GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)

(Deemed to be University, Estd. u/s 3 of UGC Act 1956)

∗VISAKHAPATNAM ∗HYDERABAD ∗BENGALURU∗

Accredited by NAAC with 'A' Grade

REGULATIONS & SYLLABUS

Bachelor of Technology

in

BIOTECHNOLOGY

(W.e.f 2015-16 admitted batch)

Website: www.gitam.edu

GITAM University

Vision

To become a global leader in higher education.

Mission

To impart futuristic and comprehensive education of global standards with a high sense of discipline and social relevance in a serene and invigorating environment.

Quality Policy

To achieve global standards and excellence in Teaching, Research and Consultancy by creating an environment in which the faculty and students share a passion for creating, sharing and applying knowledge to continuously improve the quality of education.

GITAM Institute of Technology

Vision

To become a global leader in technical education.

Mission

To impart futuristic and comprehensive education of global standards with a high sense of discipline and social relevance in a serene and invigorating environment.

Department of Biotechnology

GITAM Institute of Technology

GITAM University

VISION

To become a global leader in Biotechnology education, research, and innovation.

MISSION

- **Mission 1**: To impart the concepts of science and engineering for solving problems related to biotechnology.
- **Mission 2:** To empower students with analytical abilities for solving the social problems in dynamic international scenario.
- **Mission 3:** To find innovative solutions to industrial, medical, agricultural and environmental problems by using tools and techniques developed by research in biotechnology.
- **Mission 4:** To motivate students to apply biotechnology for sustainable growth.

B Tech (Biotechnology)

PROGRAM EDUCATIONAL OBJECTIVES

PEO 1	To impart knowledge of mathematics, science and engineering to design and deliver solutions related to biotechnological issues.
PEO 2	To inculcate analytical abilities among the students to meet the needs of biotechnology in medicine, agriculture, industry and environment.
PEO 3	To provide a platform for the graduates to design a plant for commercial production.
PEO 4	To instill team work, leadership, communication skills as well as professional, ethical and human values to become responsible citizens of the society.

Mapping of PEO statements with Mission statements

Mapping Table:

PEOs	Mission-1	Mission -2	Mission -3	Mission -3
PEO1	√		√	
PEO2		√	√	
PEO3			√	√
PEO4		√		√

Justification:

PEO1 aligns with:

- Mission 1: Both focus on imparting knowledge of science and engineering to solve problems related to biotechnology.
- Mission 3: Emphasizes designing and delivering solutions, which corresponds with finding innovative solutions using research in biotechnology

PEO2 aligns with:

- Mission 2: Aims to inculcate analytical abilities to meet biotechnology needs, aligning with empowering students to solve social problems
- Mission 3: Addresses needs in medicine, agriculture, industry, and environment, matching the mission to find innovative solutions in these areas using biotechnological research.

PEO3 aligns with:

- Mission 3: Provides a platform to design a plant for commercial production, aligning with finding innovative industrial solutions through biotechnology
- Mission 4: Designing for commercial production promotes sustainable growth, resonating with motivating students to apply biotechnology sustainably

PEO4 aligns with:

- Mission 2: Focuses on teamwork, leadership, and communication skills necessary for solving social problems in a global context
- Mission 4: Instil professional, ethical, and human values to become responsible citizens, which aligns with motivating students toward sustainable growth and ethical practices.

PEO Statements	Mission-1	Mission -2	Mission -3	Mission -3
PEO1: To impart knowledge of mathematics, science and engineering to design and deliver solutions related to biotechnological issues	3	1	2	1
PEO2: To inculcate analytical abilities among the students to meet the needs of biotechnology in medicine, agriculture, industry and environment	2	3	3	1
PEO3: To provide a platform for the graduates to design a plant for commercial production	1	2	3	2
PEO4: To instill teamwork, leadership, communication skills as well as professional, ethical and human values to become responsible citizens of the society	1	3	2	3

GRADUATE ATTRIBUTES

GA1	**ENGINEERING KNOWLEDGE: Apply the knowledge of Mathematics, Science, Engineering Fundamentals, and an Engineering specialization to the solution of Complex Engineering problems.**
GA2	**PROBLEM ANALYSIS: Identify, formulate, research literature, and analyze Complex Engineering problems reaching substantiated conclusions using first principles of Mathematics, Natural Sciences, and Engineering Sciences.**
GA3	**DESIGN/DEVELOPMENT OF SOLUTIONS: Design solutions for Complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.**
GA4	**CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.**
GA5	**MODERN TOOL USAGE: Create, select, and apply appropriate techniques, resources, and Modern Engineering and IT tools including prediction and modeling to Complex Engineering activities with an understanding of the limitations.**
GA6	**THE ENGINEER AND SOCIETY: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Professional Engineering practice.**
GA7	**ENVIRONMENT AND SUSTAINABILITY: Understand the impact of the Professional Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.**
GA8	**ETHICS: Apply ethical principles and commit to Professional Ethics and responsibilities and norms of the engineering practice.**
GA9	**INDIVIDUAL AND TEAM WORK: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.**
GA10	**COMMUNICATION: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.**
GA11	**PROJECT MANAGEMENT AND FINANCE: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.**
GA12	**LIFE LONG LEARNING: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.**

B Tech (Biotechnology)

PROGRAM OUTCOMES

The students of B Tech (Biotechnology) degree after completion of the program will be able to:

PO 1 **Apply the principles of biotechnology**

PO 2 **Integrate the concepts of biotechnology in the fields of medicine and health care**

PO 3 **Implement the concepts of biotechnology in agriculture**

PO 4 **Introduce the concepts of biotechnology in industry and environment**

PO 5 **Design a pilot plant for implementing a commercial bioprocess**

PO 6 **Adapt to changing professional and societal needs by practicing the art of lifelong learning**

PO 7 **Formulate and design end-to-end solutions for biotechnology industry**

PO 8 **Implement ethical principles to biotechnology practices**

PO 9 **Manage a team of professionals in different fields of biotechnology**

PO 10 **Take up higher studies in core and interdisciplinary fields.**

PO 11 **Carry out research in the field of biotechnology and related multidisciplinary specializations.**

PO 12 **Become an entrepreneur and contribute to industrialization to solve problems of societal relevance**

Program Outcome - Graduate Attribute Mapping

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
PO1	✓	✓	✓	✓	✓		✓					✓
PO2	✓	✓	✓	✓	✓			✓				✓
PO3	✓	✓	✓	✓	✓		✓				✓	✓
PO4	✓	✓	✓	✓	✓		✓	✓			✓	✓
PO5	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
PO6						✓			✓	✓	✓	✓
PO7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PO8						✓	✓	✓	✓		✓	✓
PO9									✓	✓	✓	✓
PO10	✓	✓	✓	✓	✓							✓
PO11						✓	✓	✓	✓		✓	✓
PO12			✓			✓	✓	✓	✓	✓	✓	✓

B Tech (Biotechnology)

PEO – PO MAPPING

Program Outcomes	Program Educational Objectives			
	PEO I	PEO 2	PEO 3	PEO 4
PO1	✓	✓	✓	
PO2	✓	✓		
PO3	✓	✓		
PO4	✓	✓	✓	
PO5			✓	✓
PO6	✓	✓	✓	✓
PO7	✓	✓	✓	✓
PO8			✓	✓
PO9			✓	✓
PO10		✓		✓
PO11		✓		✓
PO12		✓	✓	✓

Department of Biotechnology

(Effective from the academic year 2015-16)

I Semester

S. No.	Course Code	Course Title	Category	L	T	P	C
1	EMA103	Fundamentals of Mathematics-I	FC(MT)	3	0	0	3
2	EHS101	Communicative English-I	FC(HS)	3	0	2	4
3	EPH101	Engineering Physics	FC(BS)	3	0	0	3
4	ECY103	Physical and Inorganic Chemistry	FC(BS)	3	0	0	3
5	EID101	Programming with C	FC(BE)	3	0	0	3
6	EME123	Engineering Graphics	FC(BE)	1	0	3	3
7	EPH121	Engineering Physics Laboratory	FC(BS)	0	0	3	2
8	ECY123	Physical and Inorganic Chemistry Laboratory	FC(BS)	0	0	3	2
9	EID121	Programming with C Laboratory	FC(BE)	0	0	3	2
		Total					25

II Semester

S. No.	Course Code	Course Title	Category	L	T	P	C
1	EMA104	Fundamentals of Mathematics-II	FC(MT)	3	0	0	3
2	EHS102	Communicative English - II	FC(HS)	3	0	2	4
3	ECY108	Organic Chemistry	FC(BS)	3	0	0	3
4	EPH104	Solid State Physics	FC(BS)	3	0	0	3
5	EBT102	Introduction to Biotechnology	FC(BE)	3	0	0	3
6	ECY122	Organic Chemistry Laboratory	FC(BS)	0	0	3	2
7	EBT122	Biotechnology Workshop	PC(CE)	0	0	3	2
8	EME121	Workshop	FC(BE)	0	0	3	2
		Total					22

III Semester

S. No.	Course Code	Course Title	Category	L	T	P	C
1	EMA209	Linear Algebra and Vector Calculus	FC(MT)	3	0	0	3
2	EBT201	Biochemistry	FC(BS)	3	0	0	3
3	EBT203	Applied Microbiology	FC(BE)	3	0	0	3
4	EBT205	Bioanalytical Techniques	FC(BE)	3	0	0	3
5	EBT207	Biochemical Thermodynamics	FC(BE)	3	0	0	3
6	EBT209	Process Calculations	PC(CE)	3	0	0	3
7	EBT221	Biochemistry Laboratory	FC(BS)	0	0	3	2
8	EBT223	Applied Microbiology Laboratory	FC(BE)	0	0	3	2
		Total					22

IV Semester

S. No.	Course Code	Course Title	Category	L	T	P	C
1	EMA212	Differential Equations and Laplace Transforms	FC(MT)	3	0	0	3
2	EBT202	Biochemical Reaction Engineering	PC(CE)	3	0	2	4
3	EBT204	Fluid Mechanics and Particle Technology	PC(CE)	3	0	0	3
4	EBT206	Genetics and Molecular Biology	FC(BE)	3	0	0	3
5	EBT208	Biochemical Engineering	PC(CE)	3	0	0	3
6	EHS201	Environmental Studies	FC(HS)	3	0	0	3
7	EOEXXX	Open Elective-I	OE(OE)	3	0	0	3
8	EBT222	Biochemical Engineering Laboratory	PC(CE)	0	0	3	2
9	EBT224	Fluid Mechanics and Particle Technology Laboratory	PC(CE)	0	0	3	2
		Total					26

V Semester

S. No.	Course Code	Course Title	Category	L	T	P	C
1	EBT301	Bioinformatics	PC(CE)	3	0	0	3
2	EBT303	Genetic Engineering	PC(CE)	3	0	0	3
3	EBT305	Mass Transfer	PC(CE)	3	0	0	3
4	EBT307	Heat Transfer	PC(CE)	3	0	0	3
5	EHS301	Engineering Economics and Management	FC(HS)	3	0	0	3
6	EOEXXX	Open Elective-II	OE(OE)	3	0	0	3
7	EBT321	Bioinformatics Laboratory	PC(CE)	0	0	3	2
8	EBT323	Genetic Engineering Laboratory	PC(CE)	0	0	3	2
9	EBT325	Transport Process Laboratory	PC(CE)	0	0	3	2
		Total					24

VI Semester

S. No.	Course Code	Course Title	Category	L	T	P	C
1	EBT302	Bioprocess Engineering	PC(CE)	3	0	0	3
2	EBT304	Plant Biotechnology	PC(CE)	3	0	0	3
3	EBT306	Process Dynamics and Control	PC(CE)	3	0	2	4
4	EBT308	Immunotechnology	PC(CE)	3	0	0	3
5	EBTXXX	Programme Elective-I	PE(PE)	3	0	0	3
6	EBTXXX	Programme Elective-II	PE(PE)	3	0	0	3
7	EXXXXX	Inter Disciplinary Elective-I	IE(IE)	3	0	0	3
8	EBT322	Bioprocess Engineering Laboratory	PC(CE)	0	0	3	2
9	EBT324	Plant Biotechnology Laboratory	PC(CE)	0	0	3	2
		Total					26

VII Semester

S. No.	Course Code	Course Title	Category	L	T	P	C
1	EBT401	Downstream Bioprocessing	PC(CE)	3	0	0	3
2	EBT403	Animal Cell Culture Technology	PC(CE)	3	0	0	3
3	EBT405	Bioreactor Design	PC(CE)	3	0	0	3
4	EBTXXX	Programme Elective-III	PE(PE)	3	0	0	3
5	EBTXXX	Programme Elective-IV	PE(PE)	3	0	0	3
6	EXXXXX	Inter Disciplinary Elective-II	IE(IE)	3	0	0	3
7	EBT421	Computational Methods in Biotechnology Laboratory	PC(CE)	0	0	3	2
8	EBT491	Mini Project	PP(PW)	0	0	3	2
9	EBT392	Seminar	PC(CE)	0	0	2	1
10	EBT493	Summer Internship	PP(PW)				2
11	EHS407	Professional Ethics and Human Values	FC(HS)	1	0	0	1
		Total					26

VIII Semester

S. No.	Course Code	Course Title	Category	L	T	P	C
1	EBTXXX	Programme Elective-V	PE(PE)	3	0	0	3
2	EBTXXX	Programme Elective-VI	PE(PE)	3	0	0	3
3	EXXXXX	Inter Disciplinary Elective-III	IE(IE)	3	0	0	3
4	EBT492	Comprehensive Viva	PC(CE)				2
5	EBT494	Project Work	PP(PW)			16	8
		Total					19

Number of Credits

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	25	22	22	26	24	26	26	19	**190**

Category and Credits

UGC			AICTE		
Category		Credits	Category		Credits
FC	Foundation Courses	77	HS	Humanities and Social Sciences	15
			BS	Basic Science	23
			MT	Mathematics	12
			BE	Basic Engineering	27
PC	Programme Core	68	CE	Core Engineering	68
PE	Programme Electives	18	PE	Programme Electives	27
IE	Interdisciplinary Electives	9	IE		
OE	Open Electives	6	OE	Open Electives	6
PP	Professional Practice	12	PW	Project Work	12
		190			190

Open Elective-I

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks
1	EOE 202	German for Beginners	OE(OE)	3	0	0	3	
2	EOE 204	Chinese for Beginners	OE(OE)	3	0	0	3	
3	EOE 206	Introduction to Music	OE(OE)	3	0	0	3	
4	EOE 208	Gandhian Philosophy	OE(OE)	3	0	0	3	
5	EOE 210	Philosophical Foundations of Education	OE(OE)	3	0	0	3	
6	EOE 212	Analytical Essay Writing	OE(OE)	3	0	0	3	
7	EOE 214	Indian Economy	OE(OE)	3	0	0	3	
8	EOE 216	Public Administration	OE(OE)	3	0	0	3	
9	EOE 218	Environmental Ecology	OE(OE)	3	0	0	3	
10	EOE 220	Indian History	OE(OE)	3	0	0	3	

Open Elective-II

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks
1	EOE 301	Indian Constitution	OE(OE)	3	0	0	3	
2	EOE 303	Japanese for Beginners	OE(OE)	3	0	0	3	
3	EOE 305	French for Beginners	OE(OE)	3	0	0	3	
4	EOE 307	Contemporary Relevance of Indian Epics	OE(OE)	3	0	0	3	
5	EOE 309	Indian National Movement	OE(OE)	3	0	0	3	
6	EOE 311	Science and Technology	OE(OE)	3	0	0	3	
7	EOE 313	Professional Communication	OE(OE)	3	0	0	3	
8	EOE 315	Ethics, Integrity and Attitude	OE(OE)	3	0	0	3	
9	EOE317	Personality Development	OE(OE)	3	0	0	3	

Programme Elective-I

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks
1	EBT342	Applied Mathematics for Biotechnology	PE(PE)	3	0	0	3	
2	EBT344	Physiology and Clinical Biochemistry	PE(PE)	3	0	0	3	
3	EBT346	Sea Food Production and Processing Technology	PE(PE)	3	0	0	3	
4	EBT348	Micropropagation	PE(PE)	3	0	0	3	

Programme Elective-II

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks
1	EBT350	Fermentation Technology	PE(PE)	3	0	0	3	
2	EBT352	Genetics, Genomics and Proteomics	PE(PE)	3	0	0	3	
3	EBT354	Food Science and Technology	PE(PE)	3	0	0	3	
4	EBT356	Environmental Biotechnology	PE(PE)	3	0	0	3	

Programme Elective-III

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks
1	EBT441	Renewable Energy Engineering	PE(PE)	3	0	0	3	
2	EBT443	Biomedical Instrumentation	PE(PE)	3	0	0	3	
3	EBT445	Thermal Operations in Food Processing	PE(PE)	3	0	0	3	
4	EBT447	Nanobiotechnology	PE(PE)	3	0	0	3	

Programme Elective-IV

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks
1	EBT449	Bioprocess Modeling and Simulation	PE(PE)	3	0	0	3	
2	EBT451	Molecular Diagnostics	PE(PE)	3	0	0	3	
3	EBT453	Food Handling, Packaging and Storage	PE(PE)	3	0	0	3	
4	EBT455	Systems Biology	PE(PE)	3	0	0	3	

Programme Elective-V

S. No	Course Code	Course Title	Category	L	T	P	C	Remarks
1	EBT442	Metabolic Engineering	PE(PE)	3	0	0	3	
2	EBT444	Cancer Biology	PE(PE)	3	0	0	3	
3	EBT446	Dairy Process Technology	PE(PE)	3	0	0	3	
4	EBT448	Process Instrumentation	PE(PE)	3	0	0	3	

Programme Elective-VI

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks
1	EBT450	Applied Biocatalysis and Biotransformations	PE(PE)	3	0	0	3	
2	EBT452	Stem Cells and Tissue Engineering	PE(PE)	3	0	0	3	
3	EBT454	Plant and Equipment Design	PE(PE)	3	0	0	3	
4	EBT456	Patent Law and Drafting	PE(PE)	3	0	0	3	

Inter Disciplinary Elective-I

S. No.	Stream	Course Code	Course Title	Category	L	T	P	C	Remarks
1	Professional Courses	EEE101	Basic Electrical Engineering	IE	3	0	0	3	Offered by EEE
2	Computer Oriented Courses	ECS362	Operating System Concepts	IE	3	0	0	3	Offered by CSE/IT
3		ECS364	Fundamentals of Data Structures	IE	3	0	0	3	Offered by CSE/IT
4		EIT362	Introduction to Programming with Java	IE	3	0	0	3	Offered by CSE/IT
5		EIT364	Fundamentals of Computer Organization &Architecture	IE	3	0	0	3	Offered by CSE/IT
6	Management Courses	EHS302	Organizational Behaviour	IE	3	0	0	3	Common to All Branches Except CSE/IT
7		EHS304	Business Ethics and Corporate Governance	IE	3	0	0	3	Common to All Branches

Inter Disciplinary Elective-II

S. No.	Stream	Course Code	Course Title	Category	L	T	P	C	Remarks
2	Professional Courses	EMA202	Numerical Methods	IE	3	0	0	3	
3	Computer Oriented Courses	ECS461	Introduction to Database Management Systems	IE	3	0	0	3	Offered by CSE
4		ECS463	Introduction to Computer Networks	IE	3	0	0	3	Offered by CSE/IT
4	Management Courses	EHS401	Project Management	IE	3	0	0	3	Common to All Branches
5		EHS403	Disaster Management	IE	3	0	0	3	Common to All Branches
6		EHS405	Entrepreneurship Development	IE	3	0	0	3	Common to All Branches

Inter Disciplinary Elective – III

S. No.	Stream	Course Code	Course Title	Category	L	T	P	C	Remarks
1	Professional Courses	EME403	Operations Research	IE	3	0	0	3	Offered by ME
2	Computer Oriented Courses	ECS462	Fundamentals of Software Engineering	IE	3	0	0	3	Offered by CSE/IT
3		EIT462	Introduction to Neural Networks and Fuzzy Logic	IE	3	0	0	3	Offered by CSE/IT
4		ECS464	Introduction to Web Technologies	IE	3	0	0	3	Offered by CSE/IT
5		EHS402	Operations and Supply Chain Management	IE	3	0	0	3	Common to All Branches
6		EHS404	Total Quality Management	IE	3	0	0	3	Common to All Branches

EBT102: INTRODUCTION TO BIOTECHNOLOGY

L	T	P	C
3	0	0	3

This course is designed to impart basic biotechnology concepts and techniques at the entry level, and to introduce the students to a wide range of biotechnology applications.

Course Objectives:

1. Acquire fundamental knowledge about the applications of modern biotechnology.
2. Develop basic concepts of genetics and inheritance.
3. Explore the applications of recombinant DNA technology to plants, animals and microbes.
4. Describe the applications of biotechnology in medicine and industry.
5. Introduce the concepts of patents and bioethics.

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

1. Acquire knowledge of microbes, plants and animals, relevant to biotechnology.
2. Apply the basic concepts of genetics and genetic engineering for biotechnology related problems.
3. Apply the knowledge of biotechnology in transgenic plant development.
4. Apply the knowledge of biotechnology in transgenic animal development.
5. Evaluate the applications of biotechnology in industry and microbial technology.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1										2			3		
CO2											2		3		
CO3		2	2							1			2		
CO4	3									3				3	
CO5		3				1				3	1	1			3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Biotechnology: Concept, scope and importance. Origin of life-theories. Structure of bacterial, plant and animal cells-functions of cell organelles, mechanism of cell division. Biomolecules-their significance in biological systems.

Module II 8**hours**

Fundamentals of genetics (Mendel's laws only). The central dogma of molecular biology. Concepts of genetic engineering. Polymerase Chain Reaction. Introduction to bioinformatics and biological databases.

Module III **8hours**

Plant Biotechnology: Strategies for engineering stress tolerance, transgenic plants. Micropropagation of novel varieties. Production of secondary metabolites and their importance. Molecular pharming.

Module IV **8hours**

Animal Biotechnology: Applications in animal husbandry, medicine and live-stock improvement. Transgenic animals. Gene therapy and genetic counseling. Bioethics.

Module V **8hours**

Industrial and Microbial biotechnology: Overview of industrial fermentation process and products. Fermentation technology for production of Penicillin. Introduction to patents. Biotech industry in India and abroad.

Text Book(s)

1. J.M. Walker and R. Rapley, Molecular Biology and Biotechnology, 5/e, Royal society of chemistry, 2009.
2. W. Godbey, An Introduction to Biotechnology, The Science, Technology and Medical Applications, 1/e, Woodhead Publishing, 2014.

References

1. H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, A. Bretscher, H. Ploegh, Amon and M. P. Scott, Molecular Cell biology, 7/e, W.H Freeman and Company, 2014.
2. R.C. Dubey, Text book of Biotechnology, 5/e, S. Chand Publishing, 2014.
3. P.K. Gupta, Biotechnology and genomics, Rastogi publications, 2004.
4. B. Albert's, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts and P. Walter, Molecular Biology of the Cell, 6/e, Garland Publishers, 2014.
5. P.K. Gupta, Elements of Biotechnology, 2/e, Rastogi Publications, 2014.

EBT122: Biotechnology Workshop

L	T	P	C
0	0	3	2

Course Objectives:

The main aim of this course is to expose the students to various techniques used in biotechnology and to generate motivation and curiosity on concepts underlying biotechnology and relevant laboratory techniques.

1. Introduce laboratory techniques in microbiology and biochemistry.
2. Demonstrate separation techniques such as column chromatography, TLC, HPLC and GLC.
3. Describe spectroscopic techniques like NMR, IR and Florescence
4. Illustrate the principles of bioinformatics

Course Outcomes:

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

1. Apply scientific calculator and determination of rate constant of a reaction by integral method.
2. Discuss measurement of oxygen diffused in water and sugar content by Brix meter.
3. Understand principles of fermentor, microbial growth and biological production of wine.
4. Explain calibration of pH meter and rotaevaporator.
5. Apply usage of different biological databases and flow cytometry for animal cell counting.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1		1	1			3	2	3	3
CO2	3	3	3	2	1	1		1	1			3	2	3	3
CO3	3	3	3	2	3	1		3	1			3	2	3	3
CO4	3	3	3	2	2	1		1	1			3	2	3	3
CO5	3	3	3	2	3	1		2	1			3	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Minimum of 10 experiments from the following:

1. Working in sterile environment
2. Sterilization of equipment
3. Sterilization of culture media
4. Operation of a compound microscope
5. Thin layer chromatography
6. Column chromatography
7. High pressure liquid chromatography
8. Gas chromatography
9. Centrifugation
10. Colorimeter
11. Spectrophotomer
12. Atomic absorption spectrometry
13. Fluorescence spectrometry
14. Infrared spectrometry
15. NMR spectrometry
16. Mass spectrometry
17. Flow cytometry

18. pH meter
19. Biotechnology literature search on internet
20. Biological databases
21. Biological information servers

EBT201: BIOCHEMISTRY

L	T	P	C
3	0	0	3

This course is designed to impart the basic concepts of biochemistry with relevance to Biotechnology applications.

Course Objectives:

This course is proposed with following objectives:

1. Illustrate the organization of life, structure and function of proteins and enzymes
2. Describe the structure, functions and metabolism of carbohydrates, lipids, nucleic acids, Heme and related genetic disorders.
3. Estimate the production of energy from carbohydrates.
4. Describe the physiological functions of vitamins, minerals and hormones.
5. Appraise the nutritional aspects of amino acids, proteins and fatty acids.

Course Outcomes:

At the end of the course students will be able to

1. Explain the structure and properties of amino acids, proteins, and enzymes.
2. Interpret carbohydrates and carbohydrate metabolism.
3. Discuss lipid structure and lipid metabolism.
4. Explain nucleic acids and nucleic acid metabolism.
5. Discuss nutritional biochemistry and hormones for human health.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1					1	2	2	1	1
CO2	3	3	3	3	3	1					1	2	2	2	1
CO3	3	3	3	3	3	1					1	2	2	2	1
CO4	3	3	3	3	3	1					1	2	2	2	1
CO5	3	3	3	3	3	3					3	2	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Organization of life. Importance of water in living cell. Chemistry, structure and functions of amino acids; Peptides: Solution and solid phase synthesis of peptides. Proteins: classification, purification and physicochemical characterization. Protein structure: Primary, secondary, tertiary and quaternary structure of proteins. Functions of hemoglobin, myoglobin, and chymotrypsin. Enzymes: classification, factors effecting enzyme action, coenzymes.

Module II **8 hours**

Carbohydrates: Classification, structure and functions of monosaccharide (ribose, glucose, fructose), disaccharides (sucrose and lactose), polysaccharides (starch, cellulose and glycogen). Metabolic pathways: Glycogenesis and glycogenolysis, glycolysis and TCA cycle, HMP shunt pathway, Electron transport chain and oxidative phosphorylation.

Module III **8 hours**

Lipids: Classification, structure and physiological functions of triglycerides, fatty acids, phospholipids, cerebrosides, gangliosides and cholesterol. Digestion and absorption of fats. Synthesis and degradation of fatty acids and triglycerides.

Module IV **8 hours**

Nucleic acids: Structure, properties and functions of purines, pyrimidines, nucleotides and nucleic acids. Types of DNA and RNA. Biosynthesis and degradation of purine and pyrimidine nucleotides. Urea cycle.

Module V **8 hours**

Biosynthesis and degradation of heme. Genetic disorders involving metabolism. Physiological functions of vitamins, minerals and hormones. Nutritional aspects of amino acids, proteins and fatty acids.

Text Book(s)

1. U. Satyanarayana, U. Chakrapani, Biochemistry, 3/e, Books & Allied, 2008.
1. R.K. Murray, D.A Bender, K.M. Botham , P.J. Kennelly, V.W. Rodwell , P. Anthony Weil, Harper's Illustrated Biochemistry, 28/e. McGraw-Hill's, 2009.

References

1. David L. Nelson and Michael M. Cox, Lehninger Principles of Biochemistry, 6/e, W. H. Freeman, 2012.
2. J.M. Berg, J.L. Tymoczko , L. Stryer , Biochemistry, 6/e, W.H. Freeman, 2006.
3. D. Voet, J.G. Voet, Biochemistry, 3/e, John Wiley, 2004.
4. E.S.West, W.R. Todd, H.S. Mascon and J.T. Van Bruggen, Text Book ofBiochemistry, 4/e, Oxford and IBH Publishers, 1974.

EBT202: BIOCHEMICAL REACTION ENGINEERING

L	T	P	C
3	0	2	4

This course is designed to explain the basic concepts of reaction engineering with relevance to biochemical processes.

Course Objectives

The objectives of this course are to:

1. Apply the principles of chemical reaction kinetics and thermodynamics to various types of biochemical reactors.
2. Describe the different types of biochemical reactors (Batch, Tubular, CSTR).
3. Assess the advantages and disadvantages of each type of biochemical reactor.
4. Analyze experimental kinetic data to determine reaction mechanisms.
5. Apply the numerical methods to design biochemical reactors.

