Good manufacturing practice and Good lab practices (GMP and GLP).

05 Hours

Unit III

6. Intellectual Property rights: Introduction to history of GATT, WTO, WIPO and TRIPS; Introduction to IPR, Types of IP: Patents, Trademarks, Copyright, Design & Related Rights. Plant variety protection, Traditional knowledge, breeders rights, Geographical indications, Biodiversity and farmers rights. Patenting in biotechnology, case studies.

05 Hours

7.Food, Agri and Pharma Sector: The GM-food debate and biosafety assessment procedures for biotech foods including transgenic food crops, case studies- Golden Rice and Flav Savr Tomatto. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials.

05 Hours

Text Books:

1. Bioethics & Biosafety- Sateesh MK, I.K.International Publishing House
2. Intellectual Property rights on Biotechnology – Singh K, BCIL, New Delhi.
3. Biotechnology: Expanding Horizons - B D Singh, Kalayani Publishers, 2010

Reference Books:

1. Bioethics & Biosafety – R. Rallapalli & Gita Bali, APH publication, 2007
2. Safety considerations for Biotechnology-Paris, OECD publications

BACK

Program: Biotechnology		Semester: VII
Course Title: Vaccine Technology		Course Code:21EBTE401
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1 History of Vaccine Discovery and Development

Variolation and Vaccination in Late Imperial era, early methods of vaccination, Edward Jenner's Role in the Introduction of Smallpox Vaccine, Eradication of small pox. Fight against polio,Historical background of vaccination, vaccine preventable infectious diseases, Over view of bacterial and viral vaccines and their importance to public health. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, and Tetanus.

07 Hours

2. Role of vaccines in epidemiology and public health system.

Active and passive immunization, General immunization practices, Strategies for improving vaccination levels. Timing and Spacing of Vaccines.. Adverse Reactions Following Vaccination. Contraindications and Precautions to Vaccination. Role of B and T cells, primary and secondary immune response, Immunological memory, Booster doses, Factors influencing the magnitude of vaccine performance, adjuvants. Immune correlates in vaccine development.

08 Hours

Unit II

3. Vaccine design, development and types:

Subunit vaccine component - antigen, delivery system. Structure-based Vaccine design - tools and techniques. Characters of effective vaccines: Vaccines, Live, killed, attenuated, sub unit vaccines, conjugated vaccines. Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines, Edible vaccines.

06 Hours

4. Vaccine manufacturing and Quality Control.

Commercial scale vaccine manufacturing: Upstream (use of cell lines, human diploid) and downstream (chromatography) of active substances. Vaccine formulation (liquid and lyophilization). Use of additives/adjuvants/stabilizers. Vaccine safety and efficacy of vaccines (in vitro and in vivo). cGMP implementation in the production of safe vaccines. Case study of vaccine manufacturing: HBV and polio vaccine **09 Hours**

Unit III

5. Policies, ethical considerations and Regulatory affairs of vaccines.

Regulation and testing of vaccines, Regulation of vaccines in developing countries, Role and functioning of National Regulatory Authorities (ICMR) and WHO .Different stages of review and regulation of vaccines (investigational new drug application, biologics license application, post-licensure). Evolution of vaccine regulations overtime and the current status of NRAs functionality globally. Brief on Indian regulatory system.

05 Hours

6. Recent advancements in vaccinology:

Concepts of reverse vaccinology, case study of Reverse Vaccinology. Novel vaccine delivery systems. Tools & servers for computational Vaccine design-from Genome to Vaccine. Antigenicity modification, epitope replacement, germline targeting. Antigenically variable infectious agents and their vaccines.

05 Hours

Text Books:

1. IAP Textbook of Vaccines by Nitin K Shah, Rohit Agrawal, Vipin M Vashishtha, TU Sukumaran
2. Vaccines. 6th Edition, Stanley Plotkin Walter Orenstein Paul Offit.