Course Outcomes:

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

1. Able to understand the different types of chemical and biochemical reactions, and their kinetics and influence of various parameters on chemical and biochemical process kinetics.
2. Able to understand principles involved in various reactors and choose suitable reactor for various biochemical reactions. Able to analyze reaction data and use it in the design of ideal batch reactor, fermenter, etc.
3. Able to determine design equations for various ideal flow reactors and analyze their performance in single and combined reactors.
4. Able to determine design equations for batch and flow reactors under non-isothermal conditions. Able to understand the kinetics in batch and continuous sterilization processes.
5. Able to identify problems involved during operation of real reactors.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1		1				1	1	3	2
CO2	3	3	3	1	1	2	3	1					2	3	2
CO3	3	3	3	1	1	2	2						2	3	2
CO4	3	3	3	1	2	1		2	1			1	2	3	2
CO5	3	3	3	3	1	1	2		2	1			1	2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Batch reactors: Introduction and overview of the subject, kinetics of homogeneous reactions, elementary and non elementary reactions; collision theory and transition state theory, Arrhenius' relation, various methods of analysis of batch reactor data (including variable volume and variable pressure data). Isothermal batch reactor design.

Module II **8 hours**

Homogeneous flow reactors: Design equation for plug flow reactor (PFR) and continuous stirred tank reactor (CSTR), Design of PFR and CSTR for single reactions. Cascade of CSTRs and combination of PFR and CSTR (design of autocatalytic reactions not included).

Module III **8 hours**

Design for multiple reactions: Parallel reactions, series reactions (omit reversible and series,parallel reactions).

Module IV **8 hours**

Non-isothermal design: Energy balance equations for batch, PFR and CSTR under non-isothermal conditions. Equilibrium conversion under adiabatic conditions. Design of the homogeneous reactors under adiabatic conditions.

Module V **8 hours**

Non-ideal flow: Residence time distribution curves E, F and C; interpretation of the response data for the dispersion and tanks -in-series models (omit multi parameter models).

Text Book(s)

1. Octave Levenspiel, Chemical Reaction Engineering, 3/e, John Wiley, 2010.
2. Pauline M. Doran, Bioprocess Engineering Principles, 1/e, Academic Press, 2009.
3. M.L. Shuler and F. Kargi, Bioprocess Engineering: Basic Concepts, 2/e, Prentice Hall, 2002.

References

1. H. Scott Fogler, Elements of Chemical Reaction Engineering, 4/e, Prentice Hall, India, 2008.
2. J.M. Smith, Chemical Engineering Kinetics, 3/e, McGraw Hill, 1981.
3. Bailey and Ollis, Biochemical Engineering Fundamentals, 2/e, McGraw Hill, 2010.

EBT203: APPLIED MICROBIOLOGY

L	T	P	C
3	0	0	3

This course is designed to impart concepts of microbiology with relevance to Biotechnological applications.

Course objectives:

The objectives of this course are to

1. Acquire knowledge of history, salient developments and key contributors in microbiology.
2. Describe the morphological structure of Viruses, Yeast, Molds and Bacteria.
3. Examine the effect of various parameters on microbial growth.
4. Assess the role of microbes in industrial fermentation techniques.
5. Describe the microbial decontamination techniques.

Course Outcomes:

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

1. Gain the knowledge the techniques for microbial isolation and purification.
2. Understand morphological structure of Viruses, Yeast, Molds and Bacteria with its physiological pattern.
3. Able to understand effect of various parameters on microbial growth and its metabolic pathways.
4. Apply the microbial decontamination processes and techniques for healthcare.
5. Understand the role of microbes in industrial fermentation process and also in agriculture.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	2	1	1	2	2	1	1	1	1	2	2	2
CO2	2	2	1	1	2	2	2	2	2	1	1	2	2	2	2
CO3	3	2	2	1	1	1	2	2	1	1	2	2	3	2	3
CO4	2	2	2	2	2	1	2	2	1	1	1	2	2	2	2
CO5	3	3	3	2	3	1	3	2	2	1	2	1	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

History and development of Microbiology, Contributions of Nobel Laureates in Microbiology; Robert Koch, Emil, A.Von Behring, Ronald Ross and Barry Marshall. Microbial Taxonomy and diversity of Bacteria, Archea, molecular approaches to microbial taxonomy. Physiology of thermophiles, psychropiles, halophiles and methanogens.

Module II **8 hours**

Morphology of viruses, bacteria, yeast, molds.
Viruses: Morphology of viruses; size, shape, symmetry, replication of viruses; lytic and lysogenic cycle.
Bacteria: Ultra structure of Bacteria, cell wall, cell membrane, flagella, pili, capsule, endospore, and cell inclusions, differences between prokaryotic and eukaryotic cell. Bacterial growth kinetics.
Yeasts and Molds: life cycle, economic importance of yeast and *Aspergillus*.

Module III **8 hours**

Microbial nutrition: Nutrition requirements, nutritional types of bacteria, uptake of nutrients by cell. Microbial metabolism: Respiration, Photosynthesis and Nitrogen fixation.

Module IV **8 hours**

Control of microorganisms: Sterilization and Disinfection, effect of physical (moist and dry heat, radiation and filtration) and chemical agents. Antibiotics: classification, mode of action and resistance.

Applied Microbiology: Water, Food and Milk borne contamination and remedy. Basic microbial genetics: conjugation, transformation and transduction. Strain improvement of microbes of industrial importance.

Module V **8 hours**

Fermentation technology for production of alcohol, wine and beer. Role of baker's yeast in bread making. Production of amylases and cellulases.

Text Book(s)

1. Lansing M Prescott, Donald A Klein and John P Harley, Microbiology, 7/e , McGraw Hill, 2008.
2. Ananthanarayan R and Paniker J, Microbiology, 9/e, Orient Longman , 2013.

References

1. Michael J Pelczar, JR. ECS Chan, Noel R, Krieg, Microbiology, 5/e , Tata Mc Graw Hill, 2007.
2. Stanier RY, Ingraham JL, Wheelis ML, Painter P, General Microbiology,5/e, The MacMillan Press Ltd, 2003.
3. Madigan MT, Martinko JM, Parker, Brock Biology of Microorganisms, 10/e, Prentice Hall, 2003.
4. Bergey's Manual of systematic Bacteriology, Volumes 1-5, Springer, 2012.

EBT204: FLUID MECHANICS AND PARTICLE TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

This course is designed to introduce the fundamentals of fluid mechanics and mechanical operations, related problem solving skills necessary for bioprocess engineers.

1. Discuss the applications of fluid mechanics and mechanical operations in bioprocess engineering.
2. Explain the principles of fluid statics and dynamics.
3. State methods related to size reduction and separation of particles.
4. Describe the applications of fluidisation in bioprocesses.
5. Predict the energy changes during fluid processes.
6. Perform dimensional analysis to find the relationships among the variables.

Course Outcomes:

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

1. Comprehend the principles of fluid statics and fluid flow in motion. Using the concepts of fluid statics to detect pressure in practical situations and bioprocess applications.
2. Use Bernoulli's equation and pump calculations to solve fluid flow problems by applying mass, energy, and momentum balances.
3. Analyze fluid drag on particles. Computing the energy losses that occur when fluids are transported through pipelines, packed beds, and fluidized bed equipment.
4. Calibrate and use various flow measuring devices for calculation of flowrates in biochemical applications. Use various particle separation equipment for particle characterization studies.
5. Determine the energy needs for a range of industrial size reduction applications and choosing appropriate size reduction equipment for particle characteristic investigations.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	3	1	2	1	2	2	3	3	3
CO2	3	3	2	3	3	2	3	1				2	3	3	2
CO3	3	3	3	2	3	2	3					2	3	3	2
CO4	3	3	2	1	2	2	2	1	1	1	2	2	2	2	2
CO5	3	3	3	3	2	2	3	1	1	1	2	2	3	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Units and dimensions, types of fluids, hydrostatic pressure, pressure distribution in static fluids, pressure measuring devices, introduction to fluids in motion, concept of stream lines, stream tubes, viscosity, rheological properties of fluids.

Module II **8 hours**

Boundary layer formation and growth in tubes and on plates; Basic equations of fluid flow: continuity equation, momentum balance equation (concept of Navier-Stokes equation) and mechanical energy equation (Bernoulli equation). Flow of incompressible fluids in pipes: relation between skin friction and wall shear, laminar flow in pipes: Hagen-Poiseulle equation, friction factor, friction from changes in velocity or direction.

Module III **8 hours**

Drag, drag coefficient, flow through beds of solids, fluidization, mechanism of fluidization, applications of fluidization. Transportation and metering of fluids: reciprocating, rotary and centrifugal pumps; flow measuring devices: venturi meter, orifice meter, rotameter and pitot tube.

Module IV **8 hours**

Characteristics of solid particles, principles of comminution: laws of crushing (Rittinger's, Bond's, Kick's laws); description and working of size reduction equipment: jaw, gyratory and roll crushers, ball mill, hammer mill, attrition mill, fluid energy mill, and cutting machines.

Module V **8 hours**

Mechanical Separations: Screening, differential and cumulative screen analysis, capacity and effectiveness of screens; screening equipment: grizzly, gyratory and vibratory screens, revolving screens, trammels.

Text Book(s)

1. W.L. McCabe, J.C. Smith, and P. Harriot, Unit Operations of Chemical Engineering, 7/e, McGraw-Hill International Edition, 2005.

References

1. J.M. Coulson, and J.F. Richardson, Chemical Engineering-Volume One, 6/e, The English Language Book Society and Permagon Press, 1999.
2. G.G. Brown, Unit Operations, CBS Publishers, 2005.

EBT205: BIOANALYTICAL TECHNIQUES

L	T	P	C
3	0	0	3

Bioanalytical techniques are used to estimate and characterize biomolecules and biomolecular systems. The biomolecules may be present in a pure form in solution, or may be part of a complex biomolecular system, or a part of a complex matrix.

Course Objectives:

The objectives of this course are to

1. Introduce the principles of bioanalytical techniques
2. Develop expertise in bioanalytical data interpretation and evaluation.
3. Describe advantages and disadvantages of available bioanalytical techniques.
4. Describe how the advantages and disadvantages are expected to change with changing technology.
5. Discuss the specific biological problems and applicable bioanalytical techniques.

Course Outcomes:

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

1. Compare methods for determination of mass and particle size.
2. Determine the sequence of proteins from mass spectrometry data.
3. Analyze data from NMR spectroscopy.
4. Select optimum instrumental method for monitoring the quality of biotechnology products.
5. List the applications of high-throughput and miniaturized devices in Biotechnology.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3						3	3	2	3	3	1
CO2	3	3	3	3						3	3	2	3	3	1
CO3	3	3	3	3						3	3	2	3	3	1
CO4	3	3	3	3						3	3	3	3	3	1
CO5	3	3	3	3						3	3	3	3	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Chromatography: General principles and modes of chromatography, chromatographic media and applications of the chromatographic techniques; Ion-exchange, gel permeation, affinity, gas chromatography and HPLC.
Electrophoresis: General principles. PAGE, agarose gel electrophoresis, Isoelectric focusing, 2D GE, PFGE and capillary electrophoresis.
Centrifugation: Principles, Differential, Density gradient and analytical centrifugation. Sedimentation velocity and sedimentation equilibrium for determination of molecular mass.
Radioisotope techniques: Principles, measurement and applications of radioactivity.

Module II **8 hours**

UV-Visible Spectroscopy: Principles, instrumentation and applications.
Atomic absorption spectroscopy; Principles, and applications.
Infrared and Raman Spectroscopy: Principles, instrumentation and biomolecular applications (IR for structural studies of small molecules not included).

Spectrofluorimetry: Basic principles, fluorescence intensity, wavelength dependence, quantum yield, lifetime, polarization and rate of resonance energy transfer. Applications: DNA sequencing, fluorescence immunoassays and molecular beacons.

Module III **8 hours**

Mass spectrometry: Basic Principles and instrumentation. Ionization techniques: EI, FAB, Electrospray and MALDI. MS analyzers: Magnetic sector, quadrupole and TOF and FTICRMS.
Applications of MS: Determination of relative molecular mass, empirical formula, small molecule structural analysis, peptide sequencing and protein identification for proteomic studies.

Module IV **8 hours**

ESR spectroscopy: Principles and applications.
NMR spectroscopy: Principles of magnetic resonance. Use of NMR parameters chemical shift, coupling constants and areas for structural elucidation of small molecules. Nuclear Overhauser effect. Principles of FTNMR and 2D-NMR. Introduction to Protein structure determination by NMR. Principles of MRI and MR-spectroscopy.

Module V **8 hours**

Electrochemical methods: Principles of potentiometry. Clark's oxygen electrode.
Biosensors: Principles and applications of electrochemical, thermometric, optical and piezoelectric biosensors. Glucose biosensors.
Microarrays: Basic principles, types and methods of manufacture. Applications: Differential expression and SNP analysis.

Text Book(s)

1. K. Wilson and J. Walker (eds.), Principles and techniques of biochemistry and molecular biology, 7/e, Cambridge University Press, 2010.
2. H. Backett and J. B. Stenlaks, Practical pharmaceutical chemistry, (part two), 4/e, CBS Publication and Distributors, 2007.

References

1. J. Walker and R. Rapley (eds.), Molecular biology and biotechnology, 4/e, Royal Society of Chemistry, 2000.
2. S. K. Isaac, A. Kho and A. J. Butte, Microarrays for an integrative genomics (Computational molecular biology). MIT press, 2005.
3. K. Wuthrich, NMR of proteins and nucleic acids, Wiley 1986.
4. R. M. Silverstein, F. X. Webster, D. Kiemle and D. L. Bryce, Spectrometric identification of organic compounds, 8/e, Wiley 2014.
5. A. V. Loyd Jr., Remington: The science and practice of pharmacy, 22/e, vols. I and II, Lippincott Willams and Wilkins, 2012.

EBT206: GENETICS AND MOLECULAR BIOLOGY

L	T	P	C
3	0	0	3

This course is designed to introduce the principles of inheritance and the molecular basis of cellular structure and function.

Course Objectives:

The objectives of this course are to

1. Describe the genetic basis of inheritance.
2. Illustrate structure and functions of prokaryotic and eukaryotic cells.
3. Describe the structure and functions of chromosomes.
4. Discuss cell cycle and its role in signalling
5. Explain DNA replication, gene expression, regulation, mutations, repair and genomics.

Course Outcomes:

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

1. Explain the concepts of gene structure and its function.
2. Summarize the inheritance of characters by mendelian and non-mendelian genetics.
3. Explain the molecular basis of mutations and DNA repair.
4. Explain the mechanism of gene regulation.
5. Summarize the importance of genetic code and central dogma.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2											1	3		
CO2	2	2		3								1	3	2	2
CO3	3												2	2	
CO4	2											1	3		
CO5	3												3		

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Principles of Inheritance: Mendelian and non-mendelian inheritance, linkage and crossing over, mapping of genes and cytoplasmic inheritance.

Module II **8 hours**

Structure of cell membrane, cellular organelles and their structure and functions, organization of the chromosome, euchromatin and heterochromatin; nucleosome, cell division, cell cycle and its regulation; CDC mutants, protein kinases, cyclins; biochemistry of meiosis.

Module III **8 hours**

DNA structure and topology; replication in prokaryotes and eukaryotes, models of replication, nucleotide sequence composition; unique, middle and highly repetitive DNA, redundant DNA; genetic recombination, transposons; molecular basis of mutations, DNA repair mechanisms.

Module IV **8 hours**

Principles of transcription: prokaryotic RNA polymerase, mechanism of transcription in prokaryotes and eukaryotes, post transcriptional processing. Regulation of gene expression in *E. coli.* Operon concept; Biochemical control of gene expression in eukaryotes.

Module V **8 hours**

General features of genetic code, translation machinery in prokaryotic and eukaryotic systems, protein targeting and processing. Signal sequences, signal receptor protein, signal hypothesis.

Text Book(s)

1. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine and R. Losick, Molecular Biology of the Gene, 7/e, Benjamin Cummings publishers, 2013.
2. Robert Brooker, Genetics: Analysis and Principles, 5/e, McGraw-Hill Science Publishers, 2014.

References

1. B. Albert's, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts and P. Walter, Molecular Biology of the Cell, 6/e, Garland Publishers, 2014.
2. EDP De Robertis, Cell and Molecular Biology, 8/e, Lippincott, Williams's and Wilkins Publishers, 2010.
3. S. Kowalczykowski, N. Hunter and W. D. Heyer, DNA Recombination, 1/e, Cold spring harbor lab. Press, 2015.
4. H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, A. Bretscher, H. Ploegh, Amon and M.P. Scott, Molecular Cell biology, 7/e, W.H Freeman and Company, 2014.
5. J. E. Krebs, E. S. Goldstein and S. T. Kilpatrick, GENES XI, 11/e, Jones & Bartlett Publishers, 2014.

EBT207: BIOCHEMICAL THERMODYNAMICS

L	T	P	C
3	0	0	3

The main thrust of this course is to make the student to understand the theory and applications of classical thermodynamics in biochemical processes

Course Objectives:

The objectives of this course are to

1. Explain thermodynamic properties and thermodynamic laws
2. Estimate free energies of biochemical reactions
3. Derive fundamental property relations using state variables
4. Explain phase equilibrium and chemical reaction equilibrium
5. Apply the laws of thermodynamics to biological systems.

Course Outcomes:

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

1. Comprehend fundamental thermodynamic concepts and apply the rules of thermodynamics to assess energy exchanges in a variety of systems and processes.
2. Apply Second and Third Law of Thermodynamics concepts in analyzing the thermal efficiencies of heat engines and other processes.
3. Find the thermodynamic properties data from various thermodynamic charts, diagrams and relations and determine changes in thermodynamic properties in ideal and non-ideal solutions used in biochemical applications.
4. Determine the feasibility of reactions, heat of reaction, optimum conditions and equilibrium composition for various reactions. Apply phase equilibrium concepts in various biochemical engineering contexts.
5. Apply thermodynamic concepts in bioprocess applications.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2	3	1	1		1	3	3	1	2
CO2	3	3	3	3	3	2	2	1	1	1	1	2	3	3	3
CO3	3	3	2	3		1		1	1		1	1	3	1	1
CO4	3	3	2	3	2	1		2	1			1	3	2	1
CO5	3	3	2	3	2	1	2	1	2	1	1	3	3	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

The first law of thermodynamics and other basic concepts: Joule's experiments, internal energy, the first law of thermodynamics, energy balance for closed systems, thermodynamic state and state functions, equilibrium, the phase rule, the reversible process, constant volume and constant pressure processes, enthalpy, heat capacity, mass and energy balances for open systems.

Module II **8 hours**

The second law of thermodynamics: Statement of the second law, heat engines, thermodynamic temperature scales, entropy, entropy changes of an ideal gas, mathematical statement of the second law. The third law of thermodynamics.

Module III **8 hours**

Thermodynamic properties: PVT behavior of pure substances, thermodynamic property relations for homogeneous phases. Solution thermodynamics: fundamental property relation, chemical potential and phase equilibria, fugacity and fugacity coefficient of pure species, fugacity and fugacity coefficient species in solution, fugacity of a pure liquid.

Module IV **8 hours**

Chemical reaction equilibria: The reaction coordinate, application of equilibrium criteria to chemical reactions, the standard Gibbs energy change and the equilibrium constant, effect of temperature on the equilibrium constant, relation of equilibrium constants to composition, equilibrium conversions for single reactions, phase rule and Duhem's theorem for reacting systems.

Module V **8 hours**

Biochemical applications of thermodynamics: Factors affecting stability of double stranded DNA, statistical thermodynamics of monomer-dimer equilibrium for DNA and brief discussion of implications for PCR primer design and DNA microarray design, the helix-coil transition in polypeptides, ligand-receptor binding equilibria. ATP-ADP energy storage and utilization.

Text Book(s)

1. J.M. Smith, H.C. van Ness, and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 6/e, McGraw-Hill, 2003.
2. Tinoco, Sauer, and Wang, Physical Chemistry: Principles and Applications in Biological Sciences, Dorling Kindersley, 2007.

References

1. S.I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4/e, Wiley, 2006.

EBT208: BIOCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

The main aim of this course is to make the student familiar with the culture techniques, kinetics and various types of bioreactors

Course Objectives

The objectives of this course are to

1. Introduce enzyme kinetics.
2. Discuss the microbial growth kinetics and various types of fermenters.
3. Apply growth kinetics data to biochemical reactor design.
4. Appraise microbiology and cell culture techniques for animal and plant cells.
5. Employ work groups to solve biochemical engineering problems.

Course Outcomes:

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

1. Understand the different types of chemical and biochemical reactions, and their kinetics and influence of various parameters on chemical and biochemical process kinetics.
2. Understand principles involved in various reactors and choose suitable reactor for various biochemical reactions. Able to analyze reaction data and use it in the design of ideal batch reactor, fermenter, etc.
3. Determine design equations for various ideal flow reactors and analyze their performance in single and combined reactors.
4. Determine design equations for batch and flow reactors under non-isothermal conditions. Able to understand the kinetics in batch and continuous sterilization processes.
5. Identify problems involved during operation of real reactors.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1		1				1	1	3	2
CO2	3	3	3	1	1	2	3	1					2	3	2
CO3	3	3	3	1	1	2	2						2	3	2
CO4	3	3	3	1	2	1		2	1			1	2	3	2
CO5	3	3	3	3	1	1	2		2	1			1	2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Enzyme Kinetics: Simple enzyme Kinetics, Enzyme reactor with simple kinetics, Inhibition of enzyme reactions, other influences on enzyme activity.

Module II **8 hours**

Immobilized enzymes: Immobilization Techniques, Effects of intra and inter-phase mass transfer on enzyme kinetics.

Module III **8 hours**

Cell Cultivation: Microbial cell cultivation, Animal cell cultivation, Plant cell cultivation, Cell growth measurement, Cell Immobilization.

Module IV **8 hours**

Cell kinetics and Fermenter design: Growth cycle for batch cultivation, Stirred-tank fermenter, Ideal continuous stirred-tank fermenter, Multiple fermenters connected in series.

Module V **8 hours**

Sterilization: Sterilization methods, thermal death kinetics, batch sterilization, continuous sterilization, air sterilization.

Text Book

1. J.M. Lee, Biochemical Engineering, Prentice Hall, 1992.
2. D.G. Rao, Introduction to Biochemical Engineering, 2/e, Tata McGraw-Hill, 2010.

Reference Book

1. J.E. Bailey, D.F. Ollis, Biochemical Engineering Fundamentals, 2/e, Tata McGraw-Hill, 2010.
2. H.W. Blanch, D.S. Clark, Biochemical Engineering, Marcel Dekker Inc., 1997.
3. M.L. Shuler, F. Kargi, Bioprocess Engineering: Basic Concepts, 2/e, Prentice Hall, 2002.

EBT209: PROCESS CALCULATIONS

L	T	P	C
3	0	0	3

This course is designed to make the student familiarize with mass and volumetric relationships in chemical reactions together with fundamental units for computing the changes in mass and composition

Course Objectives:

The objectives of this course are to

1. Estimate vapor pressure in the absence of experimental data
2. Predict the effect of temperature on vapor pressure
3. Analyze material balance problems encountered in the unit operations and processes.
4. Apply the first law of thermodynamics to perform energy balances on steady-state non-reactive and reactive processes.
5. Discuss the principles and applications of stoichiometric calculations in microbial growth and product formation.

Course Outcomes:

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

1. Explain the composition of solids and liquids, & behaviour of gases.
2. Understand the effect of temperature on vapour pressures of miscible and immiscible liquids.
3. Apply concepts of humidity and saturation.
4. Explain the process flow diagrams with material and energy transfers.
5. Perform material and energy balances for the bioprocesses.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1		1	1	1	1	3	2	
CO2	3	1	1	2	3	2	1		1	2		1	3	2	1
CO3	3	1	2	2	3	2	1		1	1	1	1	3	2	1
CO4	3	2	1	1	3	2	1		1	1	1	1	3	2	2
CO5	3	2	1	1	3	2	1		1	1	1	1	3	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Chemical reaction, Stoichiometric and composition relationships. Basis of calculation: Weight percent, volume percent and mole percent, density and specific gravity. behaviour of ideal gases, application of the ideal gas law. Dalton and Amagat laws of gaseous mixtures. Composition of gases on dry and wet basis.

Module II **8 hours**

Vapor pressure of liquid, effect of temperature on vapor pressure. Antoine equation. Reference substance vapor pressure plots. Vapor pressure of immiscible liquids. Ideal solutions and Raoult's law, Non-volatile solutes humidity, Percentage saturation. Relative saturation and relative humidity. Dew point, vaporization, condensation. Wet and dry bulb temperatures. Adiabatic vaporization and adiabatic saturation temperature.

Module III **8 hours**

Material balances: Law of conservation of mass. Material balance without chemical reactions. Tie element basis for calculations. Material balance calculations involving drying, dissolution and crystallization, Continuous filtration, Batch mixing. Recycling and bypassing operations. Material balance with chemical reactions. Concept of excess reactant, limiting reactant, conversion, yield, degree of completion.

Module IV **8 hours**

Energy balance: Law of conservation of energy. Components of energy balance equation. Heat and work. Internal energy. Concept of Enthalpy and heat capacity. Enthalpy changes. Heat effects accompanying chemical reactions. Standard heats of reaction, combustion and formation. Hess's law. Effect of temperature on standard heats of reaction. Steady state energy balance.

Module V **8 hours**

Stoichiometry of microbial growth and product formation. Stoichiometric calculations; elemental balances, degree of reduction, yield coefficients, biomass yield, product stoichiometry. Theoretical oxygen demand. Maximum possible yield. Thermodynamics of microbial growth. Heat of reaction with oxygen as electron acceptor and without oxygen. Energy balance equations for fermentation and cell culture.

Text Book(s)

1. Olaf A Hougen, Kwenneth M.Watson and Roland A.Ragatz, Chemical Process Principles Part-I, Material and Energy balances, 2/e, CBS Publishers and Distributors, 2010.
2. Pauline M .Doran, Bioprocess Engineering Principles, 1/e, Academic Press, 2009.

Reference Books:

1. K.A. Gavhane, Chemical Process Principles (Stoichiometry), 25/e, Nirali Prakashan, 2009.
2. Michael L Shuler and Fikret Kargi, Bioprocess Engg. Basic Concepts, 2/e, Prentice - Hall India, 2002.
3. Williams and Johnson, Stiochiometry for Chemical Engineers, 2/e, McGraw Hill, 1990.

EBT221: BIOCHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

Course Objectives:

The main objective of this lab is to train:

1. Calibration of pH meter and preparation of buffers
2. Quantitative estimation of bio-molecules : proteins, carbohydrates, lipids
3. Assay of enzyme activity
4. Separation of biomolecules using chromatography: amino acids, lipids and plant pigments.
5. Analysis of absorption spectra of proteins and nucleic acids.

Course Outcomes:

At the end of the course students will be able to

1. Explain the structure and properties of amino acids, proteins, and enzymes.
2. Interpret carbohydrates and carbohydrate metabolism.
3. Discuss lipid structure and lipid metabolism.
4. Explain nucleic acids and nucleic acid metabolism.
5. Discuss nutritional biochemistry and hormones for human health.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1					1	2	2	1	1
CO2	3	3	3	3	3	1					1	2	2	2	1
CO3	3	3	3	3	3	1					1	2	2	2	1
CO4	3	3	3	3	3	1					1	2	2	2	1
CO5	3	3	3	3	3	3					3	2	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

At least ten of the following experiments:

1. Calibration of pH meter and preparation of Buffers: Acetate, Phosphate and Citrate buffers
2. Estimation of total carbohydrates, amino acids, protein, lipid
3. Assay of amylase, phosphatase, urease, and catalase – (any two)
4. Determination of Km value
5. Paper chromatographic separation of amino acids, carbohydrates
6. Estimation of Thiamine and Riboflavin by Fluorimeter
7. Thin Layer chromatographic separations of sugars and lipids
8. Absorption spectra of proteins and nucleic acids
9. Determination of Tm of DNA
10. Extraction of plant pigments from leaves and separation through column chromatography
11. Electrophoretic separation of proteins and determination of molecular weight by SDS-PAGE
12. Extraction of theophylline from Tea leaves and estimation
13. Separation of proteins through native PAGE.

Demonstration experiments:

14. Separation of proteins through Gel filtration & Ion exchange chromatography
15. Separation of proteins using HPLC (High Performance Liquid Chromatography)

16. ELISA (Enzyme Linked Immuno Sorbent Assay)

Text book(s)

1. Sadasivam, Manickam, Biochemical methods, 2/e, New Age, 1996.
2. Plummer DT, Introduction to Practical Biochemistry, 3/e, Tata-McGraw Hill, 2002.

References

1. S. K. Sawhney and Randhir Singh, Introductory Practical Biochemistry, 2/e, Alpha Science International, 2005.
2. B. Shashidhar Rao and Vijay Desh Pande IK, Experimental Biochemistry. Illustrated, Anshan, 2006.
3. Dany Spencer Adams, Lab Math, CSHL Press, 2003.

EBT222: BIOCHEMICAL ENGINEERING LAB

L	T	P	C
0	0	3	2

Course Objectives:

The main objective of this lab is to train students on:

1. Isolate and study the activity of enzymes and evaluate their kinetic parameters.
2. Design of air and media sterilization systems.
3. Prepare and characterize immobilized enzymes.
4. Estimate cell growth kinetic parameters.
5. Demonstrate bioreactor construction and operation.

Course Outcomes:

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

1. Understand the different types of chemical and biochemical reactions, and their kinetics and influence of various parameters on chemical and biochemical process kinetics.
2. Understand principles involved in various reactors and choose suitable reactor for various biochemical reactions. Able to analyze reaction data and use it in the design of ideal batch reactor, fermenter, etc.
3. Determine design equations for various ideal flow reactors and analyze their performance in single and combined reactors.
4. Determine design equations for batch and flow reactors under non-isothermal conditions. Able to understand the kinetics in batch and continuous sterilization processes.
5. Identify problems involved during operation of real reactors.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1		1				1	1	3	2
CO2	3	3	3	1	1	2	3	1					2	3	2
CO3	3	3	3	1	1	2	2						2	3	2
CO4	3	3	3	1	2	1		2	1			1	2	3	2
CO5	3	3	3	3	1	1	2		2	1			1	2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

List of experiments:

1. Demonstration of various bioreactor configurations, parts and integrated process control systems.
2. To determine the enzyme kinetics via initial- rate determination.
3. Enzymes in Laundry Detergents
4. Cell growth measurement of Yeast.
5. Cell growth measurement for Plants.
6. Efficiency of air filters and Microbial death kinetics.
7. Demonstration of batch, fed-batch and continuous processes in CSTR.
8. Preparation and characterization of immobilized enzymes.
9. Determination of kinetic constants in free and immobilized enzyme systems.
10. Enzyme purification.

Text Book

1. James M. Lee, Biochemical Engineering, Prentice Hall, 1992.

EBT223: APPLIED MICROBIOLOGY LABORATORY

L	T	P	C
0	0	3	2

Course Objectives:

The main objective of this lab is to:

1. Prepare microbial culture media and isolate pure cultures
2. Apply Gram staining technique and biochemical methods for identification of bacteria.
3. Characterize the morphology and motility of bacteria
4. Illustrate a method for microbial assay of antibiotics
5. Tests for microbiological quality of milk and water

Course Outcomes:

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

1. Gain the knowledge the techniques for microbial isolation and purification.
2. Understand morphological structure of Viruses, Yeast, Molds and Bacteria with its physiological pattern.
3. Able to understand effect of various parameters on microbial growth and its metabolic pathways.
4. Apply the microbial decontamination processes and techniques for healthcare.
5. Understand the role of microbes in industrial fermentation process and also in agriculture.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	2	1	1	2	2	1	1	1	1	2	2	2
CO2	2	2	1	1	2	2	2	2	2	1	1	2	2	2	2
CO3	3	2	2	1	1	1	2	2	1	1	2	2	3	2	3
CO4	2	2	2	2	2	1	2	2	1	1	1	2	2	2	2
CO5	3	3	3	2	3	1	3	2	2	1	2	1	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

At least 10 of the following experiments:

1. Preparation of Nutrient broth and inoculation of Bacteria.
2. Preparation of Nutrient agar and inoculation of Bacteria.
3. Isolation of pure cultures.
4. Staining of Microbes- Simple staining, Gram staining, Negative staining, Capsule
5. staining and Spore staining.
6. Motility of Microbes.
7. Morphology of Fungi (*Aspergillus niger*)
8. Morphology of Yeast (*Saccharomyces cerivisiae*)
9. Bio-chemical tests - IMViC test, Amylase test, Hydrogen Sulphide production test.
10. Testing of Microbiological quality of milk.
11. Testing of Microbiological quality of water.
12. Microbial assay of antibiotics.
13. Evaluation of disinfectant.

Group and demonstration expiriments

14. Flow cytometric Technique for quantification and differentiation of Bacteria in Milk.
15. Fluorescent Microscopy.
16. Bright field Microscopy.

Text Book(S)

1. James G Cappuccino and Natalie Sherman, Microbiology, A laboratory manual, 10/e, Benjamin Cummings, 2013.
2. Aneja KR, Experiments in Microbiology, Plant Pathology and Biotechnology, 4/e, New Age International, 2013.

EBT224: FLUID MECHANICS AND PARTICLE TECHNOLOGY LABORATORY

L	T	P	C
0	0	3	2

Course Objectives:

The main objective of this lab is to:

1. Determine orifice and venturi coefficients.
2. Verify Bernoulli's equation experimentally.
3. Measure pressure drop in packed and fluidized beds.
4. Determine the effectiveness of a screen.
5. Estimate the energy consumption during size reduction.

Course Outcomes:

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

1. Comprehend the principles of fluid statics and fluid flow in motion. Using the concepts of fluid statics to detect pressure in practical situations and bioprocess applications.
2. Use Bernoulli's equation and pump calculations to solve fluid flow problems by applying mass, energy, and momentum balances.
3. Analyze fluid drag on particles. Computing the energy losses that occur when fluids are transported through pipelines, packed beds, and fluidized bed equipment.
4. Calibrate and use various flow measuring devices for calculation of flowrates in biochemical applications. Use various particle separation equipment for particle characterization studies.
5. Determine the energy needs for a range of industrial size reduction applications and choosing appropriate size reduction equipment for particle characteristic investigations.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	3	1	2	1	2	2	3	3	3
CO2	3	3	2	3	3	2	3	1				2	3	3	2
CO3	3	3	3	2	3	2	3					2	3	3	2
CO4	3	3	2	1	2	2	2	1	1	1	2	2	2	2	2
CO5	3	3	3	3	2	2	3	1	1	1	2	2	3	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

List of Experiments:

1. Calibration of Rotameter.
2. Determination of orifice coefficient.
3. Determination of venturi coefficient.
4. Verification of Bernoulli's equation.
5. Friction losses in fluid flow in pipes.
6. Determination of pressure drops in a packed bed for different fluid velocities.
7. Determination of pressure drop and void fraction in a fluidized bed.
8. Study of characteristics of centrifugal pump.

9. Sampling of materials (Riffle sampling and cone quartering sampling).
10. Determination of energy consumption in size reduction using roll crusher.
11. Determination of energy consumption in size reduction using ball mill.
12. Determination of effective of a given screen.

References

1. B. Majumdar, Fluid Mechanics with Laboratory Manual, PHI, 2013.
2. V.P. Gupta, K. Chandra, and K.S. Gupta, Laboratory Manual of Fluid Mechanics and Machines, CBS, 2009.

EBT301: BIOINFORMATICS

L	T	P	C
3	0	0	3

This course is designed to impart the basic bio-informatic concepts and computational techniques at the entry level, and to introduce the students to a wide range of biological databases.

Course objectives

This course is proposed with the following objectives:

1. Acquire knowledge available in biological databases.
2. Acquire knowledge of Algorithms for fragment assembly to deduce genomic sequence
3. Compare algorithms for sequence alignment and methods for searching sequence databases
4. Use basic algorithms for molecular phylogenetic analysis
5. Analyse protein 3D structure and prediction from amino acid sequence data.

Course Outcomes

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

1. List biological databases related to biochemicals, proteins and nucleic acids.
2. Assess similarity of biological sequences.
3. Solve problems in phylogenetic analysis.
4. Predict protein structure based on sequence information and structure of homologs.
5. Construct genomic sequences from fragments.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3						3	3	2	3	2	3
CO2	3	3	3	3						3	3	2	3	2	2
CO3	3	3	3	3						3	3	1	3	1	1
CO4	3	3	3	3						3	3	2	3	2	1
CO5	3	3	3	3						3	3	3	3	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Introduction to Biological databases. Brief introduction to information available in following databases (details to be covered in practicals): NCBI-Genebank, PIR, PFAM, PDB, GOLD. Sequence analysis: introduction. Similarity matrices – PAM and BLOSUM.

Searching databases using BLAST. Description of the BLAST algorithm.

Module II **8 hours**

Pairwise sequence alignment using dynamic programming. Needleman & Wunsch algorithm for global alignment. Smith-Waterman algorithm for local alignment. Dynamic programming for sequence alignment with affine gap penalties. Searching for repeats and partial overlaps using dynamic programming.

Module III **8 hours**

Phylogenetic analysis. Distance based methods: UPGMA and Neighbor joining. Classical parsimony and weighted parsimony methods. Branch and bound.

Multiple sequence alignment. Multidimensional dynamic programming. Progressive alignment and profile alignment. Sankoff and Cedergren method for Simultaneous alignment and phylogeny.

Module IV **8 hours**

Prediction of transmembrane helices. Prediction of secondary structure from protein sequence – Chou-Fasman rules, neural networks. Prediction of protein conformation from protein sequence - Information theoretical methods: Homology and threading. Prediction using Force fields (Basic concepts only, regarding Energy minimization, molecular dynamics and simulated annealing)

Module V **8 hours**

Computational problems in genome sequencing (concepts). Graph theoretical formulation of the fragment assembly problem. Hamiltonian path and Eulerian path based algorithms. Gene prediction - statistical and similarity based approaches. Overview (concepts only) of methods for gene annotation. K-means and SOM algorithms for analysis of gene expression data.

Textbook(s)

1. R. Durbin, S. Eddy, A. Krogh, G. Mitchison, Biological sequence analysis: Probabilistic models of proteins and nucleic acids, Cambridge University Press. 1998.
2. D. Mount, Bioinformatics: Sequence and Genome analysis, 2/e. CBS publishers. 2005.

References

1. A. Leach, Molecular modeling: principles and applications, 2/e, Pearson, 2001.
2. T. Schlick, Molecular modeling and simulation, Springer-Verlag, 2002.
3. A. Baxevani, B.F.F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 3/e, Wiley, 2004.
4. J.R. Miller, S. Koren, G. Sutton, Assembly algorithms for next generation sequencing data. Genomics, 95:315-327, 2010.
5. PA Pevzner, H Tang, MS Waterman, An Eulerian path approach to DNA fragment assembly, Proc. Natl. Acad. Sci. 98:9748-9753. 2001.

EBT302: BIOPROCESS ENGINEERING

L	T	P	C
3	0	0	3

This course is designed to impart the basic concepts of bioprocesses with relevance to Biotechnology applications.

Course Objectives:

This course is proposed with the following objectives:

1. Utilise the concepts of cell biology and biochemistry for the design and implementation of a bioprocess system.
2. Apply the concepts of material and energy balances, reaction kinetics, and mass transfer to biological systems
3. Analyse and design bioprocesses.
4. Introduce the handling and processing of bioproducts.

Course outcomes:

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

1. Understand the definition, scope, and differences between bioprocess and chemical processing.
2. Analyze the principles of aeration, agitation, oxygen transfer, and heat evolution in bioreactors, including their impact on microbial system performance.
3. Understand the kinetics of microbial growth in batch and continuous systems, and analyze the operational principles of chemostats, fed-batch systems, and immobilized cell systems.
4. Select and operate bioreactors and understand the methods and criteria for scaling up bioreactor processes.
5. Understand the basic functions, construction, and regulatory constraints of fermenters for microbial or animal cell culture, including aseptic operations and foam control systems.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2			1									2		
CO2		2			2	1							1	2	
CO3			3		1	2								1	1
CO4				3		1	2	2							2
CO5		1		2	3				2	1	2	1	3	1	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Definition and scope of bioprocess engineering. Bioprocess vs chemical processing: advantages and disadvantages. Substrates for bioconversions. Choice of microbes. Media design and optimization. Regulatory constraints.

Module II **8 hours**

Stochiometry and energetic analysis of cell growth and product formation, degree of reduction concepts. Microbial and cellular growth kinetics, substrate utilization and product formation kinetics for batch growth-unstructured non-segregated models, models for transient behavior in batch reactor.

Module III **8 hours**

Aeration and agitation in bioreactors: Oxygen transfer in microbial systems, oxygen demand mass transfer theories, Oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

Measurement of volumetric mass transfer coefficient, power requirement in gassed and ungassed bioreactors, mixing and heat transfer in dispersed systems, biorheology.

Module IV **8 hours**

Batch and continuous bioreactors, Growth in ideal chemostat, chemostat with recycle, multistage chemostat, fed-batch growth. Immobilized cell systems. Selection and operation of bioreactors. Bioreactor instrumentation and control,

Module V **8 hours**

Application of computers in bioprocess engineering: Data logging, analysis and control; Optimization of kinetic parameters from raw fermentation data. Technologies for effective utilization of genetically engineered microorganisms for bioprocessing. Process economics: Cost benefit analysis

Text Book(s)

1. M. L. Shuler, F. Kargi, Bioprocess Engineering Basic Concepts, 2/e, Prentice Hall International edition, 2014.

References

1. Pauline M Doran, Bioprocess Engineering Principles, Elsevier, 2005.
2. P.F.A. Stanbury, A. Whitaker, S.J. Hall, Principles of Fermentation Technology, 2/e, Pergamon, 1995.

EBT303: GENETIC ENGINEERING

L	T	P	C
3	0	0	3

As a Genetic Engineer, the student has to deal with the manipulation of genes of an organism, learn molecular techniques and their applications in various fields.

Course Objectives:

Present syllabus is aimed to impart knowledge on

1. Isolation and sequencing of DNA and RNA.
2. rDNA technology- construction of vectors, genomic and cDNA library.
3. Molecular techniques such as PCR, RFLP, RAPD, AFLP etc and their applications.
4. RNA Silencing, anti-sense RNA and applications of rDNA technology

Course Outcomes:

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

1. Understand the isolation of nucleic acids, enzymes of rDNA technology and vectors.
2. Apply prokaryotic, eukaryotic expression and molecular techniques in finding gene expression.
3. Explain nucleic acid sequencing methods in understanding sequence and construction and screening of DNA libraries.
4. Apply molecular techniques for nucleic acid amplification and analysis.
5. Discuss RNAi Technology, genome editing and the applications of rDNA technology.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1			1	2	3	1	1
CO2	3	3	3	3	2	1	2	1			1	2	3	2	2
CO3	3	3	3	3	3	2	3	1			1	2	3	3	3
CO4	3	3	3	3	3	3	3	1			1	2	3	3	3
CO5	3	3	3	3	3	3	3	2			1	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Isolation and purification of nucleic acids. History and scope of enzymes involved in DNA manipulation: nucleases, polymerases, ligases and topoisomerases. Isolation of gene using restriction endonucleases and mechanical shearing. Restriction mapping,

Module II **8 hours**

Cloning vectors**:** structure and properties of plasmids, cosmids, Ti and Ri plasmids, expression vectors, YAC, BAC, PAC and phagemids and vectors used for cloning in mammalian cells. Cloning strategies: construction of recombinant vectors; gene transfer methods for bacteria, plants and animals: biological delivery systems and artificial delivery systems.

Module III **8 hours**

Expression of cloned genes in bacteria, yeast, animal and plant cells. Synthesis of cDNA. Construction and screening of genomic DNA and cDNA libraries. Isolation of cloned genes. Identification of recombinants. Methods of sequencing of DNA and RNA. Preparation of labeled probes and primers.

Module IV **8 hours**

Molecular techniques involved in study of expression of genes**:** Southern, Northern, Western, Dot and Slot blots, In-situ hybridization. Advanced techniques in gene expression and analysis: PCR, RT-PCR, DNA finger printing, RAPD, RFLP and AFLP.

Module V **8 hours**

RNA silencing: design and applications of siRNA and anti-sense. Applications of genetic engineering in medicine, agriculture, animal husbandry, environmental management and industry. Achievements, limitations and negative aspects of genetic engineering.

Text Book(s)

1. T.A. Brown, Gene cloning and DNA analysis: an introduction, 6/e, Wiley-Blackwell, 2010.
2. D. S.T. Nicholl, An introduction to genetic engineering, 3/e, Cambridge University press, 2008.

References

1. J.D. Watson, R.M. Meyers, A.A. Caudy and J.A. Witkowski, Recombinant DNA: genes and genomes - A short course, 3/e, W.H. Freeman and Co, 2007.
2. S.B. Primrose, R. Twyman, B. Old, Principles of gene manipulation, 6/e, Wiley-Blackwell, 2001.

EBT304: PLANT BIOTECHNOLOGY

L	T	P	C
3	0	0	3

The course is designed to provide a comprehensive knowledge on plant tissue culture techniques and its application in production and improvement of plants and its products.

Course Objectives

The objective of the course is to:

1. Employ sterile techniques, plant nutrition and establishment of various explants for different culture techniques.
2. Explore various techniques of plant biotechnology with special focus on industrial applications.
3. Develop protocols for in vitro plant tissue culture, micropropagation, germplasms conservation, virus elimination, screening and selection.
4. Produce, secondary metabolites, haploids, hybrids, variant, transgenic plants by tissue culture and genetic transformations.

Course Outcomes

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

1. Apply fundamental knowledge of in vitro plant propagation in laboratory and industry.
2. Develop protocols for large scale micropropagation system, germplasm conservation, virus elimination.
3. Explain screening and selection of haploids, somatic hybrids, and other variants for biotic and abiotic resistance.
4. Improvise secondary metabolites through selection and genetic transformation.
5. Calculate the cost of tissue cultured plant and the enterprises.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		3			1	2	2					3	2	2
CO2	3	1	3	2	1	1	3	2	1				3	2	2
CO3	3		2	2	1	1	3	2	1		2		3	3	3
CO4	3	2	2	2	2	1	3	2	1		1	1	3	3	3
CO5	3	3	3	3	3	1	3		1		2	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Introduction to plant biotechnology, History and land marks in the development of plant tissue culture techniques, Nutritional components of plant tissue culture media, Plant growth regulators, Aseptic preparation methods, Principle and pathways of cell differentiation and plant regeneration, Organogenesis and somatic embryogenesis.

Module II **8 hours**

Clonal (Micro) propagation and its applications, Economics and cost of micropropagated plants, Somaclonal variation: its genetic basis and application in crop improvement, Callus/cell line selection for resistance to herbicide, stress and diseases, Production of virus free plants: apical shoot meristem culture and virus indexing.

Module III **8 hours**

Anther culture: methods of haploid production and their application in plant breeding, Protoplast technology: isolation, culture and plant regeneration, Protoplast fusion: identification and characterization of somatic hybrids,

cybrids and applications of protoplast fusion, Methods of germplasm conservation: cryopreservation, gene bank, Synthetic seeds technology and their applications.

Module IV **8 hours**

Cell and suspension culture system, Production of secondary metabolites by plant cell culture, Bioreactor system: design, and models for mass cultivation of plant cells, Hairy root bioreactor for secondary metabolite production, Automation in plant tissue culture.

Module V **8 hours**

Plant genetic transformation technology: concept and methods; Indirect and direct methods of gene transfer, Vectors for plant genetic transformation. Ethical and legal issues related to GM crops. Current global status and limitations of transgenic crops. Field techniques for transgenic plants. Regulation of GM crops in India.

Text Book(s)

1. H. S. Chawla, Introduction to Plant Biotechnology, 3/e, CRC Press, 2009.
2. A. Slater, N. Scott, M. Fowler, Plant Biotechnology: The Genetic Manipulation of Plants, 2/e, Oxford University Press, India, 2008.

References

1. M. K. Razdan, An Introduction to Plant Tissue Culture, 2/e, Oxford & IBH Publishing, 2010.
2. L. Pena, (Editor), Trangenic Plant: Methods and Protocols (Methods in Molecular Biology Series Vol. 286)", Hanumana PressTotowa, New Jersey, USD, 2005.
3. S. D. Purohit, Introduction to Plant Cell, Tissue and Organ Culture, PHI Learning, 2012.

EBT305: MASS TRANSFER

L	T	P	C
3	0	0	3

Course Objectives:

The objectives of the course are

1. Introduce the principles and applications of diffusion.
2. Apply the principles, applications and industrial equipment for adsorption.
3. Explore equipment for gas liquid operations.
4. Introduce the principles of distillation.
5. Combine principles and equipments for liquid-liquid extraction.

Course outcomes:

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

1. Understand and apply the fundamental laws and equations of mass transfer across different materials and geometries.
2. Grasp the principles of absorption and different types of absorption in various systems.
3. Analyze and compare various equipment for gas-liquid operations.
4. Design and analyze distillation processes using phase diagrams, VLE data, and distillation methods such as the McCabe-Thiele technique.
5. Evaluate and optimize liquid-liquid extraction operations using equilibrium data and modern extraction techniques.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		2	1									2		
CO2	2	1	3	2		1							1	2	
CO3	2	2	3		1	1								3	1
CO4	3	3		2	2		1	1		1			3	2	
CO5	3	3	2		2	1		2			1		2	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Introduction: Mass transfer Operations, molecular diffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state equimolal counter current diffusion, Stefan's diffusion, estimation of diffusivity of gases and liquids, application of molecular diffusion, theories of mass transfer, analogy between momentum, heat and mass transfer in laminar and turbulent flow, diffusion in solids.

Interphase mass transfer: concept of equilibrium, diffusion between phases, material balances in steady state co-current and counter-current stage processes.

Module II **8 hours**

Absorption: Equilibrium solubility of gases in liquids, two component system, multi-component system, ideal and non-ideal liquid solutions, choice of solvent for absorption, material balance for single component absorption, counter current multistage operation for single component absorption, dilute gas mixtures, absorption and

stripping factors, continuous contact equipment, HETP, HTU, NTU concepts for single component absorption, graphical construction for transfer units, absorption with chemical reaction.

Module III **8 hours**

Equipment for gas-liquid Operations: sparged vessels, mechanically agitated vessels for single phase liquids and gas – liquid mixtures. Description of tray towers & its components, Sieve tray towers, various tray efficiencies, Venturi scrubbers, spray towers and spray chambers, Description of packed towers, Comparison of tray towers and packed towers.

Module IV **8 hours**

Distillation: Principles of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, differential distillation (Rayleigh equation), steam distillation, continuous distillation, McCabe-Thiele method.

Module V **8 hours**

Liquid-liquid Extraction: Liquid-liquid equilibria, choice of solvent for extraction, analytical and graphical solutions for single and multistage operations, continuous counter current operation. Equipment: Mixer settler cascades, Rotating disc contactor, Scheibel extractor, Pulsed column, Centrifugal extractor.

Text Book(s)

1. R.E. Treybal, Mass Transfer Operations, 3/e, McGraw Hill International Editions, 1981.
2. B.K. Dutta, Principles of Mass Transfer and Separation Processes, Prentice-Hall of India, 2007.

References

1. W.L. McCabe, J. Smith, P. Harriot, Unit Operation of Chemical Engineering, 6/e, McGraw Hill International Edition, 2001.

EBT306: PROCESS DYNAMICS AND CONTROL

L	T	P	C
3	0	2	4

Process dynamics and control is the study and application of automatic control in the field of biochemical engineering (or Chemical Engg.).

Course Objectives:

The objectives of process dynamics and control is to

1. Operate a process at the desired operating conditions, safely and efficiently, while satisfying environmental and product quality requirements.
2. Develop models of important physical process systems.
3. Design various control systems.
4. Apply the control systems in various chemical and biochemical processes.

Course outcomes:

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

1. Able to develop models to determine the dynamics of first and higher order systems.
2. Able to understand the concepts of different types of controllers, and control systems and able to determine their stability in various processes.
3. Able to use various frequency response methods to determine the stability of control systems.
4. Able to understand the concepts of various advanced controllers and determine their optimum controller settings for operating under stable conditions.
5. Able to know how to measure and control various parameters in a fermenter. Able to understand how data is collected, analyzed and used for controlling bioreactors.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2		1		1		1	1	3	2
CO2	3	3	3	1		3	2	1		1		2	2	3	3
CO3	3	3	3	1		2	1	1				2	2	2	3
CO4	3	3	3	1	2	2		2				1	2	2	2
CO5	3	3	3	1	2	2	2	1				2	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Linear open-loop systems: Response of first-order systems, physical examples of first-order systems, response of first-order systems in series, second-order systems, transportation lag.

Module II **8 hours**

Linear closed-loop systems: The control system, controllers and final control elements, closed-loop transfer functions, stability, root locus.

Module III **8 hours**

Frequency response: Introduction to frequency response, control system design by frequency response.

Module IV **8 hours**

Process applications: Cascade control, feed forward control, ratio control, selective controllers, split range controller, controller tuning, control valves.

Module V **8 hours**

Applications of controllers in bioprocesses: Bioreactor operation, measurement and control: Aseptic operations, measurement and control of biochemical process variables pH, dissolved oxygen, viscosity, temperature, NADH; agitation rate, and foam control; Measurement and control of data acquisition, analysis and computer control of bioreactors.

Text Book(s)

1. D.R. Coughnowr and S.E. LeBlanc, Process Systems Analysis and Control, 3/e, McGraw-Hill, 2009.

References

1. P.F.A. Stanbury, A. Whitaker, S.J. Hall, Principles of Fermentation Technology, 2/e, Pergamon, 1995.
2. G. Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Pearson Education, 2005.
3. D.E. Seborg, D.A. Mellichamp, T.F. Edgar, and F.J. Doyle, Process Dynamics and Control, 3/e, Wiley, 2010.

PROCESS DYNAMICS AND CONTROL LABORATORY

List of Experiments:

1. Calibration of thermocouples.
2. Calibration of rotameter with compressible fluid.
3. Response of resistance thermometer
4. Response of bare mercury in glass thermometer.
5. Response of bare mercury in glass thermometer with thermal well.
6. Response of U-tube manometer.
7. Response of single-tank liquid-level system
8. Response of two-tank interacting liquid-level system.
9. Response of two-tank non-interacting liquid-level system.
10. Study of ON-OFF control action.

Text Book(s)

1. D. Mukund, B. Nitin, Process Dynamics Laboratory**,** LAP Lambert Academic Publishing, 2011.
2. D.R. Coughnowr, S.E. LeBlanc, Process Systems Analysis and Control, 3/e, McGraw-Hill, 2009.

EBT307: HEAT TRANSFER

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Apply conservation of mass and energy to a control volume or control surface. And to analyze transient problems using the lumped capacitance method.
2. Explain physical phenomena associated with convection, Newton's law of cooling, and the significance of non dimensional parameters in convection heat transfer.
3. Use empirical correlations to analyze external and internal, forced and free convection problems.
4. Acquire knowledge of enhanced heat transfer by phase changes
5. Examine different types of heat exchangers and their suitability for particular applications.

Course Outcomes

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

1. Understand and apply the fundamental laws and equations of heat transfer across different materials and geometries.
2. Analyze convective heat transfer processes and their efficiency using dimensional analysis and heat transfer coefficients.
3. Grasp the principles of heat transfer involving change of phase.
4. Acknowledge the heat transfer by radiation, laws of heat transfer by black bodies.
5. Design and analyse heat exchangers.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		2	1									2		
CO2	2	1	3	2		1							1	2	
CO3	2	2	3		1	1								3	1
CO4	3	3		2	2		1	1		1			3	2	
CO5	3	3	2		2	1		2			1		2	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Introduction: Modes of heat transfer. Basic laws of heat transfer. Analogy between heat flow and electrical flow. Conduction: The Fourier heat conduction equation. Steady state and one dimensional heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces. Three dimensional heat conduction equation. Numerical problems on unsteady state heat conduction through a semi-infinite slab, through an infinite slab, infinite cylinder, and sphere. Critical insulation thickness.

Module II **8 hours**

Convection: The convective heat transfer coefficient. Introduction to thermal boundary layer. Dimensionless numbers in heat transfer and their significance. Dimensional analysis. Forced convection: heat transfer by forced convection in turbulent flow, heat transfer in transition region between laminar and turbulent flow. Analogy

between momentum and heat transfer. Reynolds, Colburn and Prandtl analogies. Natural convection: natural convection from vertical and horizontal surfaces. Grashoff number.

Module III **8 hours**

Heat transfer with phase change: Heat transfer from condensing vapors- Film type and dropwise condensation, Derivation and practical use of Nusselt equations, Condensation of superheated vapors, Effect of non-condensable gases on rate of condensation. Heat transfer to boiling liquids: pool boiling of saturated liquid, maximum heat flux and critical temperature drop, minimum flux and film boiling.

Module IV **8 hours**

Heat transfer by radiation: Thermal radiation, Black body radiation, Kirchoff's law, emissivity, gray body, Laws of black body radiation, Geometric or shape factor. Radiation in enclosures with black and gray surfaces, Large parallel plates, Concentric cylinders and spheres. Combined heat transfer by conduction, convection and radiation.

Module V **8 hours**

Heat exchangers: types of heat exchangers. Log-mean temperature difference, Energy balances, Overall heat transfer coefficients, Heat exchanger effectiveness, Fouling factors, Design and description of heat transfer equipment, Heat exchangers, Condensers, and Kettle Reboilers, Extended surface equipment.

Text Book(s)

1. Warren L. McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7/e, McGraw Hill, 2005.
2. D.Q.Kern, Process Heat Transfer, Tata-McGraw Hill, 2001,

References

1. J.M. Coulson and J.F. Richardson, Chemical Engineering Volume-1 , 4/e, The English Language book society and Permagon Press, Oxford, 2005.
2. William McAdams, Heat Transmission, 3/e, McGrawHill, 1985.

EBT308: IMMUNOTECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

The objectives of the course is to

1. Introduce history, cells and organs of immune system and types of immune responses, presentation and processing of antigens
2. Explain structure and types of antibodies, role of cytokines and complement proteins in biological system.
3. Explore Ag-Ab interaction, methods for immunological techniques, production of monoclonal antibodies and their applications
4. Analyse hypersensitivity reactions, immunological disorders, transplantation immunology
5. Appraise the development of transgenic mice and production of vaccines.