Reference Books:

1. Vaccine Development and Manufacturing. Emily P. Wen (Editor), Ronald Ellis (Editor), Narahari S. Pujar (Editor).
2. Vaccines & Vaccine Technologies. Jose Ronnie Vasconcelos

BACK

Program: Biotechnology		Semester: VIII
Course Title: Biological Data Analysis		Course Code:18EBTE402
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1.Introduction to Basic statistics:

Strategy of Experimentation, History of the Design of Experiments, Basic Principles of DOE: Randomization, Replication, Blocking, Multi-factor Designs, Confounding; Steps for Planning, Conducting and Analyzing an Experiment, Typical applications of Experimental design, Basic Principles, Guidelines for Designing, Concepts of random variable, probability, density function, cumulative distribution function. Concept of confidence level. Statistical Distributions: Normal, Log Normal &Weibull distributions. Hypothesis testing, Probability plots.

04 Hours

2. Screening Design:

Introduction, Terminology: factors, levels, interactions, treatment combination, Orthogonal array, PB design, analysis of PD design, Numericals.

05 Hours

3.Full Factorial Design:

Basic Definitions and Principles, The Advantage of Factorials, The Two-Factor Factorial Design, Statistical Analysis of the Fixed Effects Model, Model Adequacy Checking, Estimating the Model Parameters, Concept of the General Factorial Design, 2^k Factorial Design, The 2^2Design, The 2^3 Design, The General 2^k Design.

07 Hours

Unit II

4. Response surface methods:

Introduction, Central composite design, Box Behnken design, importance of counter and surface plots.

05 Hours

5. R Programming Basics:

Overview of R programming, Environment setup with R Studio, R Commands, Variables and Data Types, Control Structures, Vectors, Factors, Functions, Matrices, Arrays and Lists.

06 Hours

6. Interfacing:

Interfacing R to other languages, Parallel R, Basic Statistics: Linear Model, Generalized Linear Models, Non-linear models, Time Series, Autocorrelation and Clustering.

05 Hours

Unit III

7. Introduction to Bioconductor for Sequence Data:

Sequencing Resources, Ranges Infrastructure, DNA /amino acid sequence from FASTA files, Reads from FASTQ files, Aligned Reads from BAM files, Called Variants from VCF files, Genome Annotations from BED, WIG, GTF files.

04 Hours

8. Biological Data Analysis:

Preparing count matrices, The DESeq, DataSet, sample information, and formula design, exploratory analysis and visualization, Differential expression analysis, Plotting results, Annotating and exporting results

04 Hours

Text Books:

1. R for Everyone: Advanced Analytics and Graphics: b y Jared P. Lander Addison Wesley Data & Analytics Series, 2013.
2. Design and analysis of experiments" by D.C. Montgomery, 7th edition John Wiley and sons, New York

Reference Books:

1. A Little Book of R for Bioinformatics: by Avril Coghlan, Release 0.1
2. Design and Analysis of Experiments by Das. M.M. and Giri N.C, Newage publishers, 2017

BACK

Program: Biotechnology		Semester: VIII
Course Title: Genomic Data Analysis		Course Code:21EBTE402
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1.Introduction to Genomics and Data science:

Genomics- Introduction, Structure of prokaryotic and eukaryotic genome, Central dogma, Genome analysis– Introduction, necessity and tools of genome analysis Genome Sequencing methods, Next Generation Sequencing, Introduction to Data Science: Data, Information, Data science, Data science process, Data analytics process, exploratory data analysis, data types and plotting.

05 Hours.

2. Python for genomic data science:Part I

Introduction, Installation, Jupyter note book, types and sequence, python numbers and strings, variables, handling numerical data, python objects, data structure.

10 Hours

Unit II

3. Python for genomic data science:Part II

Ifs and loops, python functions, library, communication with outside, modules and package**.**

05 Hours

4. Genomic analysis: Algorithms

Introduction, DNA as string, manipulation of DNA, Dynamic programming: Local and Global alignment, BLAST algorithm, DNA assembly.