Course Outcomes:

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

1. Explain the basics of immune system.
2. Understand the antibody structure, types, Complement pathways and cytokines.
3. Apply Ag-Ab specificities in various immunological techniques and monoclonal antibodies production.
4. Explain hypersensitivity, auto immunity, Immuno defeciency diseases and transplantation.
5. Apply principles of vaccine production, transgenic and knockout mice model systems.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	1	3	1		3	1			3	2	2	3
CO2	3	1	3	1	3	1		3	1			3	2	2	3
CO3	3	1	3	2	3	1	1	3	1			3	2	2	3
CO4	3	1	3	3	3	2	1	3	1			3	2	2	3
CO5	3	1	3	3	3	2	3	3	1			3	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

History of immunology; Types of immunity: Innate and adaptive. Cells of the immune system, T and B lymphocytes: Origin, activation, differentiation, characteristics and functions. Nature of T and B cell surface receptors. Macrophages, phagocytosis. Structure and function of primary and secondary lymphoid organs. Antigens, immunogen, hapten, adjuvant, epitope, super antigens. Major Histocompatibility Complex, Human Leukocyte Antigens (HLA), antigen presenting cells, processing and presentation of antigens. Necrosis and apoptosis.

Module II **8 hours**

Structure of immunoglobulin, imunoglobulin classes and biological activities. Isotypes, allotypes, idiotypes. Immunoglobulin genes and antibody diversity, class switching, humoral and cell mediated immune responses, cytokines, interleukins, interferons, TNF. The complement, pathways and consequences of complement activation.

Module III **8 hours**

Antigen-antibody interactions**:** Antibody affinity and avidity, precipitation reactions: immunodiffusion, radial immunodiffusion, double immunodiffusion, immunoelectrophoresis, rocket immunoelectrophoresis. Agglutination reactions: hemagglutination and complement fixation, immunoflourescence, RIA, ELISA, immunoblotting, flow cytometry and fluorescence, hybridoma technology: production of monoclonal antibodies and their applications.

Module IV **8 hours**

Hypersensitivity: Immediate (Type I, Type II, Type III) and delayed hypersensitivity reactions,
Autoimmunity: Organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases. Transplantation immunology: auto, allo, iso and xenograft, bone marrow and kidney transplants, graft rejection (Graft versus host rejection and host versus graft rejection mechanisms), immuno suppressive agents. Tissue compatibility tests. Immunodeficiency disorders: SCID and AIDS.

Module V **8 hours**

Knockout mice. Transgenic mice as models of immune system diseases: nude mice and SCID mice. Vaccines: Types of vaccines. Development and production of Polio, Measles-Mumps-Rubella, Diphtheria-Tetanus-Pertussis vaccines.

Textbook(s)

1. J.K. Thomas, A.G. Richard, A.O. Barbara and K. Janis, Kuby Immunology, 6/e., W.H. Freeman, 2007.
2. P.M. Lydyard, A. Whelan and M.W. Fanger, Instant notes in Immunology, Viva publishers, 2008.

References

1. W.E. Paul, Fundamentals of Immunology, 6/e, Lippincott Williams and Wilkins, 2008.
2. P.J. Delves, S.J. Martin, D.R. Burton, I.M. Roit, Roitt's, Essential Immunology, 12/e, Wiley-Black well, 2011.

EBT321: BIOINFORMATICS LABORATORY

L	T	P	C
0	0	3	2

Course objectives:

The course objective is to

1. Use of sequence alignment methods
2. Explain different methods for prediction of coding regions
3. Explore methods for phylogenetic analysis
4. Use of molecular graphics
5. Predict structure from sequence information

Course Outcomes

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

1. List biological databases related to biochemicals, proteins and nucleic acids.
2. Assess similarity of biological sequences.
3. Solve problems in phylogenetic analysis.
4. Predict protein structure based on sequence information and structure of homologs.
5. Construct genomic sequences from fragments.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3						3	3	2	3	2	3
CO2	3	3	3	3						3	3	2	3	2	2
CO3	3	3	3	3						3	3	1	3	1	1
CO4	3	3	3	3						3	3	2	3	2	1
CO5	3	3	3	3						3	3	3	3	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

At least 12 of the following experiments are required:

1. Needleman-Wunsch algorithm for Global alignment.
2. Smith-Waterman algorithm for Local alignment.
3. Multiple sequence alignment.
4. Prediction of coding regions.
5. Phylogeny: Parsimony, Neighbor-Joining, Tree display
6. Secondary structure prediction.
7. Prediction of transmembrane regions.
8. Molecular graphics.
9. Molecular modeling.

Use of following databases:

10. Pubmed and PMC.
11. NCBI-Genbank.
12. PDB.
13. KEGG.

Text Book(s)

1. Z. Ghosh, B. Mallick, Bioinformatics principles and applications, Oxford University Press, 2009.
2. Andreas D. Baxevanis, Francis Ouellette, B.F. Bioinformatics: A practical guide to the analysis of genes and proteins, 3/e, Wiley-Black Publishers, 2004.

EBT322: BIOPROCESS ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

Course Objectives:

The objective of the course is to

1. Operate and monitor bioreactors
2. Use statistical designs for media optimization
3. Measure Volumetric oxygen transfer coefficient
4. Determine residence time distribution
5. Optimize parameters for the production of biochemical products using integrated biochemical processes.

Course outcomes:

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

1. Understand the definition, scope, and differences between bioprocess and chemical processing.
2. Analyze the principles of aeration, agitation, oxygen transfer, and heat evolution in bioreactors, including their impact on microbial system performance.
3. Understand the kinetics of microbial growth in batch and continuous systems, and analyze the operational principles of chemostats, fed-batch systems, and immobilized cell systems.
4. Select and operate bioreactors and understand the methods and criteria for scaling up bioreactor processes.
5. Understand the basic functions, construction, and regulatory constraints of fermenters for microbial or animal cell culture, including aseptic operations and foam control systems.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2			1									2		
CO2		2			2	1							1	2	
CO3			3		1	2								1	1
CO4				3		1	2	2							2
CO5		1		2	3				2	1	2	1	3	1	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

At least ten of the following experiments are required:

1. In situ sterilization and sterile operation of large reactors
2. Substrate processing - Pretreatment
3. Media optimization by a) Plackett and Burman method b) Response surface methodology for media design
4. Microbial growth and product formation kinetics
5. Measurement of Volumetric Oxygen transfer coefficient (K_La) by:
   a) Sodium sulphite method
   b) Dynamic gassing method
6. Batch, Fed batch and continuous bioreactors for Biotech products
7. Residence time distribution in CSTR
8. Solid – state fermentation

9. Bulk production of tailored organisms
10. Production of Citric Acid by solid state fermentation
11. Production and recovery of Penicillin
12. Production and recovery of Vitamin B_{12}.
13. Optimization of parameters for Amylase production

Text Book(s)

1. N.S. Wang, Biochemical Engineering Lab Manual, 2009.

EBT323: GENETIC ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

Course Objectives:

The objective of the course is to

1. Explore methods for isolation and estimation of DNA and RNA
2. Perform restriction digestion, ligation of DNA and transformation
3. Evaluate expression of cloned genes
4. Use PCR for DNA amplification

Course Outcomes:

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

1. Understand the isolation of nucleic acids, enzymes of rDNA technology and vectors.
2. Apply prokaryotic, eukaryotic expression and molecular techniques in finding gene expression.
3. Explain nucleic acid sequencing methods in understanding sequence and construction and screening of DNA libraries.
4. Apply molecular techniques for nucleic acid amplification and analysis.
5. Discuss RNAi Technology, genome editing and the applications of rDNA technology.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1			1	2	3	1	1
CO2	3	3	3	3	2	1	2	1			1	2	3	2	2
CO3	3	3	3	3	3	2	3	1			1	2	3	3	3
CO4	3	3	3	3	3	3	3	1			1	2	3	3	3
CO5	3	3	3	3	3	3	3	2			1	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

At least 10 of the following experiments are to be performed

1. Isolation of genomic DNA from plants and bacteria
2. Estimation by Diphenylamine method
3. Isolation of RNA and estimation by Orcinol method
4. Isolation of plasmid DNA and estimation by UV spectroscopy
5. Separation of plasmid DNA through agarose gel electrophoresis
6. Restriction digestion of DNA
7. Ligation of restricted DNA fragments
8. Preparation of competitive E. coli cells and Transformation
9. Expression of cloned genes (GFP) or Blue white screening
10. PCR amplification DNA
11. Southern blotting
12. DNA finger printing (RFLP & RAPD)
13. Regulation of Gene expression

Text Book(s)

1. Sambrook J, Russel DW, Molecular cloning, a laboratory manual, Cold spring harbor laboratory Press, New York, 2001.

EBT324: PLANT BIOTECHNOLOGY LABORATORY

L	T	P	C
0	0	3	2

This laboratory course is framed to provide practical skill on various aspects of plant tissue culture and biotechnology techniques.

Course Objectives:

The objective of this laboratory course is to:

1. Apply laboratory-based methods in plant tissue culture
2. Establish aseptic preparation techniques, media preparation
3. Develop explants for different culture techniques.
4. Perform methodologies in plant tissue/cell culture for plant improvement, production and acclimatization.

Course Outcomes

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

1. Apply fundamental knowledge of in vitro plant propagation in laboratory and industry.
2. Develop protocols for large scale micropropagation system, germplasm conservation, virus elimination.
3. Explain screening and selection of haploids, somatic hybrids, and other variants for biotic and abiotic resistance.
4. Improvise secondary metabolites through selection and genetic transformation.
5. Calculate the cost of tissue cultured plant and the enterprises.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		3			1	2	2					3	2	2
CO2	3	1	3	2	1	1	3	2	1				3	2	2
CO3	3		2	2	1	1	3	2	1		2		3	3	3
CO4	3	2	2	2	2	1	3	2	1		1	1	3	3	3
CO5	3	3	3	3	3	1	3		1		2	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

At least ten of the following:

Safety rules and regulation, Laboratory requirements: Equipment, Glass ware, Chemicals; Laboratory organization and laboratory techniques.

1. Preparation of stock solution for Murashige & Skoog's (1962) (MS) medium.
2. Establishment of seed culture.
3. Induction and establishment of callus culture.
4. Haploids from anther culture.
5. Storage organ culture.
6. Axillary bud culture.
7. Leaf disc culture.
8. Subculture and multiplication of callus.
9. Shoot tip culture.
10. Zygotic embryo culture and somatic embryogenesis.
11. Artificial seeds production and plantlets regeneration.
12. Cell suspension culture.
13. Isolation and culture of protoplasts.
14. Agrobacterium mediated genetic transformation and hairy root culture.

15. In vitro rooting/ germination of somatic embryo and regeneration of complete plant.
16. Soil transfer, hardening and acclimatization of plantlets.

Text Book(s)

1. Nagar S, Adhav M, Practical Book of Biotechnology and Plant Tissue Culture. S Chand, 2010.
2. Giri CC, Giri A, Plant Biotechnology: Practical Manual, I K International Publishing House, 2007.

References

1. Beyl CA, Trigiano RN (Editors), Plant Propagation Concepts and Laboratory Exercises, 2/e, CRC Press, Tylor & Francis Group LLC, 2015.
2. George EF, Hall MA, De Klerk, GJ (Editors) Plant Propagation by Tissue Culture, Volume 1 & 2,3/e (Volume 1, Available online), 2008.
3. Loyola-Vargas VM, Vazquez-Flota F (Editors), Plant Cell Culture Protocols, 1/e, Springer-Verlag New York, LLC, 2005.
4. Dodds JH, Roberts LW, Heslop-Harrison, J, Experiments in Plant Tissue Culture, 3/e, Cambridge University Press, (2004).

EBT325: TRANSPORT PROCESSES LABORATORY

L	T	P	C
0	0	3	2

Course Objectives:

The objective of the course is to

1. Measure thermal conductivity in steady state and unsteady state systems

2. Calculate heat transfer coefficients in heat exchangers

3. Measure equilibrium constants for vapor-liquid, liquid-liquid systems

4. Measure flow rates in a spray tower

5. Explore different methods for measurement of gas-liquid mass transfer coefficients

List of Experiments:

1. Thermal conductivity of metal rod (Steady state conduction).
2. Calculation of thermal conductance in a unsteady state heat exchange unit.
3. Calculation of film & overall heat transfer coefficients in Double pipe Heat Exchanger and Shell & Tube Heat Exchanger.
4. Ternary Liquid Equilibria (Binodal curve)
5. Liquid-Liquid Equilibria.
6. Limiting flow rates in Spray Tower.
7. Studies of axial mixing characteristics in a packed bed.
8. Vapor-Liquid Equilibria
9. Steam Distillation
10. Gas-Liquid mass transfer in (a) Packed tower. (b) Tray towers

Text Book(s)

1. N.S. Srinivas, Heat Transfer Laboratory Manual for Chemical Engineering Graduates, Create Space Independent Publishing Platform, 2014.
2. Abdul Matheen, Heat Transfer Laboratory Manual, 2/e, Laxmi Publications, 2007.
3. Awais Ali, Heat and Mass Transfer Lab Manual, 2014.

EBT342: APPLIED MATHEMATICS FOR BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Course objectives:

The course objective is to

1. Introduce the principles of statistical testing
2. Use numerical methods for solving algebraic equations, transcendental equations and differential equations
3. Apply the principles and applications of Fourier series & Fourier transformation for studies of bioprocess dynamics
4. Apply complex analysis to solve flow problems

Course outcomes:

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

1. Apply the fundamental concepts of probability and statistics.
2. Apply least square principle and sampling methods and tests.
3. Solve algebraic and transcendental equations using different methods.
4. Use Fourier series and Fourier transforms to analyze spectral data, biomedical data and bioprocess dynamics
5. Explain the concept of using partial fraction techniques to evaluate integrals.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1							1	1		1	1	1		1	
CO2								1	1	1	1	1		1	
CO3				1		1	2	1	1	2	2	1	1	1	1
CO4				1		1	1	1	1	2	2	2	1	2	1
CO5						1			1	1	1	1		1	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Probability and Statistics: Introduction to statistics and probability-Measures of central tendency (mean, median, mode) measures of dispersion: range, mean deviation, standard deviation, variance)-Binomial, Poisson and normal distribution (mean, variance, moment generating function).

Module II **8 hours**

Principles of least squares and sampling theory: Curve fitting based on least square method (straight line, parabola)- Large sample tests: test of significance. Small sample tests: chi-square distribution, t-distribution (single mean and difference mean).

Module III **8 hours**

Numerical Analysis: Solution of Algebraic and Transcendental equations, Bisection method, Newton Raphson method, Solution of linear algebraic equations using Jacobi, Gauss-Seidel iterative methods, Numerical solutions of ODE's by Euler's method, Runge-Kutta method (4th order).

Module IV **8 hours**

Fourier series : Euler's formulae- Conditions for a Fourier expansion-Functions having points of discontinuity-Change of interval- Odd or even functions-Half range series.

Fourier Transforms: Definition-Fourier integral theorem (without proof)- Fourier transforms, properties of Fourier transforms.

Module V **10hours**

Complex Analysis: Analytic functions, Harmonic functions, applications to flow problems, complex integration, Cauchy's theorem (without proof), Cauchy's integral formula (without proof). Series of complex terms, Taylor and Laurent expansions (without proofs), Residues-Residue Theorem (without proofs), Calculation of residues.

Text Book(s)

1. B.S. Grewal, Higher Engineering Mathematics, 42/e, Khanna Publications, 2013.
2. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical statistics, Sultan chand & Sons, 2014.

References

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, Wiley India, 2011.
2. N.P. Bali, M.Goyal, Textbook of Engineering Mathematics, 9/e, Laxmi Publications, 2011.

EBT344: PHYSIOLOGY AND CLINICAL BIOCHEMISTRY

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Discuss the basis of Central Nervous system and disorders
2. Discuss the basis of Cardiovascular system and disorders
3. Explain the basis of Respiratory functions and disorders
4. Explore the basis of Digestive system and disorders
5. Express the basis of Endocrine system and disorders

Module I **8 hours**

Physiology of the central nervous system : General design, major levels of CNS function, synapses and synaptic transmission. Neurodegenerative disorders : Parkinson's and Alzheimer's diseases. Physiology of the musculoskeletal system: General and molecular basis of muscle contraction, excitation – contraction coupling, muscle action potential, neuromuscular junction. Myasthenia gravis and muscular dystrophies.

Module II **8 hours**

Physiology of the cardiovascular system : Specialized excitatory and conduction system of heart, cardiac cycle, heart valves, heart sounds and heart pumping. Characteristics of normal ECG, vectorial analysis of normal ECG, Cardiac arrhythmias and ECG interpretation. Physiology of respiratory system : mechanics of pulmonary ventilation, transport of oxygen and carbondioxide in blood and tissue fluids. Pathophysiology of specific pulmonary abnormalities. Methods for studying respiratory abnormalities.

Module III **8 hours**

Maintenance of Clinical laboratory, Composition of Blood, Serum and Plasma. Collection and preservation of samples and sampling methods. Digestive system disorders: functions and methods of evaluation, Pancreatic exocrine functions and methods of evaluation. Plasma proteins: properties, functions, variations during disease. Plasma lipid and lipoproteins, variations during disease.

Module IV **8 hours**

Cerebrospinal fluid: Functions and their variation in diseases. Kidney: Function and composition of urine, investigation of renal disorders.

Liver: Liver functions and function tests, Liver diseases: Jaundice, Hepatitis, Gallstones, Cirrhosis and fatty liv er. Clinical chemistry of new born, clinical enzymology: Isoenzymes in health and disease.

Module V **8 hours**

Endocrine disorders of pancreas: Diabetes mellitus, Hypoglycemia and Glucose tolerance tests, Thyroid: Hypo and Hyper thyroidism, BMR and tests for thyroid functions. Pituitary clinical syndromes.

Text Book(s)

1. J. E. Hall and A. C. Guyton, Guyton and Hall, Textbook Of Medical Physiology, 12/e, Saunders Elsevier, 2011.
2. R. Chaterjee, Text book of Medical Biochemistry, 8/e, JP Medical Limited, 2012.

References

1. C. A. Burtis, E. R. Ashwood, Teitz, Fundamentals of Clinical Chemistry, 6/e, Elsevier, 2008.

EBT346: SEAFOOD PRODUCTION & PROCESSING TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Summarize aquaculture systems, management practices and techniques of seed production.
2. Manage Pond and water quality
3. Identify the disease and its therapy
4. Explore seafood processing and preservation techniques
5. Perform quality control, marketing and export aspects of sea foods.

Course Outcome:

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

1. Understand the scope and importance of sea foods processing with its zero wastes concept.
2. Apply processing and packaging technology for milk products with its manufacturing concept.
3. Implement thermal operation for processing /technology for milk products with its manufacturing concept.
4. Understand mechaical operation concept for milk processing/ technology with its products manufacturing.
5. Implement the regulations pertinent to the sea and dairy food industries including butter and cheese quality.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	2	2	1	1	1	1	3	2	3
CO2	3	3	1	1	2	2	2	2	2	1	1	2	3	2	3
CO3	3	2	2	1	1	1	3	2	1	1	2	2	3	2	3
CO4	3	2	2	2	2	1	2	2	1	1	1	2	3	3	2
CO5	3	3	3	2	3	1	3	2	2	1	2	1	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Culture systems and Hatchery techniques: Importance of mariculture: Aqua farms; Design and construction. Criteria for selecting cultivable species. Culture systems and management practices: extensive, semi intensive and intensive culture practices. Seed production in controlled conditions: Types, design and management of hatchery, induced spawning, mass production of seeds. Live feed culture technique and feed formulations. Probiotic bacteria : importance in aquaculture.

Module II **8 hours**

Coastal, brackish water and open sea farming: Perspectives in mariculture: Crop selection, control of biological environment, platforms, housing and energy for mariculture. Pond management : pond preparation, eradication of predators and stocking. Role of chemical fertilizers and organic manures in farm ponds. Water quality management in ponds.

Module III **8 hours**

Diseases diagnosis: Tools for disease diagnosis; Enzyme immunoassays, Dot immuno-binding assay, Western blotting and Mabs. DNA based diagnosis. Vaccines in aquaculture.

Module IV **8 hours**

Seafood Processing: Principles of preservation and processing ; chilling and freezing methods, cold storage, phenomena of rigor mortis, spoilage changes and causative factors. Drying; conventional methods, salt curing, pickling and smoking. Canning and hurdle technology in food preservation. Role of preservatives in processing. Fishery by-products.

Module V **8 hours**

Laws and standards in Fishery Industry: Quality control with reference to sea food. Novel product development, nutrition promotion, consumer studies, marketing and sea food export. MPEDA, government policies, export finance, economic importance.

Text book(s)

1. J. E. Bardach, Sustainable aquaculture - Aquaculture principles and practices, John Wiley and Sons, 1997.
2. P. Sinha, Fish processing and preservation, APH Publishing, 2011.

References

1. M. Fingerman and R. Nagabhushanam (eds.), Recent Advances in Marine Biotechnology, Science Publishers Inc., 2000.
2. W. F. Royce, Introduction to the Practice of Fishery Science, Academic Press Inc., 1996.
3. T. B. Lawson, Fundamentals of Aquacultural Engineering, CBS Publishers and Distributors, 1997.

EBT348: MICROPROPAGATION

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Implement sterile techniques.
2. Prepare plant tissue culture nutrient media.
3. Establish and maintain the aseptic cultures for multiplication.
4. Estimate the economics of micropropagated plants.
5. Perform micropropagation (Stages 0-IV) for ornamentals, horticulture and tree crops by axillary shoot culture.

Module I — 8 hours

Plant micropropagation entrepreneurship overview: organization plan for a medium size micropropagation set-up, general safety rules and regulation; Laboratory requirements: Equipment and instruments, chemicals, glass ware, plant nutrition and media composition, sterilization techniques for aseptic preparation. Routine micropropagation practices: preparation of stocks and media.

Module II — 8 hours

Micropropagation: Introduction and definition, stages in micropropagation, problems associated and techniques of acclimatization, greenhouse and field acclimatization of regenerated plants.

Module III — 8 hours

Problems in micropropagation of plants: culture contamination, screening methods for contaminating microorganisms, Organisms associated with plant surfaces, endophytic contaminants, screening of donor plants, screening of tissue cultures and progeny plants.

Module IV — 8 hours

Economics of micropropagated plants: determining factors- finance, market, research and development, production management, Pricing of micropropagated plants: general cost structure, calculation of cost and selling price, development of basic formula.

Marketing of micropropagated plants: status and nature of micropropagation business, Strengths and weaknesses of the businesses, Export potential of micropropagated plants, Strategies for gaining market share, opportunities and future.

Module V — 8 hours

Micropropagation practice: Ornamental crops; Horticultural crops, woody species, cash crops, and fiber crops. Certification of plant tissue culture laboratory and plants, quarantine rules and regulations.

Text Book(s)

1. S. Chandra, H. Lata, A. Varma, Biotechnology for Medicinal Plants: Micropropagation and Improvement, Springer, 2014.
2. M. Lambardi, E.A. Ozudogru, S.M. Jain (Editors), Protocols for Micropropagation of Selected Economically-Important Horticultural Plants, Humana Press, Springer Science + Business Media, LLC, New York, USA, 2013.

References

1. S.D. Purohit, Introduction to Plant Cell, Tissue and Organ Culture. PHI Learning , 2012.
2. E.F.George, M.A.Hall, G.J.De Klerk, (Editors), Plant Propagation by Tissue Culture, 3/e, 2008.
3. J.H. Dodds, L.W. Roberts, J. Heslop-Harrison, Experiments in Plant Tissue Culture, 3/e, Cambridge University Press, 2004.

EBT350: FERMENTATION TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Impart knowledge of the basics of industrial fermentations, types of media, microorganisms, and fermentation processes.
2. Produce primary and secondary microbial metabolites of commercial importance.
3. Generalize the commercial production of industrially important solvents, beverages and fermented foods.
4. Explore pharmaceutically important recombinant microbial products.

Course Outcome:

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

1. Identify key microorganisms and comprehend their metabolic functions critical to various fermentation processes.
2. Understand and apply the fundamentals of various fermentation processes and optimize media for effective bioconversion.
3. Analyze production methods for both primary and secondary metabolites, focusing on process optimization and compliance with regulatory standards.
4. Gain practical skills in fermenting food and beverages, ensuring product safety, quality, and enhanced nutritional values.
5. Develop competencies in producing recombinant products, particularly therapeutic proteins, with awareness of technological and regulatory challenges.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		2	1	2	3		1				3	2	2
CO2	3	3		3	2			2	1				3	3	
CO3	3	3	3		3		2	2					3	3	3
CO4	2			2		3	2		1	3	3		2		2
CO5	3	2		3			3	3	1			3	3	3	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Introduction to industrial fermentations: screening, isolation and maintenance of industrially important microorganisms. Types of fermentation processes: carbon and nitrogen sources, conventional and non-conventional raw materials and microbial growth metabolism. Isolation and purification of microbial metabolites.

Module II **8 hours**

Production of primary metabolites: Production of organic acids: citric acid, acetic acid and lactic acid.

Production of amino acids: L-glutamic acid and L-aspartic Acid. Production industrial solvents and fermented beverages: ethanol**,** beer and wine.

Module III **8hours**

Production of secondary metabolites: Production of antibiotics: tetracycline and penicillin. Production of industrial enzymes: proteases, cellulases and chitinases. Production of industrial pigments: red and violet bacterial pigments.

Module IV **8 hours**

Food fermentation: Fermented milk foods: cheese. Fermented vegetable foods: Sauerkraut and soya sauce. Production of food and fodder yeast: Baker's yeast, food and fodder yeast.

Module V **8hours**

Production of recombinant products: recombinant therapeutics. Production human insulin by bacterial and yeast expression systems. Production of human growth hormone by bacterial expression system.

Text Book(s)

1. A. H. Patel, Industrial Microbiology, 2/e, MacMillan Publishers, 2012.
2. N. Okafor, Modern Industrial Microbiology and Biotechnology, Science Publishers, 2007.

References

1. E. M. T. El Mansi, C. F. A. Bryce, A. L. Demain, A. R. Allaman, Fermentation Microbiology and Biotechnology, 3/e, Taylor and Francis, 2011.
2. W. C. Frazier, D. C. Westhoff and N. M. Vanitha, Food Microbiology, 4/e, McGraw Hill, 2014.
3. A. N. Glazer and H. Nikaido, Microbial Biotechnology: Fundamentals of Applied Microbiology, 2/e, Cambridge University Press, 2007.
4. G. Reed, Presscott and Dunn's Industrial Microbiology, 4/e, CBS Publishers and Distributors, 2004.
5. W. Cruger and A. Cruger, Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, 2003.

EBT352: GENETICS, GENOMICS AND PROTEOMICS

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Introduce genome organization and genome sequencing techniques
2. Explain genomic organization of model organisms
3. Explore structural biology of regulatory networks
4. Integrate proteome characterization techniques and methods of protein interaction

Module I **8hours**

Organization of prokaryotic (bacterial and viral), eukaryotic, Mitochondrial and Chloroplast genomes. Genome sequencing methods and translation into large genome projects. Identification of coding and non-coding regions in the genome.

Module II **8hours**

The genomic sequence determination and genome analysis of ΦX-174 Phage, *Escherichia coli*, *Mycobacterium tuberculosis*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, *Arabidopsis thaliana* and *Homo sapiens*. Genetic diversity of infectious microbes and humans.

Module III **8hours**

Regulatory networks. Structural biology of regulatory networks, Boolean and Bayesian models of networks. Introduction to comparative genomics, Genome alignment and re-arrangement.

Module IV **8hours**

Introduction to proteomics. Protein analysis, 2-D electrophoresis of proteins, microscale solution isoelectricfocusing, N-terminal sequencing, protein sequencing by MALDI-TOF, ESI-TANDEM mass spectrometry, LC/MS-MS for identification of proteins and modified proteins, SAGE, Peptide fingerprinting.

Module V **8hours**

Networks and graphs, methods for study of protein-protein interaction, analysis of microarray data, PCR-directed protein *in situ* arrays,

Textbook(s)

1. D.C. Labler, Introduction to proteomics, tools for the new biology. Humana Press, New Jersey, 2002.
2. S.B. Primrose and R.M. Twyman, Principles of gene manipulations and genomics,7/e, Blackwell publishing, Oxford, U.K. 2006.

References

1. T.A. Brown, Genomes, 3/e, Garland Science, 2006.
2. A.M. Campbell and L.J. Heyer, Discovering Genomic, Proteomics and Bioinformatics, 2/e, Benjamin Cummings, 2006.