05 Hours

5. Biopython

Introduction, working with sequence, sequence objects, sequence alignment, reading genomic sequence files**.**

05 Hours

Unit III

6. Introduction to Galaxy software

Introduction, galaxy platform, working with genomic data, creation of work flow, annotation, sharing and publishing of genomic data, Genome and RNA sequence analysis.

05 Hours

7. Introduction to Bioconductor for Sequence Data

Sequencing Resources, Ranges Infrastructure, DNA /amino acid sequence from FASTA files, Reads from FASTQ files, Aligned Reads from BAM files, Called Variants from VCF files, Genome Annotations from BED, WIG, GTF files.

05 Hours

Text Books:

1. Bioinformatics with Python Cookbook, Second Edition: Tiago Antao, Ingram short title; 2nd edition (1 January 2018), ISBN-13 : 978-1789344691.
2. R Bioinformatics Cookbook, Dan MacLean, Packt Publishing Limited (11 October 2019), ISBN-13 : 978-1789950694.
3. Hahne F, Huber W, Gentleman R, Falcon S. Bioconductor Case Studies. Springer Publishing Company, 2008. Mathur SK.

Reference Books:

1. Lee JK. Statistical Bioinformatics: A Guide for Life and Biomedical Science Researchers.

   Hoboken, N.J.: WileyBlackwell, 2010.
2. Statistical Bioinformatics with R. Academic Press, 2010.
3. Genome Data Analysis, Ju Han Kim,2019, Springer Singapore

BACK

Program: Biotechnology		Semester: VIII
Course Title: Bio-business & Entrepreneurship		Course Code:20EBTE402
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit-I

1. Entrepreneurship

Concept of Entrepreneurship - Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs. Entrepreneurship in India: Small scale industries: Definition; Characteristics; Need and rationale. Objectives; Scope; Introduction to bio-business, from the Indian context, SWOT analysis of bio-business.

10 Hours

2. Social Responsibilities of Business

Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance Institutional Support for Business Enterprises: Introduction, Policies & Schemes of Central Level Institutions, State Level Institutions.

05 Hours

Unit-II

3. Entrepreneurship opportunity in biotechnology

Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case studies on entrepreneurship opportunities in different domains of Biotechnology (Agri biotechnology, industrial Biotechnology, food biotechnology, Biopharma, Nutraceuticals. etc).

05 Hours

4. Project management, technology management and startup schemes

Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

10 Hours

Unit-III

5. Startup Schemes

Building Biotech business challenges in Indian context-biotech partners (BIRAC, DBT, Incubation centers. Etc.), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Business incubation support schemes, Successful startups-case study.

05 Hours

6. Funding Opportunities

Startup schemes in Indian government Sources of Funding for startups. Crowd funding, Self-funding, Venture Capitalists, Angel Investment. Banking support for startup business. Types of companies: Sole proprietorship company, Partnership company, Private Limited, Limited company etc.

05 Hours

Text Books:

1. Principles of Management – P. C.Tripathi, P.N. Reddy – Tata McGraw Hill,
2. Entrepreneurship Development - S.S.Khanka - S.Chand & Co.
3. Project Management by Sahni, Ane Books.

Reference books

1. Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier - Thomson 1996
2. Project Management for Business & Technology, Nicholas, PHI.

BACK

Program: Biotechnology		Semester: VIII
Course Title: Phytochemicals and Herbal Products		Course Code:22EBTE403
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1. Crude Drugs, Medicinal and Aromatic Plants

Crude Drugs - Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Collection and processing of Crude Drugs; Utilization of Medicinal and Aromatic Plants in India and world; Genetics as applied to Medicinal herbs; Biogenesis of Phytopharmaceuticals.

07 Hours

2. Types of Phytochemicals

Carbohydrates and its derived products- Structures, types and extraction methods : Glycosides - Digitalis, Aloe, Dioscorea; Volatile Oils - Clove, Pippermint Oil; Alkaloids – classification and functions, Triterpenoids, Phenols, Quinines, Cinchona; Flavonoids-and Resins; Tannins (Hydrolysable and Condensed types). Application of phytochemicals in industry and healthcare; Antioxidants, Biocides, Biofungicides, Biopesticides. Case studies

08 Hours

Unit II

3. Analysis of Phytochemicals

Methods of Drug evaluation (Morphological, Microscopic, Physical and Chemical); Preliminary screening, Assay of Drugs - Biological evaluation / assays, Microbiological methods, Chemical Methods of Analysis and Detection of Adulterants: Chemical estimations; Drug adulteration - Types of adulterants.

07 Hours

4. Techniques for Extraction and characterization of phytochemicals

Extraction and characterization techniques**,** Cold extraction, hot extraction, Soxhlet apparatus, Solvents: Petroleum ether, chloroform, ethanol, water, Separation techniques: TLC, colum, HPLC, Characterization techniques: UV spectra, IR specta, GC/MS, HPTLC.

08 Hours

Unit III

5. Herbal Products and regulation

History, Scope, and Current aspects of herbs and herbal medicines; Preparation of standardized extracts of Garcinea, Forskolin, Garlic, Turmeric and Capsicum, issues of licensing of herbal drugs**.** Herbal drug standardization: Regulatory bodies and guidelines, WHO and AYUSH guidelines.

05 Hours

6. Herbal Informatics

Applications of informatics in Herbal medicine, Databases and Tools for listing of phytochemicals and their applications. Databases: Super Natural II, CMAUP, BATMAN, ZINC, PubChem, ChEBI, KNApSAcK. Tools : Openbabel, Chemtools, ChemDraw, PkCSM. Molecular docking and analysis. Tools : MGL tools, Autodock Vina, PLIP. Network pharmacology and its application. Tools and Databases: Cytoscape, BindingDb.

05 Hours

Text Books:

1. Shah B, Textbook of Pharmacognosy and Phytochemistry, 2nd edition, CBS publisher, 2019.
2. Dr. Deep Panhekar, Ms. Trupti P. Sawant, Dr. D. P. Gogle, Phytochemicals - Extraction, Separation & Analysis Techniques | Phytochemistry - Study of Plants | | Plant Physiology, Plant Biotechnology and Plant Pathology Book, Global Education Limited; First Edition, 2019.
3. John R Harrison, International Regulation of Natural Health Products, Universal Publishers, 2008.

Reference Books:

1. R Amjesh, Bioinformatics in Drug Discovery from Medicinal Plants, LAP Lambert Academic Publishing, 2018.
2. Shao Li, Network Pharmacology Kindle Edition,Springer, 2021.

BACK

Program: Biotechnology		Semester: VIII
Course Title: Industrial Waste Management		Course Code:19EBTO401
L-T-P:: 3-0-0	Credits:3.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration: 3 Hours	

Unit I

1 Introduction

Introduction to waste management, general outline of waste management, Importance of waste management in industries.

04 Hours

2 Waste Water Treatment

Waste water characteristics: Physical, Chemical and Biological characteristics. Chemical Oxygen Demond (COD) and Biochemical Oxygen Demond (BOD). Introduction to physical and chemical waste water treatment methods. Biological wastewater treatment methods: Aerobic suspended growth treatment processes (Activated Sludge Process, aerared lagoons etc), Aerobic attached growth treatment processes (Trickling Filter). Anaerobic treatment.

11 Hours

Unit II

3. Solid Waste Management

Basic aspects, Generation of industrial solid wastes, general composition of Municipal solid waste, On site handling, storage and processing, Collection of solid wastes. Solid waste processing techniques and equipments. Recovery of biological conversion products from solid waste such as composting and anaerobic digestion. Disposal of solid wastes.