EBT354: FOOD SCIENCE AND TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Discuss the effect of food processing on nutrition and quality of food
2. Acquire knowledge on thermal and non-thermal processing of foods
3 Assess various methods of food quality.
4 Implement food packaging in maintaining shelf life of food
5 Formulate and manufacture neutraceuticals

Course Outcome:

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

1. Understand the nutritional aspects of cereal foods and its processing impacts.
2. Apply the importance of thermal methods of food processing for post-harvested food.
3. Implement non-thermal approaches of food processing for post-harvested food.
4. Implement food quality and packaging at national/ international levels.
5. Formulate foods for nutraceuticals development for better human health.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	2	1	1	1	1	1	3	2	1
CO2	3	2	2	2	1	1	2	2	1	1	1	2	3	2	2
CO3	3	1	1	2	3	1	3	2	1	1	2	2	3	2	2
CO4	3	2	2	3	3	1	3	2	1	1	1	2	3	3	2
CO5	3	3	3	3	3	1	3	1	2	1	2	1	2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Nutritive aspects of raw food products: cereals, legumes, fruits and vegetables; Introduction and scope of food processing, Post harvest technology: cleaning, grading, milling, hydrothermal treatment and conditioning of plant products; Principles and methods of food processing; preservation method of food products: freezing, heating, dehydration, canning, additives, fermentation, irradiation, extrusion cooking, dielectric heating; Hurdle technology: concept of hurdle technology and its application.

Module II **8hours**

Thermal methods of food processing: Microwave and radio frequency processing: Definition, Advantages, mechanism of heat generation and application; Application of following technologies: High intensity light, pulsed electric field, ohmic heating, IR heating, inductive heating and pulsed X-rays.

Module III **8hours**

Non-thermal methods of food processing: Overview of Membrane technology: Micro-filtration, Ultra filtration (UF), Nano filtration (NF) and Reverse Osmosis (RO), industrial applications; High Pressure Concept, equipment for HPP treatment, mechanism of microbial inactivation, its application in food processing; Ultrasonic processing: Properties and application of ultrasonic processing techniques.

Module IV **8hours**

Food quality assurance and packaging: Methods of quality assessment of food materials. Concept of codex Alimentarious / HACCP/ USFDA/ ISO 9000 series. Principles of food packaging: types of designs for containers, food packaging materials, function and safety of food packaging; Causes of foodstuff deterioration, control methods; Shelf life of packaged foodstuff, methods to extend shelf life. Applications of nanotechnology in food packaging

Module V **8hours**

Introduction to nutraceuticals. Manufacturing aspects of selected nutraceuticals; lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals.

Text Book(s)

1. P. Jelen, Introduction to food processing, Prentice Hall, 1985.
2. N. N. Potter, J. H. Hotchkiss, Food Science, 5/e, Springer, 1995.

References

1. P. J. Fellows, Food Processing Technology. Principles and practice, 3/e, Woodhead Publishing, 2009.
2. M. Maracotte, H. Ramaswamy, Food Processing: Principles and Applications, Taylor and Francis, 2006.
3. G. V. Barbosa-Canovas, M. Tapia and M. P. Cano, (eds.), Novel Food Processing Technologies. CRC Press, 2005.
4. J. Shi, (ed.), Functional Food Ingredients and Nutraceuticals: Processing Technologies, CRC, 2006.
5. J. R. Nesser and B. J. German, Bioprocesses and Biotechnology for Nutraceuticals, Chapman and Hall, 2004.

EBT356: ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Introduce Environmental biotechnology and pollution monitoring methods
2. Establish waste water treatment processes and health hazards due to water pollution
3. Assess waste water treatment of distillery and other industries
4. Perform solid waste management and reuse
5. Implement the concepts bioremediation and biodegradation

Course Outcome:

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

1. Describe methods for biomonitoring of pollution.
2. Describe principles and methods for biological treatment of wastewater.
3. Describe methods for wastewater treatment and solid waste management.
4. Describe principles and applications of biodegradation and bioremediation.
5. Explain potential of genetically engineering microbes for bioremediation.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	1	2	2	1	1	1	2	3	1	1
CO2	3	1	3	3	2	1	3	2	2	1	1	1	3	2	2
CO3	3	1	1	2	3	1	3	2	1	1	2	2	3	3	3
CO4	3	2	2	3	3	1	3	2	1	1	1	1	3	3	3
CO5	3	3	3	3	3	1	3	1	2	1	2	1	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Introduction to environmental biotechnology: Pollution monitoring: biotechnological methods for measurement of pollution (plant and animal test system in bioassays), cell and molecular biology in environmental monitoring, biosensors, management of metal pollution, sources of air pollution, effects of air pollution, monitoring and control of air pollution.

Module II **8hours**

Biological treatment processes for sewage treatment. Aerobic suspended and attached growth system: activated sludge process, trickling filters, rotating biological contractors (RBC). Anaerobic suspended and attached growth systems: anaerobic digestion, anaerobic filter process, UASB.

Module III **8hours**

Tertiary treatment of sewage: solids removal, removal of biological nitrogen and phosphorus, disinfection. Waste water treatment of some industries (dairy, distillery, tannery and pharmaceuticals).

Module IV **8hours**

Solid waste management: sources, preliminary operations, sludge thickening, sludge stabilization, composting, conditioning of sludge, dewatering, heat drying, disposal of sludge.

Module V **8hours**

Biodegradation and bioremediation: biodegradation of hydrocarbons, pesticides, herbicides and xenobiotics. Bioremediation of contaminated soil, genetically engineered microorganisms in bioremediation.

Text Book(s)

1. Martin Alexander, Biodegradation and Bioremediation, 2/e, Academic press, 2012.
2. U. Satanarayana, Biotechnology, 1/e, Books and Allied, 2005.

References

1. B.E. Rittmann, P.L. Mc Carty, Environmental Biotechnology: Principles and applications, Mc Graw Hill, 2012.

EBT392: SEMINAR

L	T	P	C
0	0	2	1

Course Objectives:

The course objective is to

1. Explore the sources of information in biotechnology
2. Apply different methods to access relevant databases in biotechnology
3. Summarize the information
4. Develop eeffective communication skills
5. Appraise the latest developments in the field of biotechnology

Student has to select a topic of his/her interest in consultation with the faculty incharge of seminar. He/She can collect information from the books, journals, internet and prepare a report. Prepare for a power point presentation on the topics and present to a committee to evaluate the seminar.

Seminar is separate for each student.

EBT401: DOWNSTREAM BIOPROCESSING

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Explore methods for cell disruption.
2. Introduce methods for separation of cells and other insolubles from fermented media.
3. Explain methods for separation based on extraction and adsorption.
4. Examine the methods for purification based on crystallization.
5. Illustrate the methods for drying of products.
6. Analyze the methods for recovery of ethanol, citric acid, penicillin and enzymes.

Course Outcome:

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

1. Introduce the methods for the separation of bioproducts.
2. Describe the various methods for the purification of recombinant proteins.
3. Analyse the principles of major unit operations used in Bioseparations.
4. Explain nucleation and growth of crystals.
5. Create process flow sheet using the unit procedure concept.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		2		2	1	1	1	2	3	2	1	
CO2	1	3	3	1			3	2	2	1	2	1	1	2	2
CO3	1	2		3	2	2	3	2	1	1	2	2	3	3	3
CO4	1	1	2	2	1	3	3	2	1	1	2	1	3	3	3
CO5	2	3	2	1	3	3	3	2	2	1	3	2	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Overview of bioseparation, classification of bioproducts; Recovery of intracellular products: Cell disruption methods: physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear), chemical methods (alkali, detergents), enzymatic methods.

Module II **8 hours**

Separation of cells and other insolubles from fermented broth: Sedimentation, filtration (pretreatment, filtration theory, continuous rotary filters), microfiltration, ultrafiltration, centrifugation (batch, continuous and basket).

Module III **8 hours**

Extraction: Phase separation and partioning equilibria, liquid-liquid extraction methods, reciprocating-plate column, centrifugal extractor. Adsorption: Theory of adsorption, adsorption isotherms, industrial adsorbents, adsorbtion types, ion-exchange, column chromatography.

Module IV **8 hours**

Crystallization: Crystallization theory, rate of nucleation and rate of crystal growth, particle size distribution of crystals, batch crystallizer, model for Mixed-Suspension-Mixed-Product -Removal (MSMPR) crystallizer. Drying of bioproducts, methods of drying, equipment for drying, equilibrium moisture content of bioproducts, rate of drying curves, convective, radiative and conductive heat transfer in constant rate drying period, falling rate drying period, freeze drying. Effect of thermal processing on food constituents.

Module V **8 hours**

Product recovery: ethanol, citric acid, penicillin, enzyme.

Text Book(s)

1. P.A. Belter, E.L. Cussler, Wei-Shou Hu, Bioseparations: Downstream Processing for Biotechnology, Wiley-Interscience, 2012.

References

1. R.G. Harrison, P.Todd, S.R. Rudge, Bioseparation Science and Engineering, Oxford University Press, 2006.
2. W.L. McCabe, J.C. Smith, and P. Harriot, Unit Operations of Chemical Engineering, 7/e, McGraw-Hill International Edition, 2005.
3. J.A. Asenjo, Separation Processes in Biotechnology, CRC Press, 1990.

EBT403: ANIMAL CELL CULTURE TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Introduce the primary cell culture principles and practices.
2. Explore parameters of cell culture and its propagation.
3. Appraise recent advances in the areas of *in vitro* fertilization, stem cell technology, transgenic animal production.
4. Explore the methods for scaling-up of animal cell culture and its applications.

Course Outcomes:

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

1. Learn basic concepts and techniques of animal cell culture.
2. Understand and apply stem cell technology.
3. Understand In-vitro fertilization.
4. Explain production of transgenic animal.
5. Understand different types of bioreactors used in animal cell culture technology.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	1	1		2			1	2	3	1	1
CO2	3	3	1	2	1	1		2			1	2	3	2	1
CO3	3	3	1	2	1	1		2			1	2	3	2	1
CO4	3	3	1	2	1	1		2			1	2	3	2	1
CO5	3	3	1	2	3	3		2			3	2	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation.

Module I **8 hours**

Basic techniques of cell, tissue and organ culture. Primary culture and subculture of cells. Kinetics of cell growth. Role of carbon dioxide, serum, and other supplements in cell culture. Different types of culture media. Different methods for the estimation of cell viability and cytotoxicity. Applications of cell culture.

Module II **8 hours**

Stem cells: embryonic and adult stem cells. Isolation and culture of stem cells. Induced pluripotency of stem cells. Stem cell markers. Stem cell plasticity and differentiation. Application of stem cells in medicine - with reference to degenerative diseases – parkinson's disease, stroke and diabetes.

Module III **8 hours**

In vitro fertilization in humans and cattle- types and causes of male and female infertility. Sperm collection and Cryopreservation. Artificial insemination, superovulation and oocyte recovery. In vitro oocyte maturation. Embryo culture and transfer. Amniocentesis, immunocontraception.

Module IV **8 hours**

Production of transgenic animals - mouse, sheep, cattle and fish by microinjection, retroviral vector method and embryonic stem cell method. Animal cloning - somatic cell nuclear transfer and embryonic stem cell nuclear transfer methods. Biopharming and gene knockout.

Module V **8 hours**

Special cultivation techniques - disposable bioreactors for inoculum production and protein expression, hollow fiber cell culture, cultivation of mammalian cells in fixed - bed reactors, configuration of bioreactors, vaccine production: State of the art and future needs.

Text book(s)

1. R. Ian Freshney, Culture of animal cells: A manual of basic technique and specialized applications, 6/e, Wiley, 2007.
2. Ralf Portner, Animal cell biotechnology: methods and protocols, 2/e, Humana Press Inc., 2007.

References

6. B. K. Sinha and R. Kumar, Principles of animal cell culture students' compendium, International Book Distributing Co. Publishers, 2008.
7. M. Butler, Animal cell culture and Technology, 2/e, Taylor and Francis, India, 2003.

EBT405: BIOREACTOR DESIGN

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Introduce the principles for the design and analysis of bioprocesses.
2. Introduce the techniques for the design and analysis of bioprocesses.
3. Develop analytical abilities for industrial bioprocesses.
4. Develop problem solving methodologies for industrial bioprocesses.
5. Compare the 'traditional' and advanced bioprocesses.

Course Outcomes:

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

1. Understand and apply essential design parameters and procedures for bioprocess equipment.
2. Grasp scale-up issues and perform preliminary scaling measures for various bioprocess equipment.
3. Select, design, and maintain bioprocess equipment with sterility considerations.
4. Understand facility requirements, utility supply, safety regulations, and implement validation processes.
5. Efficiently design a pilot plant, accounting for fermentation & downstream processing calculations, and environmental/economic considerations.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	2	2	1	1		1	1	1	1	1	2	2
CO2	2	2	3	2	2	1	1		1	1	1	1	1	2	2
CO3	2	1	1	1	1	2	1		1	1	1	1	1	2	2
CO4	2	1	1	1	1	2	1		1	1	1	1	1	2	2
CO5	1	2	3	2	2	1	1		1	1	1	1	1	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Design of a fermenter: Basic functions of a fermenter for microbial or animal cell culture. Aseptic operation and containment, Body construction: construction material, temperature control, aeration and agitation, foam control system, factors affecting antifoam requirements, antifoam addition system.

Module II **8 hours**

Bioreactor Operation: Introduction, common operations of bioreactor, selection and spectrum of basic bioreactor operations, reactor operation for immobilized systems, operation of animal cell bioreactors, operation of bioreactors for plant cell culture, reactors for waste management.

Module III **8 hours**

Types of Bioreactors and Accessories: Description, working, advantages and limitations of stirred tank, airlift, packed bed, fluidized bed, photo, trickle bed and flocculated cell bioreactors. Description and functions of the following accessories for bioreactors: Pumps, valves, steam traps.

Module IV **8 hours**

Mechanical aspects of Bioreactor Design: Requirements for construction of a bioreactor, guidelines for bioreactor design, bioreactor vessels, agitator assembly.

Module V **8 hours**

Scale-up of Bioreactors: Introduction, criteria of scale-up, similarity criteria, scale-up methods.

Text Book(s)

1. T Panda, Bioreactors: analysis and design, Tata McGraw Hill, 2011.
2. P.F.A. Stanbury, A. Whitaker and S.J.Hall, Principles of Fermentation Technology, 2/e, Pergamon, 1995.

References

1. D.G. Rao, Introduction to Biochemical Engineering, 2/e, Tata McGraw-Hill, 2010.

EBT421: COMPUTATIONAL METHODS IN BIOTECHNOLOGY LABORATORY

L	T	P	C
0	0	3	2

Course Objectives:

The course objective is to

1. Apply methods for solution of material and energy balance
2. Relate methods for solution of differential equations involving fluid flow and heat transfer operations.
3. Apply numerical methods used for used for modeling of mass transfer operations.
4. Relate methods for modeling and simulation of metabolic and signaling networks
5. Apply methods for modeling and simulation of neural and cardiac systems.

List of Experiments:

Any ten of the following experiments:

1. Solution of simultaneous equations for Material Balance
2. Solution of simultaneous equations for Energy Balance
3. Numerical Differentiation for Fluid flow operations
4. Solution of differential equations for Fluid flow operations
5. Solution of differential equations for Heat transfer calculations
6. Roots of algebraic equations for Mass transfer operations
7. Numerical Integration for Mass transfer operations
8. Interpolation methods for Mechanical Operations
9. Extrapolation methods for Mechanical Operations
10. Regression analysis for Prediction of physical properties
11. Matrix methods for modeling of metabolic networks
12. Modeling and Simulation of Cell signaling networks
13. Parameter tuning of Cell signaling networks
14. Modeling and Simulation of Neural networks
15. Modeling of oscillating networks and Cardiac simulations

Text Book(s)

1. R. Schilling and S. L. Harris, Applied numerical methods for engineers, Brooks and Cole, 1999.
2. A. Constantinides, Applied numerical methods with Personal Computers, McGraw Hill, 1987.

EBT441: RENEWABLE ENERGY ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives:

The course objective is to

1. Introduce various renewable energy generation methods.
2. Discuss challenges of designing, promoting and implementing renewable energy solutions technology.
3. Estimate economics of renewable energy systems
4. Explore the context of sustainability for the renewable energy systems.

Module I **8hours**

Introduction: Conventional and non-conventional resources. Solar energy: Solar radiation, solar thermal flat plate collectors, concentrating collectors. Applications: heating, cooling, desalination, power generation, drying, cooking; principle of photovoltaic conversion of solar energy, types of solar cells, photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping.

Module II **8hours**

Wind energy: Nature of the wind, power in the wind, factors influencing wind, wind shear, turbulence, wind speed monitoring, operating principles of different types of wind energy mills,.

Module III **8hours**

Bio-energy: Biomass resources and their classification, chemical constituents and physicochemical characteristics of biomass, biomass conversion processes, principles and operation of aerobic and anaerobic digesters, biogas generation, parameters affecting gas production, effect of additives on biogas yield, possible feed stocks, types of biogas plants, biogas applications, biodiesel sources and production methods.

Module IV **8hours**

Hydrogen and fuel cells: Thermodynamics and electrochemical principles, basic design, types, and applications, production methods, biophotolysis; Hydrogen generation from algae. Fuel cells: principle of working, various types, construction and applications.

Module V **8hours**

Hydropower and tidal energy: Basic concepts of hydroelectricity, hydro power plant, potential applications, site selection, construction, environmental issues. Principles of tidal power, power plants, applications, utilization of tidal energy, site requirements.

Text Book(s)

1. G.N. Tiwari and M.K. Ghosal, Fundamentals of Renewable Energy Sources, Narosa Publishing House, 2007.
2. S. Rao and B.B. Parulekar, Energy Technology, 4/e, Khanna Publishers, 2005.

References

1. D.P. Ranjan, R. Singal, K.C. Kothari, Renewable Energy Sources and Emerging Technologies, PHI, 2/e, 2011.

2. D.Y. Goswami, F. Kreith, J.F. Kreider, Principles of Solar Engineering, 2/e, Taylor and Francis, 2003.
3. G.D. Rai, Non-conventional Energy Sources, Khanna Publishers, 2004.
4. D. Mukherjee and S.Chakrabarti, Fundamentals of Renewable Energy Systems, New Age International Publishers, 2007.

EBT442: METABOLIC ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Introduce the principles and methodologies of metabolic engineering,
2. Explain experimental and mathematical techniques related to metabolic engineering.
3. Explore the quantitative microbial bio-processes and products.

Module I **8hours**

Review of cellular metabolism, material balance and data consistency*:* An overview of cellular metabolism, transport processes, fuelling reactions: glycolysis, fermentative pathways, biosynthetic reactions, polymerization, cellular energetics. Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations, analysis of over determined systems- identification of gross measurement errors.

Module II **8hours**

Metabolic flux analysis theory, over determined systems, underdetermined systems- linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labeling, applications of metabolic flux analysis.

Module III **8hours**

Metabolic control analysis and analysis of metabolic networks: Fundamentals of metabolic control analysis, control coefficients and the summation theorems, determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations.

Module IV **8hours**

Control of flux distribution at a single branch point, grouping of reactions, case studies, extension of control analysis to intermetabolite, optimization of flux amplifications, consistency tests and experimental validation.

Module V **8hours**

Calculation of theoretical yield, amino acid production by glutamic acid bacteria, metabolic flux in mammalian cell culture, metabolic engineering of lactic acid bacteria, riboflavin production by *Bacillus subtilis*, metabolic engineering of *Saccharomyces cerevisiae*.

Text Book(s)

1. G.N. Stephanopoulos, A.A. Aristidou, J. Neilsen, Metabolic engineering Principles and Methodologies, Academic Press, Elsevier, 1998.

References

1. C .Wittman, S.Y.Lee (ed.), Systems metabolic engingeering, Springer, 2012.
2. B.N. Kholodenko, H.V. Westerhoff (ed.), Metabolic engineering in the post-genomic era, Horizon bioscience, 2004.

EBT443: BIOMEDICAL INSTRUMENTATION

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Identify different types of electrodes used to detect ionic potentials generated in the body.
2. Introduce various transducers used for converting physiological signals into electrical signals.
3. Explain various biomedical recorders and their components.
4. Discuss telemetry and its application in transmission of physiological signals.
5. Explore the usage of imaging techniques for health care and other applications.

Module I **8hours**

Bioelectric signals and electrodes: Origin of bioelectric signals, electrical activity of excitable cells, action potentials. Recording electrodes: Skin – contact impedance, electrodes for ECG, electrodes for EEG, electrodes for EMG, electrode arrays, microelectrodes. Electrode jellies and creams.

Module II **8hours**

Physiological transducers: Pressure transducers, transducers for body temperature measurement. Pulse sensors, respiration sensors.

Module III **8hours**

Biomedical recorders: Electrocardiograph: Block diagram, ECG leads, effects of artifacts on ECG recordings. Phonocardiograph. Electroencephalograph: Block diagram, recording of evoked potentials, computerized analysis of EEG. Electromyograph: Block diagram, preamplifiers, filters, integrators and stimulators.

Module IV **8hours**

Biomedical telemetry: Wireless telemetry: single channel and multichannel telemetry systems. Therapeutic devices: cardiac pacemakers, bladder & muscle stimulators, cochlear prosthesis and lithotripsy. Types of lasers and laser guided surgery. Robot aided surgery, status in India.

Module V **8hours**

Biomedical imaging instruments: X-ray, PET and MRI ; working principle, components, imaging and analysis. Patient safety: Effects of electricity on human body. Macro and micro shock hazards. Electrical safety codes and standards. Types of leakage currents. Electrical safety analyzers

Text Book(s)

1. R. S. Khandpur, Hand Book of Biomedical Instrumentation, 3/e, McGraw Hill Education, 2014.
2. R. Anandanatarajan, Medical Instrumentation and Measurements, PH I, 2011.

References

1. L. Cromwell, F. J. Weibell, E. A. Pfeiffer, Biomedical Instrumentation and Measurements, 2/e, PHI, 2010.

EBT444: CANCER BIOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to:

1. Introduce and explain the importance of cancer on human health.
2. Explain the advances in biomedical technology in identification of cancer
3. Explore the underlying causes of cancer and its treatment.
4. Describe the genomic technologies for cancer prevention, diagnosis and treatment.

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Learn characteristics of human cancers.
2. Understand the biochemistry of cancer.
3. Explain molecular genetics of cancer.
4. Understand the tumor immunology.
5. Explain cancer treatment methods.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1				3		2			2	3	3	1	1
CO2	3	1				3		3			2	3	3	1	1
CO3	3	1				3		3			2	3	3	1	1
CO4	3	1				3		2			2	3	3	1	1
CO5	3	1				3		2			2	3	3	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Characteristics of human cancer; causes of cancer; the epidemiology of human cancer, types of cancers, principles of chemical and physical carcinogenesis.

Module II **8hours**

The biochemistry and cell biology of cancer: historical perspectives, growth characteristics of malignant cells, modification of extra-cellular matrix components, mechanisms of cancer cell proliferation versus differentiation, cell cycle regulation, apoptosis, growth factors, overview of signal transduction pathways important in cancer. Angiogenesis. Biology of tumor metastasis.

Module III **8hours**

Molecular genetics of cancer: split genes and RNA processing, genetic recombination, gene amplification, cis-acting regulatory elements: promoters and enhancers, transcription factors, DNA methylation, molecular genetic alterations in cancer cells, oncogenes, tumor suppressor genes, basic concepts of cancer stem cells.

Module IV **8hours**

Tumor immunology and diagnosis: mechanisms of the immune response to cancer, role of gene rearrangement in the tumor response, heat shock proteins as regulators of the immune response, immunotherapy, categories of

tumor markers, gene expression microarrays in cancer diagnosis, proteomics in cancer diagnosis, circulating endothelial cells and endothelial progenitor cells, molecular imaging, haplotype mapping in cancer diagnosis.

Module V **8hours**

Cancer treatment and prevention: patient–tumor interactions, fever and infection, sequelae of cancer treatment, molecular mechanisms of aging and its prevention, diet and cancer prevention, chemoprevention, antioxidants, protease inhibitors, histone deacetylase inhibitors, statins, multi-agent chemoprevention.

Text Book(s)

1. R.W. Ruddon, Cancer Biology, 4/e, Oxford University Press, 2007.
2. R.A. Weinberg, The Biology of Cancer, Garland Science, 2007.

References

1. Roger J.B. King, Cancer Biology, 1/e, Longman publishres, 1996.
2. Raymond. W. Ruddin, Cancer Biology, 3/e, Oxford University Press, 1995.

EBT445: THERMAL OPERATIONS IN FOOD PROCESSING

L	T	P	C
3	0	0	3

Course objectives:

The objective of the course is to:

1. Explore thermal methods for destruction of microbes in food processing operations.
2. Identify various methods involved in food processing.
3. Study the processes involved in minimizing moisture content from food materials.

Module-I **8hours**

Overview of thermal operations carried out in dairy and food processing. Pasteurization and Sterilization: microbial destruction in batch and continuous sterilization; kinetics of loss of nutrients in sterilization; UHT processing; action of chemicals on death kinetics of microbes; aseptic packaging.

Module-II **8hours**

Irradiation and microwave processing of foods; Effects of heat, acid and short wave electromagnetic radiation on kinetics of enzyme inactivation. Crystallization and Freezing: Planck's law and estimation of freezing time of foods; equipment used for freezing water in food for production of crystalline foods, e.g. sucrose and lactose; freeze concentration of liquid food.

Module-III **8hours**

Concentration and Evaporation: Concentration of liquid food in batch and continuous type evaporators; heat and energy balance in multiple effect evaporators; design of calendria in the evaporators, falling and rising film evaporators; mechanical and thermal vapour recompression systems.

Module-IV **8hours**

Water relation to food: role of water and activity in foods; control of water activity by addition of solute and moisture removal; measurement of water activity; different models of sorption isotherms, their limitations and applicability, prediction and moderation of water activity of foods.

Module-V **8hours**

Drying of Foods: various mechanisms of moisture removal in solid and liquid foods during drying; properties of air-water vapour mixture; drying operations based on conduction, convection and radiation heat transfer; spray, freeze, roller, tray and through-flow drying operations.

Text Book(s)

1. P. Richardson, Thermal technologies in food processing, Woodhead Publishing Limited and CRC Press LLC, 2001.
2. R. Simpson, Engineering aspects of thermal food processing, CRC Press, 2009.

References

1. H.S. Ramaswamy, Food processing Principles and applications, CRC press, 2010

EBT446: DAIRY PROCESS ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to:

1. Identify the purity and quality of milk and other dairy related products.
2. Explain various processes for the production, storage of different dairy products.
3. Explore the thermal and mechanical operations in dairy and food processing.

Module I **8hours**

Review of dairy development in India. National dairy development board and operation flood. Market milk industry in India and abroad; Milk Composition; Factors affecting composition of milk, Physico-chemical properties of milk, judging and grading of milk, flavour defects in milk, their causes and prevention. Platform tests. Quality control in milk processing. Tests for evaluation of quality of milk.

Module II **8hours**

Milk processing: Fluid milk processing, packaging and distribution. Common dairy processes: cream separation (standardization), pasteurization, sterilization and homogenisation. UHT processing of milk. Process technology for manufacture of evaporated milk, condensed milk, dried milk, malted milk, reconstituted/rehydrated milk, recombined milk, toned milk and fermented milk.

Module III **8hours**

Butter: Composition, flow diagram of production, yield, fat loss in butter making. Continuous butter making, grading of table butter, defects in butter; causes and prevention. Cheese: Flow diagram of production. Cheddar cheese, mozzarella cheese and processed cheese manufacturing. Curing and storage of cheese. Defects causes, prevention and quality control. Ice Cream: Composition and flow diagram of production. Infant, baby foods and indigenous dairy products.

Module IV **8hours**

Dairy and food processing operations 1: Overview of thermal operations carried out in dairy processing. Role of water and water activity in foods. Crystallization and freezing. Estimation of freezing time of foods. Concentration of liquid foods in batch, continuous type and multiple effect evaporators with mechanical and thermal vapour compression. Mechanism of moisture removal in solid and liquid foods during drying. Spray, freeze, roller tray and through-flow drying operations.

Module V **8hours**

Dairy and food processing operations 2: Overview of mechanical operations carried out in dairy processing. Particle size separation in spray dryer and gravity separator. Filtration of food. Slurry filter medium and cake resistances. Size separation through sieving. Particle movement in sediment and centrifugal settling tank. Solid bowl and disc bowl centrifuges. Operation of cyclone separator and self-cleaning centrifuge. Agitation and mixing of liquid foods, powders and pastes.

Text Book(s)

1. A. Tufail, Dairy Plant Engineering and Management, Kitab Mahal Distributors, 2014.
2. S. De, Outlines of Dairy Technology, Oxford University Press, 2001.

References

1. A.W. Farrall, Engineering for Dairy and Food Products, John Wiley and Sons, New York, 1963.
2. R. P. Aneja, B. N. Mathur, R. C. Chandan and A. K. Banerjee, Technology of Indian Milk Products: Handbook on Process Technology, Modernization for Professionals, Entrepreneurs and Scientists. A Dairy India Publication, 2002.

EBT447: NANOBIOTECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to:

1. Introduce the principles of nanotechnology for biotechnological applications.
2. Explore structure, properties, manufacturing, and applications of silicon, carbon and other nano-materials.
3. Explain the fabrication methods of nanomaterials.
4. Describe various methods for characterization of nanomaterials.

Course Outcome:

Upon completion of this course, the student should be able to:

1. Understand and explain the unique properties of nanomaterials.
2. Compare the methods for fabrication of nanomaterials.
3. Select optimum methods for nanomaterial characterization.
4. Compare drug delivery vectors.
5. Describe the applications of nanobioelectronics.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3						3	3	2	3	2	3
CO2	3	3	3	3						3	3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3	3
CO4	3	3	3	3						3	3	3	3	3	3
CO5	3	3	3	3						3	3	3	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Introduction to Nanotechnology: Size dependent properties. Size dependence of sedimentation rate, adsorption effects, scattering of light, absorption of electromagnetic radiation, electrical and magnetic properties. Effects of confinement on protein stability.

Module II **8 hours**

Production of nanomaterials: Top down & bottom up strategies. Microbial production. Thermodynamics and statistical mechanics of self-assembly. Cooperative transitions in biological systems. Zimm-Bragg theory for polypeptides and base-pairing between complementary strands of nucleic acids.

Module III **8 hours**

Vectors for drug delivery: Micelles, viral capsids and diatom skeletons. Targeted drug delivery. Controlled drug release. Diagnostics and Prognostics: Principles and applications of Nanoarrays and Nanofluidics. Nanopore sequencing of DNA.

Module IV **8 hours**

Nanomaterials for biomedical imaging: Quantum dots. Iron oxide particles for MRI based imaging and theranostics. Bionanomaterial characterization: Scattering of electromagnetic radiation. Electron microscopy. Force microscopy. Optical tweezers.

Module V **8 hours**

BioNanomechanics: NanoBiomotors. Mechanics of cilia and flagella. Nanobioelectronics: Nanowires based on DNA. Molecular transistors. Voltage gated ion channels.

Text Book(s)

1. Tuan Vo-Dinh, Nanotechnology in biology and medicine: Methods, devices and applications, CRC Press, 2007.

References

1. V.K. Varadan, Nanomedicine: Design and Applications of magnetic nanomaterials, nanosensors and nanosystems, Wiley Dreamtech India, 2008.
2. G.T. Hermanson, Bioconjugate techniques, Academic Press, 2008.
3. C.M. Niemeyer, Bioconjugation protocols: strategies and methods. In Methods in molecular biology, Humana Press, 2004.
4. Challa S.S.R. Kumar, Nanosystem characterization tools in the Life Sciences, Wiley Dreamtech India, 2006.

EBT448: PROCESS INSTRUMENTATION

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Explain the importance of instrumentation in bio-processing industries.
2. Explore various instruments used to sense, measure and transmit signals for process variables.
3. Manage and control bio-process variables.

Module I **8hours**

Principles of measurement, error analysis, static and dynamic characteristics of instruments. Temperature Measurement: Classification of temperature measuring systems, bimetallic thermometers, thermocouples, resistance thermometers, radiation and optical pyrometers.

Module II **8hours**

Measurement of pressure and vacuum: Liquid column manometers, bourdon tubes, measuring elements for gauge pressure and vacuum. Vacuum Measurement: McLeod gage, Knudsen gage, thermal conductivity gage, pirani gage, ionization gage.

Module III **8hours**

Methods of composition analysis: Gas analysis by thermal conductivity, analysis of moisture in gases (humidity), psychrometer method, hygrometer method, dew-point method for moisture analysis in gases, measurement of moisture in paper, textile and lumber.

Module IV **8hours**

Measurement of Head and Level: Classification of level measurement methods and devices, direct measurement of liquid level, pressure (level) measurement in open vessels, level measurement in pressure vessels, level measurement by weighing. Measurement of density, specific gravity, and humidity.

Module V **8hours**

Flow measurement: Classification of flow measurement systems, electromagnatic flow meters, ultrasonic flow meters, hot wire anemometer, orifice meter, venturi meter, rotameter, turbine flow meter. Measurement of Viscosity: Basic principles of capillary viscometers, friction type viscometers, float type viscometers, ultrasonic viscometer, electrical type viscometers.

Textbook(s)

1. D.P. Eckman, Industrial Instrumentation, Wiley, 1993.
2. W.C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGraw-Hill, 2005.

References

1. G.D. Considine, Hand Book of Instrumentation and Control, 3/e, McGraw-Hill, 1985.
2. A.P. Kulkarni, Process Instrumentation and Control, Nirali Publication, 2011.
3. G.K. McMillan and D.M. Considine, Process/Industrial Instruments and Controls Handbook, 5/e, McGraw-Hill, 1999.

EBT449: BIOPROCESS MODELING AND SIMULATION

L	T	P	C
3	0	0	3

Course objective:

The objective of the course is to

1. Introduce the concepts of mathematical modeling and simulation.
2. Develop mathematical models for various bio-processes.
3. Establish possible solution for the mathematical models.
4. Extrapolate the mathematical models using simulation techniques.

Module I **8hours**

Modeling of biological systems: Modeling principles, significance of modeling and simulation, model development from first principles. Modeling approaches for Biological systems – structured and unstructured systems; Compartment models (two and four); Deterministic and stochastic, segregated and unsegregated approaches for modeling structured systems. kinetic models on different approaches; product formation model; genetically structured models, modeling of extra cellular enzyme production.

Module II **8hours**

Modeling of diffusion: Bioprocess modeling: Modeling of continuous sterilization of medium; Models for external mass transfer, internal diffusion and reaction within biocatalysts, model for SCP production from spent sulphite liquor, model for antibiotic formation; modeling of therapeutic protein production with recombinant cells. Modeling of activated sludge process with a control system; model for anaerobic digestion.

Module III **8hours**

Bioreactor modeling: Ideal and non-ideal bioreactors; stirred tank models; characterization of mass and energy transfer distributions in stirred tanks, tower reactor model; flow modeling, bubble column flow models, mass transfer modeling, structured models for mass transfer in tower reactors, process models in tower reactors, airlift models, modeling of non-ideal behaviour in bioreactors-tanks-in-series and dispersion models.

Module IV **8hours**

Linear system analysis: Study of linear systems, linearization of non-linear systems; Software based simulation of linear models; Parameter estimation and sensitivity analysis; Steady state and unsteady state systems; stability analysis; Case study of recombinant protein production (Insulin). Simulation techniques (Software): continuous system simulators; dynamic process simulators ; steady state material and energy balance programs.

Module V **8hours**

Hybrid and other modeling techniques: Simulation techniques (numerical methods): Programs based on numerical methods like algebraic equations, Newton_Raphson method for algebraic convergence, interpolation, arbitrary function generation. Programs based on solution of differential equations: Euler method for 1st and 2nd order integration; Fourth order Runga –Kutta method: stability of numerical integration, variable slip size method.

Case studies, numerical problems. Advanced modeling techniques such as fuzzy logic, neural network, hybrid systems and fuzzy logic systems; case studies.

Text Book(s)

1. B.W.Bequette, Process Dynamics: Modeling, Analysis and Simulation, Prentice-Hall, 1998.
2. Said S.E.H. Elnashaie, P. Garhyan, Conservation Equations and Modeling of Chemical and Biochemical Processes, Marcel Dekker, Inc., 2003.

References

1. I.J. Dunn, Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples, Wiley-VCH, 2003.

EBT450: APPLIED BIOCATALYSIS AND BIOCONVERSION

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Understand the importance of biocatalyst in fermentation and bioconversion technologies.
2. Specify the mathematical representations of enzymatic reaction in microbial systems.
3. Apply biocatalysts in fermentation and bioconversion technology.

Module I **8hours**

General usage of biocatalysts, fermentation and applied biocatalysis. Types of bioconversion reactions, Procedures for biotransformations, use of cells and enzymes for biotransformation, Genetic manipulations of organisms for biotransformation, Application of bioconversions.

Module II **8hours**

Reaction types for microbial transformations of steroids, microbial breakdown of sterol side chain. L-Ascorbic acid, Dihydroxy acetone from glycerol, Prostaglandins, Hydantoinases, Carbamoylases, catalytic antibodies, Acylases and peptidases, reaction of penicillin and cepharosporin substrates, protection of amino groups, accumulation of pesticides, pesticides as carbon source, conjugate formation.

Module III **8hours**

Nitrile hydratases and nitrilases, biotechnology of nitrile transformations, regio and stereo selective biotransformation of nitriles, commercial processes, search for novel nitrile biotransforming activities, redesign of existing enzyme by protein engineering, metabolic engineering by multistep biotransfornation, cyanide biotranformation

Module IV **8hours**

Commercial lipases, properties and application of lipases, lipid or surfactant coated lipases, inter-esterification of fats and oils, enantioselective esterification by lipase, commercial application (food ingredients and enantiomerically pure chemical and pharmaceutical intermediates)

Module V **8hours**

Tropane alkaloid biosynthesis, microbial metabolism of tropane alkaloids, morphine alkaloid biosynthesis, transformation of morphine alkaloid by *Pseudomonas putida* M10, microbial transformation of heroin.

Text Book(s)

1. A.J.J. Straathof, P Adlercreutz (Eds.), Applied catalysis, 2/e, Hardwood academic publishers, Taylor and Francis, 2005.

EBT451: MOLECULAR DIAGNOSTICS

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Introduce methods for isolation and sequencing of nucleic acids.
2. Explore techniques useful for molecular diagnosis and prognosis.
3. Explain the methods for molecular diagnosis of genetic disorders, cancer and infectious diseases.
4. Discuss the standards related to quality control and quality assurance of molecular diagnostics.

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Explain nucleic acid isolation, sequencing of DNA and lab on chip technology.
2. Discuss molecular techniques involved in molecular diagnostics.
3. Explain various genetic disorders and molecular diagnostics of cervical cancer.
4. Identification of genetic disorders and their molecular diagnosis.
5. Apply quality control, quality assurance, regulatory and ethical considerations in molecular diagnostics.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1			2			3	2	3	3
CO2	3	3	3	3	3	2			2			3	2	3	3
CO3	3	3	3	3	3	3		2	1			3	2	3	3
CO4	3	3	3	3	3	3		2	1			3	1	3	3
CO5	3	3	3	3	3	3		3	1			3	1	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Nucleic acid isolation. Nucleic acid amplification methods. Hybridization based methods. Next-generation sequencing methods. Lab-on-a-chip approach to molecular diagnostics.

Module II **8hours**

Molecular techniques: Southern, Northern, Western, Dot and Slot Blots. PCR-RFLP, RT-PCR, multiplex-PCR, SSCP, CSGE, DGGE, DHPLC, MALDI-TOF, DNA sequencing.

Module III **8hours**

Genetic Disorders: classification of genetic disorders, single gene disorders (Cystic Fibrosis, Marfan's syndrome), multifactorial disorders (diabetes, Atherosclerosis, Schizophrenia). Molecular basis of cancer: gene expression analysis for tumor profiling. Molecular diagnostics for hematopoietic disorders. Molecular diagnosis for cervical cancer.

Module IV **8hours**

Disease identification and Genetic tests for following disorders: thrombofilia, cystic fibrosis, Huntington disease, fragile-X syndrome, thalassemia, sickle cell anemia, Alzheimer's disease, Huntington's disease, hepatitis C virus, cytomegalovirus. Molecular diagnostics for streptococcus and tuberculosis. Molecular diagnosis for HLA typing.

Module V **8hours**

Quality control and quality assurance: identification and standards for molecular diagnosis. Regulatory issues in molecular diagnostics. Ethical considerations in molecular diagnostics.

Textbook(s)

1. C.A. Burtis, D.E. Bruns Tietz, Fundamentals of clinical chemistry and molecular diagnostics, 7/e, Saunders, 2014.
2. L. Buckingham, Molecular Diagnostics: fundamentals, methods and clinical applications, F.A. Davis Company, 2011.

References

1. G.P. Patrinos, W.J. Ansorge, Molecular Diagnostics, 2/e, Elsevier publications, 2010.
2. W.W. Grody, R.M. Nakamura, F.L. Kiechle, C. Storm, Molecular diagnostics: techniques and applications for the clinical laboratory, 1/e, Academic press, 2009.
3. D.E. Bruns, E.R. Ashwood, C.A. Burtis, Fundamentals of molecular diagnostics, Elsevier-Saunders. 2007.
4. C.A. Burtis, D.E. Bruns**,** eds. Tietz Fundamentals of clinical chemistry and molecular diagnostics, 7/e, Saunders-Elsevier, 2015.

EBT452: STEM CELLS AND TISSUE ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Introduce the concepts of stem cell biology, materials science.
2. Explore bioreactor design with respect to tissue engineering.
3. Identify examples for tissue engineering.

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Understand the concepts of self-renewal and differentiation of cells.
2. Describe the role of the extra cellular matrix in a tissue.
3. Assess the use of various biomaterials for cell culture and scaffolding.
4. Understand the concepts of scaffold design and fabrication.
5. Design bioreactors for tissue engineering.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1	1	1		3	1		3	1	
CO2	3	3	3	2	1	1	1	1		3	1		3	1	
CO3	3	3	3	1	2	1	1	1		3	1		3	1	
CO4	3	3	3	2	3	1	1	1		3	1		3	3	1
CO5	3	3	3	3	3	3	2	1		3	1		3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Basic biology of stem cells; Types & sources of stem cells with characteristics: embryonic, adult, cancer stem cells, induced pluripotent stem cells; signaling mechanisms of stem cell self-renewal and differentiation.

Module II **8hours**

History and scope of tissue engineering. Organization of cells into higher ordered structures. Composition and diversity of extracellular matrix, receptors for ECM molecules. Matrix molecules and their ligands. Preparation of ECM, biologic activities of ECM, scaffolds. Commercially available scaffolds composed of extracellular matrix, cell differentiation and migration.

Module III **8hours**

Biomaterials in cell culture: harvest, selection, expansion, and differentiation, cell nutrition, natural polymers in tissue engineering applications, biomaterial scaffold properties. Models as precursors for prosthetic devices, quantitative aspects, cell tissue mechanics. Mechano-chemical control of cell fate switching.

Module IV **8hours**

Scaffold design and fabrication: degradable polymers and bioceramics for tissue engineering. Principles of scaffold design. Scaffold fabrication technologies: foaming, sintered microspheres, solvent casting, phase separation, electro-spinning. Textile technologies for fibre and fabrics. Solid free form fabrication.

Module V **8hours**

Bioreactors for tissue engineering: 2D and 3D cell culture. Key functions of bioreactors in tissue engineering. Bioreactor design and development. Bioreactors as 3D in vitro model systems, bioreactors in clinical applications, tissue engineering of skin, bone, cartilage, nervous system, lung, liver and pancreas.

Text Book(s)

1. C.A. van Blitterswijk and P. Thomsen, Tissue engineering, Academic Press series in biomedical engineering, 2008.
2. R.P. Lanza, R. Langer, W.L. Chick, Principles of tissue engineering, 3/e, Elsevier Publishers, 2007.

References

1. Donglu Shi, Biomaterials and Tissue Engineering, Springer publishers, 2003.
2. Peter C. Johnson and Antonios G. Mikos, Advances in Tissue Engineering, Mary Ann Liebert publishers, 2012.

EBT453: FOOD HANDLING, PACKAGING AND STORAGE

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Explore material handling technology used in the food industry.
2. Apply the properties of food packaging materials and techniques in the food industry.
3. Identify the sources of storage loss and methods of minimization.

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Designing various food packaging materials and the equipment used in handling of materials.
2. Select the packaging materials on their properties of food materials.
3. Apply principle of food processing for efficient packaging with enhanced self-life with implementation of various acts and rules.
4. Specialised and sustainable (environmental) packaging for end user satisfaction.
5. Structuring storage facilities to control insect and pests.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1			1	1	2		1	1		1	3	1	1
CO2	3	2	1		1	I	2	1	2	1	1	1	3	2	1
CO3	3	1	1	2	2	1	1		1	1		1	3	2	1
CO4	3	2	2	2	2	1	2	1	1	1	1	1	3	2	2
CO5	3	2	2	2	3	1	3	1	2	1	2	1	3	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Material Handling: Solids and granular materials handling: elevators, conveyors; Pumps: centrifugal and positive displacement; Liquid filling machines: open vent, closed vent and piston fillers.

Module II **8hours**

Packaging Materials: Polymer films, metal containers, flexible packages, special packing.

Module III **8hours**

Food Packaging: Requirements for cereals, meat, poultry, fish, milk, vegetables, fruits, plantation crop based products and carbonated beverages.

Module IV **8hours**

Storage Principle and Practice: Storage losses and their estimation: Modified and control atmosphere storage: Bin and silo storage for cereals and pulses.

Module V **8hours**

Loss in cereal quality: insect and pest control. Design of storage structures and facilities including cold storage.

Text Book(s)

1. M.J. Kirwan, D.McDowell, R.Coles, Food packaging technology. Wiley-Blackwell, 2010.

References

1. S. Stanley, C.G. Roger, Food Packaging, AVI Publications, 1970.
2. S. Sacharow, R.C. Griffin, Principles of Food Packaging, AVI Publication, 1980.
3. F.A. Painy, A handbook of Food Packaging, App. Sci. Publishers, 1980.

EBT454: PLANT AND EQUIPMENT DESIGN

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Acquire basic understanding of design parameters, procedures for commonly used process equipment.
2. Perform preliminary design of bioprocess plant.
3. Demonstrate downstream process equipment and facility design aspects.
4. Implement simulation software in designing process flow sheet and equipment .

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Understand and apply essential design parameters and procedures for bioprocess equipment.
2. Grasp scale-up issues and perform preliminary scaling measures for various bioprocess equipment.
3. Select, design, and maintain bioprocess equipment with sterility considerations.
4. Understand facility requirements, utility supply, safety regulations, and implement validation processes.
5. Efficiently design a pilot plant, accounting for fermentation & downstream processing calculations, and environmental/economic considerations.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	2	2	1	1		1	1	1	1	1	2	2
CO2	2	2	3	2	2	1	1		1	1	1	1	1	2	2
CO3	2	1	1	1	1	2	1		1	1	1	1	1	2	2
CO4	2	1	1	1	1	2	1		1	1	1	1	1	2	2
CO5	1	2	3	2	2	1	1		1	1	1	1	1	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Introduction: General design information; Material and energy balance calculations; Process flow sheeting.

Module II **8hours**

Scale up issues: Effect of oxygenation, mixing, sterilization, pH, temperature, inoculums and nutrient availability; Bioreactor scale-up based on constant power consumption per unit volume, mixing time, impeller tip speed (shear), mass transfer coefficients. Scale up of downstream processes: Adsorption (LUB method); Chromatography (constant resolution); Filtration (constant resistance); Centrifugation (equivalent times); Extractors (geometry based rules).

Module III **8hours**

Selection of bioprocess equipment (upstream and downstream); Specifications and Mechanical design of reactors, heat transfer and mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment.

Module IV **8hours**

Facility design: Utility supply; Equipment cleaning; Cell culture banks; cGMP guidelines; Validation; Safety.

Module V **8hours**

Pilot plant design; Fermenter design calculations (simulations), downstream processing calculations, environmental and economic considerations.

Text Book(s)

1. M.V. Joshi and V.V. Mahajani, Process Equipment Design, 3/e, Macmillan India, 2008.
2. J.M. Coulson, J.F. Richardson (Eds.) and R.K. Sinnott, Chemical Engineering Volume 6: An introduction to Chemical Engineering Design, 2/e, Butterworth-Heinemann, 1996.

References

1. M. Shuler and F. Kargi, Bioprocess Engineering Basic Concepts, 2 /e, Prentice Hall, 2002.
2. M. S. Peters and K. D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 3/e, Mc Graw Hill, 2003.
3. R. H. Perry and D. W. Green (eds.), Perry's Chemical Engineers' Handbook, 8 /e, McGraw Hill, 2007.

EBT455: SYSTEMS BIOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Introduce concepts of network motifs.
2. Explain feed forward loops and their relevance for optimal gene circuit design.
3. Explore temporal expression programs by feed forward loops and study of network motifs in sensory transcription networks.
4. Integrate motifs in signal transduction networks and developmental transcription networks.
5. Introduce the principles of robustness in biological systems.

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Recall concepts of network based modelling of biological phenomena.
2. Illustrate the types and properties of motifs in transcription networks.
3. Define the principles of gene circuit design.
4. Identify properties that lead to robust systems.
5. Describe examples of adaptive networks.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3									1	
CO2	3	3	3	3	3									1	
CO3	3	3	3	3	3									1	
CO4	3	3	3	3	3									1	
CO5	3	3	3	3	3									3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Basic concepts of transcription networks: input functions - logic input function, multidimensional input functions. Dynamics and response time of simple gene regulation. Network motifs: negative autoregulation, positive autoregulation.

Module II **8hours**

Feed forward loop network motif: structure of the feed forward loop gene circuit. Dynamics of Coherent type-1 feed forward loop and Incoherent type-1 feed forward loop. Biological relevance of feed forward loop types. Optimal gene circuit design: fitness function and optimal expression level under constant conditions, optimal regulation under variable conditions. Selection of the feed forward loop network motif.

Module III **8hours**

Single input Module network motif. Generation of temporal expression programs by single input Modules. FIFO temporal order by multi output feed forward loop. Network motifs in sensory transcription networks. Global structure of sensory transcription networks.

Module IV **8hours**

Network motifs in developmental transcription networks: two node positive feedback loops for decision making. Network motifs in signal transduction networks. Information processing using multi-layer perceptrons. Network motifs in the neuronal network of *C. elegans*.

Module V **8hours**

The robustness principle. Robust patterning in development. Self enhanced morphogen degradation. Adaptation in bacterial chemotaxis. Models for exact adaptation - robust and fine tuned. Kinetic proof reading of genetic code.

Text Book(s)

1. Uri Alon, An introduction to systems biology. Design principles of biological circuits, CRC Press, 2006.

References

1. M. Ptashne, A genetic switch: phage lambda revisited, Cold Spring harbor Press, 2004.
2. C. J. Meyers, Engineering genetic circuits, CRC Press, 2009.
3. M. Ptashne, A genetic switch: phage [lambda] and higher organisms, Cell Press, 1992.
4. H. Bolouri, Computational modelling of gene regulatory networks. Imperial college press, 2008.

EBT456: PATENT LAW AND DRAFTING

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Introduce the concepts of IPR and patents.
2. Formulate patent procedure and filing in India.
3. Explain the rights of a patentee.
4. Develop knowledge related to the patents in the field of Biotechnology.
5. Define a patent specification.

At the end of the course, students are able to

1. generalize knowledge of IPR and patent system in India.
2. distinguish the patentability of different inventions.
3. apply knowledge of patent drafting and filing.

Module I **8hours**

Introduction of IPR & Patents: Understanding IPR, an overview of the IPR Regime, definition and contents of patent system, enforcement of patents, exploitation of patents and abuse of patents. International conventions on intellectual property protection: Paris, TRIPS, patent cooperation treaty, Budapest treaty, patent law treaty.

Module II **8hours**

Patent procedure in India: Salient features of Indian patent act 1970, patent amendment act 2005, non-patentable inventions, main steps for prosecution of the application, applications, preliminary scrutiny of the document, publication of patent application, publication: time limit, consequences of publication, examination, request for examination, application in which secrecy direction is imposed, divisional application, examination of application, compliance with the requirements as stated in FER, pregrant opposition, grounds for filing representation, grant and sealing of patent, postgrant opposition, notice of opposition, grounds of opposition, procedure for opposition, compulsory licensing.

Module III **8hours**

Patent cooperation treaty: Intention of the contracting states, international application, international search authorities and overview of the patent procedure. US patent regime: Patentability: Utility, novelty, non-obviousness, first to invent system, first to file system, America Invents Act (AIA). European patent regime: European patent convention, patentable inventions in European patent systems, history of the broad definition of patentability. Rights of the patentee, infringement and remedies, literal infringement, infringement by equivalents: Doctrine of equivalents, defences of infringement.

Module IV **8hours**

Biotechnology and intellectual property rights: Patenting biotechnology inventions: Objective, concept of novelty, concept of inventive step, microorganisms, moral issues in patenting biotechnological inventions. Plant varieties protection: Objectives, justification, plant varieties protection in India.

Module V **8hours**

Drafting of a Patent Specification: Description of a patent specification, kinds of patent specifications, provisional specification and complete specification, parts of the complete specification, patentable aspects of the invention to be considered in the specification.

Text Book(s)

1. M. Surhone, M.T. Timpledon, S.F. Marseken, Patent Cooperation Treaty: Patent, Lambert Done at Washington, 2001.
2. K.C. Kankanala, A.K. Narasani, V. Radhakrishnan, Indian Patent Law and Practice, Oxford University press India, 2012.
3. G. Roberts, A practical guide to drafting patents, Sweet and Maxwell, 2006.

References

1. D. Bucknell, Pharmaceutical, Biotechnology and Chemical Inventions, Oxford press India, 2011.
2. A.R. Thiele, J.R. Blakeway, C.M. Hosch, The Patent Infringement Litigation Handbook: Avoidance and Management, American Bar Association 2011.
3. R.D. Slusky, Invention Analysis and Claiming: A Patent Lawyer's Guide, American Bar Association, 2013.

EBT491: MINI PROJECT

L	T	P	C
0	0	3	2

Course Objectives:

The objective of the course is to

1. Design methods for comparative evaluation of available bioprocesses.
2. Estimate rate and cost of production.
3. Measure quality control

Course outcomes:

Upon completion of this course, the student should be able to:

1. Perform literature search and / or patent search related to the area of interest.
2. Formulate a research plan with reasonable assumptions and constraints.
3. Conduct Design and Analysis and/or experiments and/or Simulations.
4. Analyze the results.
5. Document the results in the form of technical report / presentation.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						2						3		2
CO2	3	3			3				2				3	3	
CO3	3		3	3	3				2			3	3	3	3
CO4						2		3	2						
CO5									2	3	3				

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Study of literature related to any of the above and work for a solution and submit a report. The mini project can be individual or maximum of four persons. Mini Project is a short project intended to train students to identify a problem of practical significance related to:

i) Design of component/circuit/system development for a problem.
ii) Various tools used in the industry.
iii) Modelling and analyzing a design problem

EBT492: COMPREHENSIVE VIVA

L	T	P	C
0	0	0	2

Comprehensive viva is intended to train students to face interviews. Students are expected to prepare fundamentals in all core subjects of their branch for taking comprehensive viva.

Course objectives:

The objective of the course is to

1. Evaluate knowledge in all branches of biotechnology.
2. Complete retention of knowledge and ability to integrate knowledge.
3. Acquire skill required for facing oral examination.
4. Develop ability to solve problems.

Course outcomes:

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

1. develop comprehensive knowledge of biotechnology
2. perform well in oral examination
3. integrate information from different courses

EBT493: SUMMER INTERNSHIP

L	T	P	C
0	0	0	2

Course objectives:

The objective of the course is to

1. Obtain exposure to industrial environment
2. knowledge of current industrial practices
3. correlate theory learnt in classroom with industrial procedures
4. learn alternate methods of solving technical problems
5. learn to work in groups

Course outcomes:

Upon completion of this course, the student should be able to:

1. Have an exposure to industrial practices and to work in teams.
2. Understand the impact of engineering solutions in a global, economic, environmental and societal context.
3. Develop the ability to engage in research and to involve in life-long learning.
4. Comprehend contemporary issues.
5. Communicate effectively and engage in establishing his/her digital footprint.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	2	1	1	3	3	2	3	3	3	3
CO2	3	2	3	3	2	2	1	1	3	3	2	3	3	3	3
CO3	3	2	3	3	2	2	1	1	3	3	2	3	3	3	3
CO4	3	2	3	3	2	2	1	1	3	3	2	3	3	3	3
CO5	2	2	3	3	2	2	1	1	3	3	2	3	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Summer internship is planned to expose students to industrial practices. Students have to correlate the theory learnt in classroom to the procedures adopted in industry. Students have to maintain a dairy on the work carried out in industry and submit a detailed report of her/his experience at the industry.

EBT494: PROJECT WORK

L	T	P	C
0	0	16	8

Course Objectives:

The objective of the course is to

1. Explore methods for comparative evaluation of available bioprocesses.
2. Develop methods for design of plant to implement a given bioprocess.
3. Operate and maintain an existing plant.
4. Describe quality control in bioprocess.
5. Estimate the cost of production.

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Perform literature search and / or patent search related to the area of interest.
2. Formulate a research plan with reasonable assumptions and constraints.
3. Conduct Design and Analysis and/or experiments and/or Simulations.
4. Analyze the results.
5. Document the results in the form of technical report / presentation.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						2						3		2
CO2	3	3			3				2				3	3	
CO3	3		3	3	3				2			3	3	3	3
CO4						2		3	2						
CO5									2	3	3				

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

A graduate is expected to contribute to the industry in design, development, testing maintenance of equipment and managing the employees as soon as joining the industry. Hence it is essential to have training in any of the above areas by taking up a project work. The project work can be an extension of mini project or can be an independent.

ECS362: OPERATING SYSTEM CONCEPTS (Elective)

L	T	P	C
3	0	0	3

Module I **8hours**

Introduction: Introduction to operating systems, what operating systems do user view, system view, defining operating systems, computer system architecture-single processor systems, multiprocessor systems, clustered systems.