09 Hours

4. Control of Air Pollution

Sources and classification of air pollutants, Effects of air pollution on human health, animals and plants. Sampling procedures, Control of air pollution by equipments, odour combaitment techniques, Air pollution Legislation and Regulation.

06 Hours

Unit III

5. Bioremediation

Introduction, Uses of bacteria for bioremediation, bioremediation of aromatic and aliphatic hydrocarbons, PCB dechlorination, immobilization techniques for bioremediation, biosorption

& bioaccumulation, genetic engineering of microbes for bioremediation. Phytoremediation-plants capable of assimilating heavy metals.

05 Hours

6. EM Technology

Introduction, Important organisms: Photosynthetic bacteria, Lactobacillus, yeast; their roles, Formulation of EM Mixture, Use of EM technology for treating industrial wastes – case studies.

05 Hours

Text Books:

1. Wastewater Engineering-Metcalf and Eddy. McGraw-Hill International Edition.1991
2. Solid Wastes-George Tchobanoglous, Hilary Theisen and Rolf Eliassen. McGraw Hill Kogakusha,Ltd.

Reference Books:

1. Basic Biotechnology by Colin Ratledge, Cambridge Pub. 2001
2. Air Pollution – M.N.Rao and H.V.N Rao.Tata Mc Grew Hill.

BACK

Program: Biotechnology		Semester: VIII
Course Title: Capstone Project		Course Code:20EBTW402
L-T-P:: 0-0-11	Credits:11.0	Contact Hours: 03
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours: NA	Examination Duration: 3 Hours	

Preamble:

The engineering graduate's capstone project is an essential part of the curriculum structure which integrates all the skills acquired during all the theory and laboratory courses addressing Bioprocess Engineering and Molecular Biotechnology verticals. The capstone project work requires exhaustive literature survey to define the problem statement and research objectives. Various optimization strategies help the student to select the best alternative and feasible solution. Capstone project emphasizes on solving real time problems depicting societal benefits and industrial applications. Students gain hands on experience during their capstone Project implementation. Projects also facilitate students to present their work on different platforms likes seminars, national and international conferences. Capstone project help students in their jobs opening and higher studies as well in higher research careers.

Guidelines:

1. Capstone project has to be carried out in teams of four students.
2. Every team needs to maintain laboratory work book which contains details of all the work carried out in the laboratory.
3. Make entries in log books for instrument usage.
4. Adhere on timely report submission to the coordinator.
5. Provide requisitions beforehand for any project work

Review committee:

Review committee is formed by the project coordinator taking into consideration each review committee has faculty experts of all the domains. Review committee also consists of the guide of the respective project group.

Project evaluation:

Sl. No	Phase	Marks	Review
1	Concept generation phase	10	Committee
2	Preliminary design phase	10	Guide/s
3	Definitive design phase	10	Guide/s
4	Final submission phase	20	Committee
5	ESA	50	External
TOTAL		100	

BACK

Program: Biotechnology		Semester: VIII
Course Title: Internship-training		Course Code:18EBTI493
L-T-P:: : 0-0-6	Credits:6.0	Contact Hours: 18
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours: NA	Examination Duration: 3 Hours	

Preamble: Biotechnology engineering is a field of applied biology and chemical engineering principles that involves the use of living things in engineering, technology, medicine, and other useful applications. Biotechnology is one of the top fields of studies and employment, both from Indian and global perspectives. Aspiration for a core biotech employment calls for a hands on expertise and practical work experience. An internship opportunity is the first hand real time work experience for the graduates for acquiring the practical know-how that creates better career prospects. In fact, for biotechnology domain, training and internships are almost mandatory. Internships in biotechnology provide opportunities in research and development, manufacturing and production, quality control and assurance, technical support, and regulations and documentation. The significant outcome of biotech internship is a full spectrum of lab experience to develop analytical skills.