Module II **10hours**

Process management: Process concept the process, process state, process control block process scheduling, scheduling queues, schedulers, context switch. CPU Scheduling: Basic concepts CPU I/O burst cycle, CPU scheduler, preemptive scheduling, scheduling criteria, scheduling algorithms, first come first serve scheduling, shortest job first scheduling, priority scheduling, round robin scheduling.

Module III **8hours**

Process synchronization: Critical section problem, synchronization hardware, semaphores, classic problems of synchronization. The bounded buffer problem, the readers writers problem, the dining philosophers problem, monitors.

Module IV **8hours**

Deadlock: System model, deadlock characterization necessary conditions, resource-allocation graph, methods for handling deadlocks deadlock prevention, avoidance, detection, recovery from deadlock.

Module V **10 hours**

Memory Management: Swapping, contiguous memory allocation, segmentation, paging. Virtual memory: Demand paging, page-replacement FIFO page replacement, optimal page replacement, LRU page replacement, allocation of frames, thrashing.

Text Book(s)

1. Abraham Silberchatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, 9/e, John Wiley, 2015.

References

1. Naresh Chauhan, Principles of Operating Systems, Oxford Higher Education, 2010
2. Andrew S Tanenbaum, Modern Operating Systems, 2/e, Pearson/PHI, 2008.
3. Stallings, Operating Systems' – Internal and Design Principles, 5/e, 2/e, Pearson/PHI, 2007.
4. Deitel and Deitel, Operating System, 3/e, Pearson Education, 2004.

ECS364: FUNDAMENTALS OF DATA STRUCTURES (Elective)

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Introduce the fundamental concept of data structures and to emphasize the importance of data structures in developing and implementing efficient algorithms.
2. Develop effective software engineering practice, emphasizing such principles as decomposition, procedural abstraction, and software reuse.
3. Explain technical knowhow, how data can be stored in static and dynamic data structures.
4. Explore the complex data structures such as trees and graphs.
5. Infer various techniques of sorting and searching.

Course Outcomes:

Upon completion of this course, the student should be able to:

1. To introduce the fundamental concept of data structures and to emphasize the importance of data structures in developing and implementing efficient algorithms.
2. To develop effective software engineering practice, emphasizing such principles as decomposition, procedural abstraction, and software reuse.
3. To obtain technical knowhow, how data can be stored in static and dynamic data structures.
4. To understand the complex data structures such as trees and graphs.
5. To understand the various techniques of sorting and searching.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1										2		1		
CO2	1												1		
CO3	1		3									1			3
CO4	1	2	3									1			
CO5	1	2							1	2		3	1	1	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **10 hours**

Data representation: Introduction, array based representation and operations, indirect addressing and operations, linked representation, comparisons. Searching: Linear search, binary search. Arrays: Arrays, matrices, sparse matrices.

Module II **8 hours**

Linked lists: Creation of single linked list, double linked list, circular linked list, and operations on it.

Module III **8 hours**

Stacks: Definitions, operations and applications, array and linked representation of stacks. Queues: Definitions and operations, array and linked representation of queues.

Module IV **8 hours**

Graphs: Introduction, representation of graphs, graph traversals, spanning trees. Introduction to Sorting: Insertion sort, selection sort, bubble sort, quick sort.

Module V **8 hours**

Trees: Definitions and properties, representation of binary trees, operations, binary tree traversals, binary search tree, heap sort.

Text Book(s)

1. Reema Thareja, Data Structures using C, 2/e, Oxford University Press, 2011.

References

1. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed. Fundamentals of Data Structures in C, 2/e, Universities Press, 2008.
2. Seymour Lipschutz, Data Structures with C, Tata McGraw Hill, 2011.

ECS461: INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS (Elective)

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Introduce the current theory and practice of database management systems.
2. Explain the concepts of data base models, the advantages and disadvantage of DBMS.
3. Interpret entity-relationship model and develop the conceptual database models.
4. Design logical database with integrity constraints over relations.
5. Use of DBMS in solving information processing problems which will include database design case studies as well as SQL programming assignments.
6. Familiarize with the host language programming.
7. Describes the characteristics of database transactions and how they affect database integrity and consistency.
8. Discuss the concurrency control mechanisms and crash recovery algorithms.

Course Outcomes:

At the end of the course, students are able to

1. Acquire the basic knowledge on databases.
2. Design a data base for a system using E-R data model and relational data model.
3. Design and Implement the database in SQL.
4. Formulate given query in relational algebra and relational calculus.
5. List the concept of transaction management and recovery.

Module I **8 hours**

Introduction to DBMS: Overview, file system vs DBMS, advantages of DBMS, storage data, queries, transaction management, DBMS Structure.

Module II **10 hours**

E-R model entities, attributes and entity sets, relationship and relationship sets, features of ER model, conceptual database design with ER model.

Module III **8 hours**

Relational model: Integrity constraints over relations and enforcement, querying relational data, logical database design, views, destroying/altering tables and views, relational algebra and calculus**.**

Module IV **8 hours**

Structure Query Language: Basic SQL, query, union, interest, except, nested queries, aggregated operation, null values, embedded SQL, cursors, ODBC and JDBC, triggers and active database.

Module V **8 hours**

Transaction management, concurrency control and crash recovery: Transaction concept, transactions and schedules, concurrent execution of transactions, lock based concurrency control, crash recovery.

Text Book(s)

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, McGraw-Hill, 2003.
2. H.F.Korth and A.Silberschatz, Data System Concepts, McGraw-Hill, 2011.

References

1. R.El. Masri and S.B.Navathe, Fundamentals of Database System, Benjamin/Cummings, 1989.

ECS462: FUNDAMENTALS OF SOFTWARE ENGINEERING (Elective)

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Introduce software engineering and its application to the development of and management of software systems.
2. Generalize software process models such as the waterfall, incremental process model and evolutionary models.
3. Explain software requirements and analysis model.
4. Design concepts and design model.
5. Explore different software architectural styles and patterns.
6. Explain golden rules of user interface design.
7. Integrate software testing approaches such as unit testing and integration testing, white box testing and black box testing.
8. Develop quality control and how to ensure good quality software.
9. Establish the role of project management including risk management and quality management.

Module I **9hours**

Introduction, programs vs software products, why study software engineering?, emergence of software engineering, notable changes in software development practices, classical waterfall model, iterative waterfall model, prototyping model, evolutionary model, spiral model.

Module II **8hours**

Requirements analysis and specification, requirements gathering and analysis, software requirements specification, formal system development techniques and software design, what is good software design? Cohesion and coupling, software design approaches.

Module III **9 hours**

Function-oriented software design, overview of software analysis /software design methodology, structure analysis, dataflow diagrams (DFDs), structure design, detailed design, design review, user interface design, characteristics of a good user interface, basic concepts.

Module IV **9 hours**

Coding and testing, coding, code review, testing, testing in the large vs testing in the small, unit testing, block box testing, white-box testing debugging, program analysis tools, some general issues of testing.

Module V **7 hours**

Software project management, responsibilities of a software project manager, project planning, metrics for project size estimation, scheduling, organization and team structures, staffing.

Text Book(s)

1. Rajib mall, Fundamentals of Software Engineering, 2/e, PHI Eastern Economy Edition, 2005.

References

1. Ian Sommerville, Software Engineering, 7/e, Pearson Education, 2004.
2. Pankaj Jalote, Software Engineering, A Precise Approach, Wiley India, 2010.
3. Waman S Jawadekar, Software Engineering: A Primer, Tata McGraw-Hill, 2008.

ECS463: INTRODUCTION TO COMPUTER NETWORKS (Elective)

L	T	P	C
3	0	0	3

Module I **9 hours**

Introduction: Uses of the computer networks, reference models. Medium Access Control: Channel allocation problems, multiple access protocols: CSMA, collision free protocols.

Module II **9 hours**

Ethernet: Ethernet physical layer, ethernet mac sub layer protocol, ethernet performance, switched ethernet, fast ethernet, gigabit ethernet. repeaters, hubs, bridges, switches, routers and gateways.

Module III **9 hours**

Network Layer**:** Network layer design issues, routing algorithms: optimality principle, shortest path, distance vector routing. congestion control algorithms, traffic shaping.

Module IV **9 hours**

Transport Layer**:** The transport service: Services provided to the upper layers, transport service primitives. The Internet Transport Protocols: UDP, TCP, the TCP segment header.

Module V **7 hours**

Application Layer: The domain name system, world wide web.

Text Book(s)

1. Andrew S. Tanenbaum and David J Wetherall, Computer Networks,5/e, Pearson Education, 2011.

References

1. Behrouz A Forouzan and Firouz Mosharraf, Computer Networks: A Top-Down Approach, Tata McGraw Hill Education, 2011.
2. S.Keshav, An Engineering Approach to Computer Networks,2/e, PearsonEducation, 1997.
3. Larry L Peterson and Bruce S Davie, Computer Networks: A Systems Approach,4/e, Elsevier Publication, 2011.

ECS464: INTRODUCTION TO WEB TECHNOLOGIES (Elective)

L	T	P	C
3	0	0	3

Course Objectives:

The objective of the course is to

1. Creation of web pages using HTML Frames and Forms.
2. Using CSS how to design and implement over the web pages.
3. To design interactive and dynamic web pages.

Course Outcomes:

At the end of the course, students are able to

1. Understand the web sites and web services.
2. Practice latest web technologies tools.
3. Acquire knowledge of XML fundamentals and usage of XML Technologies.
4. Know the fundamentals of client side scripting such as JavaScript and apply it for data validation.
5. Identify and Formulate Solutions for IT Related Problems.

Module I **8 hours**

Introduction to HTML Version5 and Cascading Style Sheets (CSS) Version3: Basic syntax, elements, attributes and tags, paragraph, heading, forms, frames, levels of style sheets, style specification formats, selector forms, span and div tags.

Module II **8 hours**

Introduction to Java Script and Document Object Model (DOM): Variables, literals, operator and control structures, arrays, functions, the window object, the location object, the history object and event handlers.

Module III **8 hours**

Introduction to XML: Syntax of XML, document structure, and document type definition, namespaces, XML schemas, document object model.

Module IV **8 hours**

Introduction to Servlets and Tomcat Web Server: Lifecycle of a servelet, the servlet API, the javax, servelet package, Tomcat Server and testing Tomcat, structure of web application, deploying web application.

Module V **8 hours**

Introduction to JSP: JSP and servlet, the anatomy of a JSP page, JSP syntax, comments, expressions, scriptlets, scope of objects and synchronization.

Text Book(s)

1. Uttam K.Roy, Web Technologies, 2/e, Oxford Higher Education Publication, 2010.

References

1. Dietel and Nieto, Internet and World Wide Web – How to program, PHI/Pearson, Education Asia, 2009.
2. Chris Bates, Web Programming Building Internet Applications, 3/e, Wiley India, 2009.

ECY103: PHYSICAL AND INORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Students will define various types of chemical bonding, including ionic, covalent, and metallic bonds, understanding their mechanisms and properties.
2. Students will explain the principles of analytical and electrochemistry, including techniques such as titration, spectrometry, and electrochemical methods, and their applications in chemical analysis.
3. Students will classify enantiomers and diastereomers, understanding their stereochemical relationships and differences in spatial arrangement.
4. Students will identify the structures of glucose and fructose, understanding their molecular compositions and configurations as monosaccharides.
5. Students will analyze the Merrifield synthesis of polypeptides, understanding the solid-phase peptide synthesis method and its applications in peptide and protein synthesis.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														2
CO2	2														2
CO3	1														2
CO4	1														2
CO5	1														2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8hours**

Chemical Bonding : Types of bonds, Molecular orbital theory – shapes and sign convention of atomic orbital, modes of overlapping, criteria for forming molecular orbital from atomic orbital, LCAO Concept, Types of molecular orbitals – bonding, anti-bonding and non-bonding. Molecular orbital treatment for H_2, N_2, O_2, O_2^- O_2^{2-}, NO and CO. Coordination Compounds: Werner's theory, Sidgwick's theory, effective atomic number (EAN), valence bond theory and crystal field theory.

Module II **8hours**

Chemical Equilibrium: Reversible reactions, law of mass action- Le Chatelier's principle, homogeneous equilibria in gaseous and liquid systems, effect of temperature on equilibrium, vant Hoff's equation. Chemical Kinetics: Rate constant, order and molecularity of a reaction, zero, first and second order kinetics, activation energy, effect of temperature on reaction rate, elementary treatment of collision theory and activated complex theory.

Module III **8hours**

Physical properties of liquids: Surface tension: Definition, explanation, measurement and applications. Viscosity: Definition, explanation, measurement and applications. Colligative properties: Raoult's law, osmotic pressure, elevation of boiling point and depression of freezing point, vapour pressure composition diagrams of binary liquid mixtures

Module IV **8hours**

Electrochemistry: Difference between Galvanic and Electrolytic cells. Single electrode potential and its determination. Nernst equation. electrochemical series, reference Electrodes, hydrogen and calomel electrodes. Conductance, molar and equivalent conductivities, Kohlraush's Law.

Module V **8hours**

Analytical Chemistry: Titrimetric analysis, Classification of reactions in titrimetric analysis, standard solutions, Equivalents, Normalities and Oxidation numbers. Preparation of standard solutions, Primary and Secondary standards, accuracy and precision, Errors, classification of errors. Determinate and Indeterminate errors, absolute and relative error. Minimization of errors, significant figures, mean and standard deviation.

Text Book(s)

1. P.W. Atkins, Elements of Physical Chemistry, 3/e, Oxford University press, 2000.
2. C.N.R. Rao, University General Chemistry: an Introduction to chemical science, Macmillan, Madras, 1990.

References

1. J.D. Lee, Concise Inorganic Chemistry, 5/e, Oxford: Blackwell Science, 2003.
2. A.F. Cotton, G.Wilkinson, Advanced Inorganic chemistry a comprehensive text, 6/e, Wiley Eastern, 1999.
3. S. Glasstone, Text book of Physical Chemistry, 2/e, Mac million, 1980.
4. G.W. Castellan, Physical Chemistry, 3/e, Addison Wesley Publishing, 1983.
5. B.R. Puri, L.R. Sharma, M.S Pathanic, Principles of Physical Chemistry, 41/e, Vishal Publishing, 2004.

ECY108: ORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

Module I **8 hours**

Stereochemistry: Stereoisomerism, optical activity, the polarimeter, specific rotation, enantiomerism, chiral center, enantiomers, racemic modification, configuration, R & S notation, examples - Cahn – Ingold – Prelog's sequence rules, diastereomers, conformations of cyclohexane, 1, 3 – diaxial interactions.

Module II **9 hours**

Aliphatic Compounds: Alkanes: Free radical substitution (mechanism of halogenation), energy of activation, transition state; Alkenes: 1, 2 eliminations (E_1 and E_2 mechanism), electrophilic and free radical addition reactions, Morkonikov's and anti – Makonikov's rule; (peroxide effect). Alkynes: acidity of alkynes, dienes, 1,2 vs. 1,4 additions. (electrophilic additions), Diels – Alder reactions (HOMO-LUMO interactions). Alkyl halides: S_N1 and S_N2 reactions with mechanism.

Module III **8 hours**

Aromatic Compounds: Benzene: Mechanism of electrophilic aromatic substitution, nitration, sulphonation, halogenation, Friedel Crafts alkylation, Friedel Crafts acylation- orientation of disubstituted benzenes, activating and deactivating groups, clemenson and wolf kishner reductions. Phenols: acidity of phenols, Kolbe's reaction - Reimer Tieman reaction.

Module IV **8 hours**

Alcohols: differentiation tests of alcohols. Aldehydes and ketones: differentiation tests, nucleophilic addition reactions - Cannizaro reaction, Perkin, Reformatsky and Wittig reactions. Carbohydrates: Classification, Kiliani–Fischer Synthesis, Ruff's degradation and Wohl's degradation.

Module V **9 hours**

Carboxylic acids and Derivatives, Amines: Claisen condensation; preparation and synthetic applications of malonic ester and acetoacetic ester. keto-enol tautomerism. Amines: benzidine rearrangement; effect of substituents on basicity. Preparation and synthetic applications of diazonium salts. Sulpha Drugs – preparation of sulphanilamide, antibacterial activity. Soaps and Detergents: preparation and cleansing action. Identification of organic compounds using IR, NMR and Mass spectroscopies. Examples: acetaldehyde, benzaldehyde, acetophenone.

Text Book(s)

1. B.Mehta and M. Mehta, Organic Chemistry, PHI, 2005.
2. R.T. Morrison and R.N. Boyd, Organic chemistry, 6/e, PEI, 2008.

References

1. L.G. Wade, Organic Chemistry, 6/e, Pearson education, 2005
2. F.A. Carey, Organic Chemistry (Sie), Tata McGraw Hill, 2008.

ECY122: Organic Chemistry Laboratory

L	T	P	C
0	0	3	2

1. **Qualitative analysis**: Identification of the following functional groups in at least SIX organic compounds by adopting a systematic qualitative analysis:
   a) Carboxylic acids
   b) Phenols
   c) Aldehydes and Ketones
   d) Esters
   e) Carbohydrates
   f) Hydrocarbons and Ethers
   g) Primary, Secondary and Tertiary amines
   h) Amides and imides
   i) Nitro groups.

2. **Preparation of a minimum of three simple organic compounds involving the following Reactions:**
   a) Acetylation : Acetanilide from aniline and aspirin from salicylic acid
   b) Benzoylation : Benzanilide from aniline
   c) Nittration : p – nitroacetanilide from acetanilide
   d) Methylation : β - naphthyl methyl ether from β -naphthol
   e) Sulphonation : Sulphanilic acid from aniline
   f) Oxidation : p-benzoquinone from hydroquinone,

Text Book(s)

1. AI Vogel, A Text book of Qualitative Organic Analysis, Orient Longmans Ltd.

ECY123: PHYSICAL AND INORGANIC CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Students will define various types of chemical bonding, including ionic, covalent, and metallic bonds, understanding their mechanisms and properties.
2. Students will explain the principles of analytical and electrochemistry, including techniques such as titration, spectrometry, and electrochemical methods, and their applications in chemical analysis.
3. Students will classify enantiomers and diastereomers, understanding their stereochemical relationships and differences in spatial arrangement.
4. Students will identify the structures of glucose and fructose, understanding their molecular compositions and configurations as monosaccharides.
5. Students will analyze the Merrifield synthesis of polypeptides, understanding the solid-phase peptide synthesis method and its applications in peptide and protein synthesis.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														2
CO2	2														2
CO3	1														2
CO4	1														2
CO5	1														2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

List of Experiments:

1. Estimation of Sodium Hydroxide using Hydrochloric acid
2. Estimation of sodium carbonate in soda ash.
3. Estimation of oxalic acid using potassium permanganate
4. Estimation of Mohr's salt using potassium permanganate
5. Estimation of Hydrogen Peroxide using potassium permanganate
6. Estimation of Ferrous iron using potassium dichromate
7. Estimation of potassium dichromate using sodium thiosulphate
8. Estimation of copper using sodium thiosulphate

Demonstration Experiments:

A. Determination of rate constant of acid catalysed hydrolysis of an ester.

B. pH metric titration – Estimation of Sodium Hydroxide using Hydrochloric acid.

C. Potentiometric titration – Estimation of Ferrous Iron using Potassium dichromate.

D. Determination of Viscosity of a Liquid.

E. Determination of Surface Tension of a Liquid.

Text Book(s)

G. Svehla, Vogel's Quantitative Inorganic Analysis, 7/e, PEI, 2008.

EEE101: BASIC ELECTRICAL ENGINEERING

L	T	P	C
3	0	0	3

Course outcomes:

Upon completion of this course, the student should be able to:

1. Student can able to Forecast and assess the behavior of electrical circuits.
2. Student can able to evaluate performance metrics like losses and efficiency, and discern applications of DC machines.
3. Student can able to describe the role of transformers in transmitting and distributing electric power, along with other applications.
4. Student can able to illustrate the operation and diverse applications of various electronic devices.
5. Student can able to construct both inverting and non-inverting configurations of operational amplifiers.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3					2	3		2	2		1	3		1
CO2	3					2	3		2	2		1	3		1
CO3	3					2	3		2	2		1	3	2	1
CO4	3					2	3		2	2		1	3	2	1
CO5	3					2	3		2	2		1	3		1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

DC Generators: Constructional features, function of commutator, induced emf expression, relationship between terminal voltage and induced emf, different types of excitation and performance characteristics of different types of DC generators.

Module II **10 hours**

Principle and working of DC motor, torque expression, relationship between terminal voltage and back EMF, performance characteristics of different types of DC Motors, starting and speed control of DC Motors, losses and efficiency, efficiency by direct loading, Swinburne's test, applications of DC motors.

Module III **8 hours**

Transformers: Constructional details, emf equation, equivalent circuit, voltage regulation, losses and efficiency, open circuit test and short circuit test, determination of efficiency and regulation.

Module IV **8 hours**

Single – Phase Motors: Double revolving field theory, methods of starting, single phase induction motors, split phase type, capacitor start, and capacitor run, shaded pole motors, universal motor, stepper motor.

Module V **10 hours**

Three– Phase Induction Motors: Construction, rotating magnetic field and 3-phase induction motor, power flow diagram, torque and torque-slip characteristics, condition for maximum torque and its value, losses and efficiency.

Text Book(s)

1. S. K. Bhattacharya, Electrical Machines, 2/e, Tata Mc-Graw Hill, 1998.
2. P. S. Bhimbra, Electrical Machinery, 7/e, Khanna Publishers, 2003.

References

1. Stephen. J. Chapman, Electric Machinery Fundamentals, 4/e, Tata Mc-Graw-Hill, 2005.

EHS101: COMMUNICATIVE ENGLISH - I

L	T	P	C
3	0	0	3

Course outcomes:

Upon completion of this course, the student should be able to:

1. Think critically, analytically, creatively and communicate confidently in English in social and professional contexts with improved skills of fluency and accuracy.
2. Write grammatically correct sentences employing appropriate vocabulary suitable to different contexts.
3. Comprehend and analyze different academic texts.
4. Make notes effectively and handle academic writing tasks such as Paragraph writing and Essay writing.
5. Effectively handle formal correspondence like e-mail drafting and letter writing.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		2													
CO2						1									
CO3							2								
CO4										3					
CO5										3					

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **9 hours**

Introduction

Brief orientation - an integrated approach to LSRW skills; Self assessment of skills at the entry level.
Grammar: Tenses; Articles; Subject-verb agreement.
Writing: Constructing complete and meaningful sentences.

Module II **8 hours**

Choices and Implications

Reading: Researching texts for essays; Skimming and scanning; Identifying the sequence of ideas; Understanding implicit meanings; Inferring the meaning of words; Understanding how essay types are organized.
Writing: Drafting the introduction to an essay; Summarizing.
Grammar and Vocabulary (Contextual): Word families -linking words; Verb-noun collocations.

Module III **8 hours**

Risks and Hazards

Reading: Selecting and prioritizing what you read; Inferring the meaning of words; Making notes.
Writing: Using claims to plan essays; Supporting claims with evidence; Drafting the body of an essay using the given notes.
Grammar and Vocabulary (Contextual): Countable and uncountable nouns; Word families: adjectives meaning large and important; Adjective+ noun combinations; Prefixes.

Module IV **8 hours**

Language and Communication

Reading: Predicting the content of a text; Reading for detail; Scanning for information; Understanding implicit meanings; Making notes.
Writing: Reporting what is read; Writing a paragraph or two using the given notes.

Grammar and Vocabulary (Contextual): Word families: nouns with related adjectives ending -ic and -ical; Reporting verbs.

Module V **9 hours**

Difference and Diversity

Reading: Reading in detail; Collecting information for writing tasks.
Writing: Reporting what is read; Writing a paragraph or two using the given notes (compare and contrast).
Grammar and Vocabulary (Contextual): Linking parts of a text: conjunctions and sentence connectors; Single-word verbs and multi-word verbs; Word families: nouns with related adjectives.

Laboratory

Listening: **26 hours**

Listening for information; Identifying key terms; Understanding outlines; Identifying main and secondary points; Understanding short presentations and following the logical flow of thought; Taking notes; Understanding short discussions; Making predictions while listening to short talks; Identifying topic change; Following an argument; Making predictions during lectures; Matching phrases to functions such as introducing a topic, sub-topic, clarification/ explanation.

Speaking:

Discuss and decide - key terms, main and secondary points (pair work); Making suggestions in group work; Making mini oral presentations using appropriate discourse markers; Discussing preparation strategies before a lecture starts; Working in small groups - generating ideas and reporting (based on listening materials); Making oral presentations based on prompts given.

Text Book(s)

Hewings, Martin. Cambridge Academic English B2 Student's Book.Cambridge University Press. Delhi, India. First South Asian Edition. 2014.

Teacher Resource Material:

Hewings, Martin. Cambridge Academic English B2 Teacher's Book.Cambridge University Press. Delhi, India. First South Asian Edition. 2014.

Class Audio CD, DVD, Audio & DVD Pack.

Supplementary material chosen will be from public domain/ free resources for classroom use. Sources will be cited wherever available/applicable.

EHS102: COMMUNICATIVE ENGLISH – II

L	T	P	C
3	0	0	3

Course outcomes:

Upon completion of this course, the student should be able to:

1. Think critically, analytically, creatively and communicate confidently in English in social and professional contexts with improved skills of fluency and accuracy.
2. Write grammatically correct sentences employing appropriate vocabulary suitable to different contexts.
3. Comprehend and analyze different academic texts.
4. Make notes effectively and handle academic writing tasks such as Paragraph writing and Essay writing.
5. Effectively handle formal correspondence like e-mail drafting and letter writing.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		2													
CO2						1									
CO3							2								
CO4										3					
CO5										3					

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **9 hours**

The World We Live In
Reading: Recognizing plagiarism; Identifying the main ideas in a text; Summarizing what is read.
Writing: Using paraphrases; Including quotations in writing.
Grammar and Vocabulary (Contextual): Articles: zero article and complex prepositions. Vocabulary: single-word verbs and multi-word verbs, hedging adverbs.

Module II **9 hours**

Behaving the Way We Do
Reading: Organizing information for an essay; Skimming and scanning texts; Taking notes and explaining what is read.
Writing: Writing conclusions in essays; Giving references; Language for writing: hedging.
Grammar and Vocabulary (Contextual): Avoiding repetition: expressions with Wh- noun clauses.
Vocabulary: collocations - verb/ adjective+ preposition combinations.

Module III **9 hours**

Bringing about Change
Reading: Reading critically; Finding information and taking notes; Retelling what is read.
Writing: Using an academic style.
Grammar and Vocabulary (Contextual): Relative clauses; It clauses: expressing personal opinions impersonally; Abstract nouns+of+-ing/to-infinitive; Inferring the meaning of words.

Module IV **8 hours**

Work and Equality

Reading: Understanding figures and tables; Scanning for information; Understanding the significance of references.

Writing: Structure and content of reports; Describing events in a time sequence; Cause and effect.

Grammar and Vocabulary (Contextual): Passive voice; Past perfect, -ing nouns.

Module V **7 hours**

Writing Formal Letters

Letters of enquiry, seeking permission, complaint and adjustment, job application (cover letter).

Laboratory

Listening: **26 hours**

Listening for gist and detail; Identifying contrasts while listening to lectures/ presentations (pitch, emphasis); Understanding the organization of a talk; Understanding the relationship between parts of a lecture; Listening for a lecture summary; Understanding descriptions of processes.

Speaking:

Reaching a consensus in group work; Referring forward and backward in presentations; Concluding a presentation; Taking part in discussions; Group discussions; Making presentations using PowerPoint slides.

Text Book(s)

1. Hewings, Martin. Cambridge Academic English B2 Student's Book. Cambridge University Press. Delhi, India. First South Asian Edition. 2014.

Teacher Resource Material:

Hewings, Martin. Cambridge Academic English B2 Teacher's Book.Cambridge University Press. Delhi, India. First South Asian Edition. 2014.

Class Audio CD, DVD, Audio& DVD Pack.

Supplementary material chosen will be from public domain/ free resources for classroom use. Sources will be cited wherever available/applicable.

EHS201: ENVIRONMENTAL STUDIES

L	T	P	C
3	0	0	3

Module I **12 hours**

Introduction to Environment and Natural Resources: Introduction to environment: Definition, scope and importance, multidisciplinary nature of environment, need for public awareness. Natural Resources: Renewable and non-renewable resources, natural resources and associated problems. Forest resources: Uses, Reasons for over-exploitation, deforestation effects, timber extraction, case studies. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Uses, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, Impacts of overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, use of renewable and non renewable energy sources, case studies. Role of an individual in conservation of natural resources.Equitable use of resources for sustainable lifestyles.

Module II **9 hours**

Ecosystems and Biodiversity: Structural components of ecosystem: Biotic and Abiotic components. Functional components of an ecosystem: Food chains, Food webs, Ecological pyramids, Energy flow in the ecosystem (10% law), Ecological succession. Biogeochemical cycle: (Nitrogen, carbon, Phosphorus cycle). Introduction, types, structure and function of the following ecosystem: Forest ecosystem. Grassland ecosystem.Desert ecosystem.Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity: Definition, Levels of biodiversity: genetic, species and ecosystem diversity. Biogeographical classification of India, Values of biodiversity: consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega-diversity nation.Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: In situ and Ex situ conservation of biodiversity.