Duration- Jan-May During 8th semester (5 months Full time)

Internship course- Internship training

Credit Weightage – 6 credits

Assessment: Industry Training: ISA: 50 M, ESA 50 M [Total 100M]

Reports: Industry Training

Stages of Internship process

1. **Identification of industry-** The major role of the internship coordinator is to identify suitable industry for student internships. The selection of an industry depends on several criteria like, reputation of the company, establishment and stability, products & research focus, infrastructure and instrumentation facilities that could be provided for interns, kind of projects that could be offered to students, student learning opportunities etc. After studying the industry, the industry is recommended by

coordinator for approval by the department head and members of committee. Justification is provided by the coordinator on suitability of the company. Well established industries and start up's are preferred for student internships. The department approved industry list is sent for consent approval to the university. The final approved list is recorded with the placement cell. The department and the coordinator are completely responsible for the internship process.

2. **Internship evaluation**- The evaluation of the internship program is carried out by the identified industry guide/s for training (50 marks) and project (50 marks). The final evaluation of internship training (50 marks) and project (50 marks) is conducted by the department during ESA by external and internal examines. The students have to demonstrate the learning experience undergone during internship.
3. **Internship feedback**- The performance of the interns and the internship is collected in the form of valuable feedback from the industry guides. The internship experience feedback is collected from the students after the completion of the internship to understand the industry requirements and gaps.
4. **Development**- Based on the feedback from guides and students, the department is involved in strengthening the gaps and meeting the industry requirements.

BACK

Program: Biotechnology		Semester: VIII
Course Title: Internship-Project		Course Code:20EBTW494
L-T-P:: : 0-0-11	Credits:11.0	Contact Hours: 33
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours: NA	Examination Duration: 3 Hours	

Preamble: Biotechnology engineering is a field of applied biology and chemical engineering principles that involves the use of living things in engineering, technology, medicine, and other useful applications. Biotechnology is one of the top fields of studies and employment, both from Indian and global perspectives. Aspiration for a core biotech employment calls for a hands on expertise and practical work experience. An internship opportunity is the first hand real time work experience for the graduates for acquiring the practical know-how that creates better career prospects. In fact, for biotechnology domain, training and internships are almost mandatory. Internships in biotechnology provide opportunities in research and development, manufacturing and production, quality control and assurance, technical support, and regulations and documentation. The significant outcome of biotech internship is a full spectrum of lab experience to develop analytical skills.

Duration- Jan-May During 8th semester (5 months Full time)

Internship course- Internship project

Credit Weightage – 11 Credits

Assessment: Industry Project: ISA: 50 M, ESA 50 M [Total 100M]

Reports: Industry Project

Stages of Internship process

1. **Identification of industry-** The major role of the internship coordinator is to identify suitable industry for student internships. The selection of an industry depends on several criteria like, reputation of the company, establishment and stability, products & research focus, infrastructure and instrumentation facilities that could be provided for interns, kind of projects that could be offered to students, student learning opportunities etc. After studying the industry, the industry is recommended by coordinator for approval by the department head and members of committee.

Justification is provided by the coordinator on suitability of the company. Well established industries and start up's are preferred for student internships. The department approved industry list is sent for consent approval to the university. The final approved list is recorded with the placement cell. The department and the coordinator are completely responsible for the internship process.

2. **Internship evaluation**- The evaluation of the internship program is carried out by the identified industry guide/s for training (50 marks) and project (50 marks). The final evaluation of internship training (50 marks) and project (50 marks) is conducted by the department during ESA by external and internal examines. The students have to demonstrate the learning experience undergone during internship.
3. **Internship feedback**- The performance of the interns and the internship is collected in the form of valuable feedback from the industry guides. The internship experience feedback is collected from the students after the completion of the internship to understand the industry requirements and gaps.
4. **Development**- Based on the feedback from guides and students, the department is involved in strengthening the gaps and meeting the industry requirements.

BACK