Module III **8 hours**

Environmental Pollution and Control : Environmental Pollution: Definition, causes, effects and control measures of :- Air Pollution, Water pollution, Soil pollution, Marine pollution, Thermal pollution, Nuclear hazards, Solid waste Management, e-waste, Hazardous waste management. Role of an individual in prevention of pollution.Pollution case studies. Disaster Management: floods, earthquake, cyclone and landslides.

Module IV **7 hours**

Social Issues and Global Environment Problems and Efforts: Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management, Remote sensing and GIS methods. Resettlement and rehabilitation of people: its problems and concerns. Case Studies, Environmental ethics: Issues and possible solutions. Green building concept, Environmental Impact Assessment (Checklists, matrix methods), Environmental Management Plan, Climate change: global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Module V **6 hours**

Human Population and Environment Legislation: Population growth, variation among nations. Family Welfare programme.Environment and human health.HIV/AIDS, Human rights. Value Education. Women and Child Welfare.Role of Information Technology in Environment and human health.Environment Legislation.Air (Prevention and Control of Pollution) Act.Water (Prevention and Control of Pollution) Act.Wildlife Protection Act.Forest Conservation Act.Environmental Protection Act. Issues involved in enforcement of environmental legislation. Public awareness.Project Work.

Text Book(s)

1. Kaushik & C.P. Kaushik, A Text book of Environmental Studies, 4/e, New Age International, 2014.
2. Erach Bharucha, Textbook of Environmental studies for undergraduate courses 2/e, University Grants Commission, Universities Press, 2013.

References

1. Benny Joseph, Textbook of Environmental Studies for undergraduate courses, 2/e, Tata McGraw Hill, 2008.
2. K.C. Agarwal, Environmental Biology, Nidi Publishing, Bikaner, 2001.
3. Calvin Brunner, Hazardous Waste Incineration, McGraw Hill Education, 1993.

EHS301: ENGINEERING ECONOMICS AND MANAGEMENT

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Obtain the basic terminology, laws of demand and supply.
2. Evaluate the economic theories and cost concepts.
3. Analyze various accounting concepts and financial management techniques for preparing effective profit and loss statements.
4. Examine and analyze break-even evaluation concepts for identification of minimum production volume for survival and to gain profits.
5. Adapt and build good manager skills by employing the concepts of various skills like good leadership qualities, utilizing motivation capabilities, and incorporating communications skills.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				1							3	2	1		1
CO2				2							3	2	1		1
CO3				3							3	2	1		1
CO4								2	3	3	3	2	1		1
CO5								2	3	3	3	2	1		1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Economics: Utility, value, wealth, consumption, wants , necessaries, comforts and luxuries.
Demand: law of demand, elasticity of demand , price elasticity of demand, factors affecting elasticity of demand , simple problems.

Module II **8 hours**

Costing: Cost concepts, elements of cost. Methods of distribution of overhead costs, unit costing, job costing and process costing; Simple problems.
Accounts: Preparation of profit and loss account and balance sheet (outlines only).

Module III **6 hours**

Break-Even Analysis: Assumptions, break-even charts, simple problems.
Depreciation: Depreciation methods - Simple problems.

Module IV **10 hours**

Forms of Business organization: Single trader, partnership and public limited company.
Principles of Organization: Types of organization; Span of management; Authority, delegation and decentralization, source of formal authority, difference between authority and power, line and staff authority, simple case studies.

Module V **10 hours**

Principles of Management: Importance of management, definition of management, management process, roles of a manager; Management, a science or art - Management, a profession; Functions of management. Leadership: Difference between a leader and a manager, characteristics of leadership, Functions of a leader, simple case studies.

Text Book(s)

1. Tara Chand, Engineering Economics, Vol - 1, 13/e, Nem Chand & Bros, 2012.
2. O.P Khanna, Industrial Engineering and Management, 14/e, Dhanpat Rai Publications, 2011.

References

1. Maheswari, Engineering and Managerial Economics, 19/e, Sultan Chand & Co, 2009.
2. Shukla, Grewal, Cost Accounting, 12/e, S.Chand & Company, 2007.
3. L.M.Prasad, Principles and Practice of Management, 8/e, Sultan Chand & Sons, 2012.

EHS302: ORGANIZATIONAL BEHAVIOUR (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Introduction, organizational behavior, nature, management functions, management roles, management skills, systematic study; foundations of individual behavior, attitudes, types of attitudes.

Module II **8 hours**

Perception and motivation**,** perception, factors, motivation, nature; Theories of motivation, hierarchy needs theory, two - factor theory, expectancy theory; Applications of motivation.

Module III **8 hours**

Foundations of group behavior**,** groups, nature, classification; stages of group development, group structure, group decision, making, groups and teams; leadership, nature, theories, trait theories, behavioral theories, contingency theories.

Module IV **8 hours**

Organizational structure**,** nature, work specialization, departmentalization, chain of command, span of control, centralization and decentralization; Organizational designs, the simple structure, the bureaucracy, the matrix structure, the team structure, the virtual organization, the boundary less organization.

Module V **8 hours**

Organizational culture and change management**,** organizational culture, nature, cultures functions, approaches to managing organizational change, Lewin's model, Kotter's plan for implementing change, organizational development techniques.

Text Book(s)

1. Robbins, Stephen and S. Sanghi, Organizational Behavior, Pearson Education. 2010.

References

1. Mullins, J. Laurie, Management and Organizational Behavior, Oxford Publishers, 2007.

EHS304: BUSINESS ETHICS AND CORPORATE GOVERNANCE (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Introduction: Corporation, definition and characteristics, history of corporate form and models, corporate objectives, corporations and government, governance, corporate governance, definition, perspectives.

Module II **8 hours**

Theoretical Foundations of Corporate Governance: Notion of conflict of interest, property rights theory, nexus of contracts, agency theory, Berle and Means' theory, concept of separation of ownership and control, shareholder, stakeholder debate.

Module III **8 hours**

Pillars of Governance in Organizations: Owners, ownership structure, types of owners, ownership vs. control, board of directors, types of directors, board roles and board attributes, board committees, executive management, role of CEO, succession planning, managerial myopia, institutional investors, types, categories, features and role.

Module IV **8 hours**

Work ethos, values and ethics, model of management in the Indian socio, political environment. Need for values in global change, Indian perspective, values for managers; Holistic approach for managers in decision making

Module V **8 hours**

Business Ethics and CSR: Corporation as a social institution, accountability and sustainability, relevance of triple bottom line reporting to CSR, codes of conduct; Applications of ethical theories to decision making, ethical issues related to employment, healthcare and advertisement.

Text Book(s)

1. Praveen B Malla, Corporate Governance: Concept, Evolution and India Story, Routledge,2010.
2. Sadri, Business Ethics: Concepts & Cases**,** TMH, 1998.

References

1. Robert Monks and Nell Minow, Corporate Governance, Wiley Publications.

EHS401: PROJECT MANAGEMENT (Elective)

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Understand characteristics and scope of management.
2. Learn the principles and goals of management.
3. Apply characteristics of entrepreneurship.
4. Evaluate project plan and report.
5. Apply business opportunity methods.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		2		2		2		1			1		2	
CO2	1		2		2	1	2		2			1		2	
CO3	1		2	1	2	1	2		2	1		1		2	
CO4	1		2		2	1	2		2	2	2	1		2	
CO5	1	1	2		2	1	2	2	1	2		1		2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Concept of project: Basic concepts, classification, characteristics of project, project life cycle, project management, tools and techniques of project management, project organization (Theory only).

Module II **8 hours**

Project identification: Identification, generation of ideas, SWOT analysis, preliminary screening, project rating index. Market and demand analysis: Collection of data, market survey, market planning, market environment, project risk analysis, demand forecasting techniques (Theory only).

Module III **8 hours**

Technical analysis: selection of technology, material input and utilities, plant capacity, location and site, machinery and equipment, structures and civil work, environmental aspects, project charts and layouts, PERT, CPM (Including Problems).

Module IV **8 hours**

Financial estimation: Project cost, source of finance, cost of production, Financial analysis: Characteristics of financial statement, working capital, project income statement, projected profitability. Investment evaluation: Investment decision rule, techniques of evaluation, payback period, accounting rate of return, internal rate of return, discounted payback period (Theory only).

Module V **8 hours**

Social Cost Benefit Analysis: Concept of social cost benefit, significance of SCBA, approach to SCBA, Project implementation: Schedule of project implementation, project planning, project control, human aspects of project management, team building, and high performance team(Theory only)

Text Book(s)

1. Prasanna Chandra, Projects - planning, analysis, implementation and review, Tata McGraw Hill, 2009.

References

1. Marwah, Project Management, Wiley Dreamtech, 2011.

EHS402: OPERATIONS AND SUPPLY CHAIN MANAGEMENT (Elective)

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Identify specific ways in which supply chain management creates value for customers and investors (customer value and financial value).
2. Analyze the existing inventory models to propose the optimal order sizes.
3. Identify sources for the variability in demand and understand the impact of globalization on supply chains.
4. Explore the different supply chain integration options to optimize the costs and time.
5. Evaluate the procurement strategies for a given business model.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1									1			3		
CO2											1		2		
CO3		2	2										2		
CO4					3		2		1	1		1	1	3	
CO5										3	3				

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Introduction to Operations Management: History of operations management, types of manufacturing systems, role and responsibilities of operations manager, services operations.

Module II **8 hours**

Understanding the logistics and supply chain: Introduction to supply chain, supply chain links, role of logistics in supply chain, drivers and metrics in supply chain, designing the supply chain network, online sales and distribution network, factors influencing the network design.

Module III **8 hours**

Impact of uncertainty in network: Globalization and supply chain, risk management in global supply chain, demand forecasting in supply chain role of information technology in forecasting.

Module IV **8 hours**

Coordination in supply chain: collaborative planning and replenishment strategies, CPFR, managing uncertainties in inventory.

Module V **8 hours**

Impact of replenishment policies in safety inventory: Role of information technology in inventory management, transportation in supply chain.

Text Book(s)

1. Sunil Chopra, Supply Chain Management: Pearson Publications, 2012.

References

1. Sridhara Bhatt, Logistics and Supply Chain Management, Himalaya Publishers, 2011.
2. D.K Agarwal, Logistics and supply chain Management, Macmillan Publishers, 2013.

EHS403: DISASTER MANAGEMENT (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Introduction to Disasters: Concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks)
Disasters: Classification causes, impacts (including social, economic, political, environmental, health, psychosocial, etc.). Differential impacts- in terms of caste, class, gender, age, location, disability. Global trends in disasters, urban disasters, pandemics, complex emergencies, climate change

Module II **8 hours**

Approaches to disaster risk reduction: Disaster cycle its analysis, phases, culture of safety, prevention, mitigation and preparedness community based DRR, structural- nonstructural measures, roles and responsibilities of- community,Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), states, centre, and other stake-holders.

Module III **8 hours**

Inter-relationship between disasters and development: Factors affecting vulnerabilities, differential impacts, impact of development projects such as dams, embankments, changes in land-use etc.Climate change adaptation. Relevance of indigenous knowledge, appropriate technology and local resources

Module IV **8 hours**

Hazard and vulnerability profile of India components of disaster relief: Water, food, sanitation, shelter, health, waste management institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, plans, programmes and legislation)

Module V **8 hours**

Project Work: (Field Work, Case Studies)
The project/fieldwork is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived creatively based on the geographic location and hazard profile of the region where the college is located. A few ideas or suggestions are discussed below.

Text Book(s)

1. G.K. Ghosh, Disaster Management, A.P.H. Publishing Corporation, 2012.
2. Mukesh Kapoor, Disaster Management, Lotus Press, 2010.

References

1. Parag Diwan, A Manual on Disaster Management, Pentagon Press, 2010.

EHS404: TOTAL QUALITY MANAGEMENT (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Quality, strategic planning and competitive advantage: Brief history, definitions of quality. Quality in manufacturing and service systems. Quality and price, quality and market share, quality and cost, quality &competitive advantages. ISO 9000, 14000.

Module II **8 hours**

Managing and organization for quality: Quality policy, quality objectives, leadership for quality, quality and organization culture, cross-functional teams, supplier/customers partnerships.

Module III **8 hours**

Quality control and Improvement tools : Cheek sheet, histogram, pareto chart, cause and effect diagram, scatter diagram, control chart, graph, affinity diagram, tree diagram, matrix diagram, process decision program chart, arrow diagram, acceptance sampling, process capability studies, zero defect program (POKA-YOKE)

Module IV **8 hours**

Quality circles,concept and total quality through bench marking, Japanese 5-S, quality management systems QS 9000, ISO 14000.
Statistical process control: Control chart – X-R, P, np and C Charts, benefits of control charts and applications (10 %)

Module V **8 hours**

Customer focus: The customer – Driven quality cycle, quality function deployment. Customer satisfaction measurement techniques, customer relationship management techniques

Text Book(s)

1. J.M. Juran, &F.M. Gryna, Quality Planning and Analysis, McGraw-Hill, 1993.

References

1. J.Bank, Essences of Total Quality Management, Prentice Hall, 2007.
2. Joel E. Ross - Text & Cases, Total Quality Management , St. Lucie Press, 1995.
3. D.L. Goetsch &S. Davis, Introduction to Total Quality, Prentice- Hall, 2002.

EHS405: ENTREPRENEURSHIP DEVELOPMENT (Elective)

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Understand characteristics and scope of management.
2. Learn the principles and goals of management.
3. Apply characteristics of entrepreneurship.
4. Evaluate project plan and report.
5. Apply business opportunity methods.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		2		2		2		1			1		2	
CO2	1		2		2	1	2		2			1		2	
CO3	1		2	1	2	1	2		2	1		1		2	
CO4	1		2		2	1	2		2	2	2	1		2	
CO5	1	1	2		2	1	2	2	1	2		1		2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Introduction, evolution of entrepreneurship, characteristics of entrepreneur, entrepreneurial mindset, theories of entrepreneurship, motivation for entrepreneurship, role of entrepreneurship in economic development, entrepreneurship development programmes, corporate entrepreneurship, meaning and benefits of corporate entrepreneurship.

Module II **8 hours**

Sources of innovative ideas, methods of generating ideas, opportunity identification, setting-up new ventures, acquiring existing business, franchising, business model, components of business model, types of business model.

Module III **8 hours**

Business plan, contents of business plan, the marketing plan, the organisational plan, the financial plan, sources of finance, institutional support to entrepreneurs, management of business, financial management, human resource management, marketing management, production and operation management.

Module IV **8 hours**

Family businesses: Importance, types and responsibilities, challenges and issues in family business, succession planning and grooming the successor, best practices in family business, live examples of family businesses.

Module V **8 hours**

Social entrepreneurship, introduction, definition, importance, characteristics of social enterprise, funding of social enterprise, significance of social entrepreneurs, measures of success in a social enterprise, live examples of Social entrepreneurs.

Text Book(s)

1. Rodert D Hisrich, M.J. Manimala, M.P.Peters, D.A.Shepherd, Entrepreneurship, McGraw Hill, 2014.
2. Rajeev Roy, Entrepreneurship, 3/e, Oxford University Press, 2012.

References

1. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice, 9/e, Cengage Learning, 2012.
2. Poornima M. Charantimath, Entrepreneurship Development – Small Business Enterprises, Pearson, 2012.
3. Arya Kumar, Entrepreneurship: Creating and Leading an Entrepreneurial Organization, Pearson, 2012.

EHS407: PROFESSIONAL ETHICS AND HUMAN VALUES

L	T	P	C
1	0	0	1

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Improving awareness about themselves and their surroundings (family, society and nature).Learn the principles and goals of management.
2. Inculcating responsibility in life and enhancing problem solving ability.
3. Maintaining hormonious relationship with society and nature.
4. Sensitivity to their commitment and understanding society and nature.
5. Understand 'self' in different day-to-day activities in real life.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	1	1	3	3	2	2	1	3	3	1	1
CO2	3	2	3	1	1	1	2	3	2	2	1	2	3	1	1
CO3	3	2	2	1	1	2	2	3	3	3	1	3	3	1	1
CO4	3	2	2	2	1	1	2	3	3	3	1	3	3	1	1
CO5	3	1	3	1	1	1	3	3	2	2	1	3	3	1	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **3 hours**

Introduction: Morals, values and ethics, integrity, work ethic, service learning, civic virtue, respect for others, living peacefully, caring, sharing, honesty.

Module II **3 hours**

Engineering Ethics: Senses of 'Engineering Ethics', variety of moral issues, types of inquiry, moral dilemmas, moral autonomy.

Module III **3 hours**

Engineering as Social Experimentation: Decomposing the system, overview of system design, system design concepts, system design activities, addressing design goals, managing system design.

Module IV **3 hours**

Safety, Responsibilities and Rights: Safety and risk, assessment of safety and risk, risk benefit analysis and reducing risk, the Three Mile Island and Chernobyl case studies. Collegiality and loyalty, respect for authority, conflicts of interest, occupational crime, professional rights.

Module V **3 hours**

Global Issues: Multinational corporations, environmental ethics, engineers as managers, consulting engineers, engineers as expert witnesses and advisors, moral leadership.

Text Book(s)

1. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw-Hill, 1996
2. M. Govindarajan, S. Natarajan, V.S. Senthil Kumar, Engineering Ethics, Prentice Hall of India, 2004.

References

1. Charles D. Fleddermann, Engineering Ethics, Pearson Education / Prentice Hall, 2004
2. Charles E Harris, Michael S. Protchard and Michael J Rabins, Engineering Ethics – Concepts and Cases, Wadsworth Thompson Learning, 2000
3. John R Boatright, Ethics and the Conduct of Business, Pearson Education, 2003
4. Edmund G Seebauer and Robert L Barry, Fundamentals of Ethics for Scientists and Engineers, Oxford University Press, 2001.

EID101: PROGRAMMING WITH C

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Students will be able to work on programming through the visual programming tool Scratch.
2. Students will be able to obtain skills for problem-solving through the flowcharting tool Raptor.
3. Students will be able to elucidate problem-solving using the Python programming language.
4. Students will be able to work on function-oriented programming paradigm through Python.
5. Students will be able to develop solutions using modular concepts.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	3	2					1		3	1	1
CO2	2	2	2	1	3	2					1		3	1	1
CO3	2	2	2	1	3	2					1		3	1	1
CO4	3	2	3	3	3	2					1		3	2	1
CO5	3	2	3	3	3	2					1		3	2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Introduction to Programming, Algorithms and Flowcharts: Programs and programming, programming languages, compiler, interpreter, loader and linker, classification of programming languages, structured programming concept, algorithms and flowcharts.

Basics of C: Developing programs in C, a simple C program, structure of a C program, concept of variable, data types in C, program statement, declaration.

Module II **10 hours**

Tokens: All tokens, operators and expressions, type conversions in C.

Input and Output: Introduction, non-formatted input and output, formatted input and output. **Control Statements:** Introduction, conditional execution (if, if-else, nested if), and selection (switch), unconditional types (break, continue, goto).

Module III **8 hours**

Loops: Iteration and repetitive execution (for, while, do-while), nested loops.

Arrays and Strings: Introduction, one dimensional array, one dimensional character arrays (strings), two dimensional arrays and character arrays (array of strings).

Module IV **10 hours**

Functions: Concept of function, using functions, call by value and call by references mechanism, working with functions-example programs, passing arrays to functions, scope and extent, storage classes, recursion.

Pointers: Understanding memory addresses, pointer operators (& and *), pointers—declaration, initialization, void pointer, null pointer, use of pointers, 1-d arrays and pointers, pointers and strings,

Module V **10 hours**

Structures: Declaring structures and structure variables, accessing members of a structure, arrays of structures, arrays within a structure.

Union: Declaring union and its members, accessing and initializing members of a union, structure versus union.

Files : Using files in c: declaration of file pointers, opening a file, closing a file, working with text files: reading from and writing into text files.

Text Book(s)

1. Pradip Dey and Manas Ghosh, Programming in C, 2/e, Oxford Higher Education, 2013.

References

1. K.R.Venugopal, S.R.Prasad, Mastering C, McGraw Hill, 2009.
2. B.A. Forouzan and R.F. Gilberg, Computer Science: A Structured Programming Approach using C, 3/e, Thomson, 2004.
3. E. Balagurusamy, Programming in ANSI C, 6/e, McGraw Hill, 2004.
4. Ashok N. Kamthane, Programming with ANSI and Turbo C, Pearson Education, 2006.

EID121: PROGRAMMING WITH C LABORATORY

L	T	P	C
0	0	3	2

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Students will be able to work on programming through the visual programming tool Scratch.
2. Students will be able to obtain skills for problem-solving through the flowcharting tool Raptor.
3. Students will be able to elucidate problem-solving using the Python programming language.
4. Students will be able to work on function-oriented programming paradigm through Python.
5. Students will be able to develop solutions using modular concepts.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	3	2					1		3	1	1
CO2	2	2	2	1	3	2					1		3	1	1
CO3	2	2	2	1	3	2					1		3	1	1
CO4	3	2	3	3	3	2					1		3	2	1
CO5	3	2	3	3	3	2					1		3	2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

LAB CYCLE

Develop the C Programs for the following Problem:

1. Conversion of an Upper-case character to a Lower-case character.
2. Finding the Sizes and Ranges of different types.(Hint: Use sizeof() and limits.h)
3. Roots of a Quadratic Equation using ‘if’.
4. Print Whether the given number is perfect (for a perfect number, the sum of divisors- except the number itself-will be equal to that number; Exs: 6,28,496,etc.).
5. First n terms of Fibonancci Sequence using (i) any loop and (ii) if statement (use ‘switch’to decide the choice).
6. Print Twin Primes up to a Specified limit.(Exs: 3-5,5-7,11-13, 17-19, etc.)
7. Generate one hundread random integers in the range of 1 to 100 , store them in an array and print the average. (using any loop)
8. Print the Average of the given numbers and also the numbers greater than the average.
9. Converting a Decimal value to Binary.
10. Program that uses a function to perform Multiplication of two Matrices.
11. Program that uses a function to perform Transpose of a given Matrix.
12. Determine if the given string is a Palindrome or not (use a function)
13. Sort the given array of strings in Dictionary order (use a function).
14. Recursive and Non recursive functions for Towers of Hanoi.

15. Program that performs all the five arithmetic Operations using Pointers.
16. Print the details of students of a class(the details may be : Roll Number, Name, Department, class, address, Marks in Five Subjects and Average of Marks) using nested structures(Calculate average).
17. Program that demonstrates the memory allocation done by a Structure and a Union (declare Structure and Union in the same program).
18. Program to demonstrate member access in a Union (declare three different types of variables in Union, assign values and print them).
19. Program that illustrates the function fprintf() to write into a text file.
20. Program that illustrates the function fscanf() to read from a text file.
21. Program that accepts the names of two files and copies the first file into the second line by line using fgets() and fputs() functions.

EIT362: INTRODUCTION TO PROGRAMMING WITH JAVA (Elective)

L	T	P	C
0	0	3	2

Module I **8 hours**

Java Evolution and Environment: Java history, features of java, how java differ from C and C++, Java and world wide web, web browser. java environment: Java Development Kit (JDK), Application Programming Interface (API).

Java programming structure, java tokens, constants, variables, expressions, decision making statements and looping, java statements, Java Virtual Machine (JVM), command line arguments.

Module II **10 hours**

Arrays and Strings:

Arrays: One-Dimensional arrays, creating an array, declaration of arrays, initialization of arrays. two-dimensional arrays, string arrays, string methods, string buffer class, basic I/O streams: scanner, buffered reader.

Classes, Objects and Methods

Introduction, defining a class, creating objects, accessing class members, constructors, methods overloading, static members.

Module III **9 hours**

Inheritance: Defining a sub class, sub class constructor, multilevel variables, final classes, and finalize methods, abstract methods and classes.

Managing Errors and Exceptions: Introduction, types of errors: compile time and run time errors, exceptions-types of exceptions, syntax of exception handling code, multiple catch statements, using finally statement, throwing our own exceptions.

Module IV **8 hours**

Interfaces-Introduction, defining interfaces, extending interfaces, implementing interfaces.

Applet Programming : Introduction, how applet differ from applications, building applet code, applet life cycle, about HTML, designing a web page, passing parameters to applets, getting input from the user.

Module V **8 hours**

Introduction to Swings: Introduction to swings, Overview of Swing components: Jbutton, JCheckBox, JRadioButton, JLabel, JTextField, JTextArea, JList.

Text Book(s)

1. Herbert Scheldt, The Java complete reference, 9/e, McGraw Hill, 2014.
2. Sachin Malhotra and Saurabh Choudhary, Programming in Java, 2/e, Oxford University Press, 2013.

References

1. Y.DanielLiang, An Introduction to JAVA Programming, 9/ e, McGraw Hill, 2008.
2. Kathy Sierra, Head First Java, 2/e, Shroff Publishers, 2005.
3. Balagurusamy, Programming with JAVA, 2/e, McGraw Hill, 2014.

EIT364: FUNDEMENTALS OF COMPUTER ORGANIZATION AND ARCHITECTURE (Elective)

L	T	P	C
0	0	3	2

Module I **8 hours**

Digital Logic Circuits: Digital computer-logic, gates, boolean algebra, map simplification, combinational circuits, flipflops.

Digital Components: Decoders, multiplexers, registers, shift registers, binary counters**.**

Module II **8 hours**

Data Representation: Data types, complements, fixed point representation, floating point representation.

Register Transfer and Micro operations: Register transfer language, register transfer, bus and memory transfers, arithmetic micro operations, logic micro operations, shift micro operations, arithmetic logic shift unit.

Module III **8 hours**

Basic Computer Organization: Instruction codes, computer registers, computer instructions, timing and control, instruction cycle, memory reference instructions, input, output and interrupt, complete computer description.

Module IV **10 hours**

Micro programmed Control: Control memory, address sequencing, microprogram example, design of control unit.

CPU Organization: Introduction, general register organization, stack organization, instruction formats, addressing modes, data transfer and manipulation, program control.

Module V **8 hours**

Memory Organization: Memory hierarchy - main memory, associative memory, cache memory, virtual memory.

Input-Output organization: Peripheral devices, input-output interface, asynchronous data transfer, modes of transfer, direct memory access.

Text Book(s)

1. Mano, Morris M, Computer System Architecture, 3/e, Pearson Education, 2000.

References

1. Stallings W, Computer Organization and Architecture, 6/e Pearson Education, 2000.
2. Hamacher, V.C., Z.G.Vranesic, and S.G.Zaky, Computer Organization, 3/e, McGraw Hill, 1990.

EIT462: INTRODUCTION TO NEURAL NETWORKS & FUZZY LOGIC (Elective)

L	T	P	C
3	0	0	3

Module I **9 hours**

Introduction Neural Networks: Basic concepts of neural networks, evolution of neural networks, basic models of artificial neural network, early neural network architectures: rosenblatt's perceptron, adaline network, madaline network , applications of neural networks.

Module II **8 hours**

Back propagation Method: Architecture: Perceptron model, solution, single layer artificial neural network, multilayer perception model, back propagation learning methods, effect of learning rule co-efficient, back propagation algorithm, factors affecting back propagation training, applications.

Module III **10 hours**

Fuzzy Logic: Basic concepts of fuzzy logic, fuzzy sets and crisp sets, fuzzy set theory and operations, properties of fuzzy sets, fuzzy and crisp relations, fuzzy to crisp conversion**,** membership functions, interference in fuzzy logic, fuzzy if-then rules, fuzzy implications and fuzzy algorithms, fuzzyfications & defuzzificataions, fuzzy controller, industrial applications.

Module IV **8 hours**

Genetic Algorithm: Fundamentals of genetic algorithms, history, basic concepts, creation of offspring's, working principle, encoding, fitness function, reproduction, genetic modelling, inheritance operators, cross over, inversion and deletion, mutation operator, bit-wise operators, bit-wise operators used in genetic algorithm, generational cycle.

Module V **8 hours**

Hybrid Systems: Integration of neural networks, fuzzy logic and genetic algorithms: hybrid systems, neural networks fuzzy logic and genetic algorithms hybrids, preview of the hybrid systems to be discussed: genetic algorithm based back propagation networks, fuzzy back propagation networks, simplified fuzzy ARTMAP, fuzzy associative memories, fuzzy logic controlled genetic algorithms.

Text Book(s)

1. S. Rajsekaran and G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications. Prentice Hall, 2003.

References

1. Tom M. Mitchell, Machine Learning, McGraw-Hill, 2013.
2. Ethem Alpaydin, Introduction to Machine Learning: Adaptive Computation and Machine Learning, MIT Press, 2004.

EMA103: FUNDAMENTALS OF MATHEMATICS-I

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Learners will be able to explain the concepts of partial fraction techniques.
2. Learners will be able to explain the concepts of trigonometry.
3. Learners will be able to understand complex numbers and their properties.
4. Learners will be able to explain the concepts of permutations and combinations.
5. Learners will be able to understand the basic concepts of limits, continuity, and differentiation.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1									1	1	1	1		1	
CO2						1	1	1	2	2	2	1	1	2	
CO3									1	1	1	1	1	1	1
CO4				1			1		1	1	1	1	1	1	
CO5				1		1	2	1	2	2	2	2	2	2	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Partial fractions: Introduction, Resolving $\frac{f(x)}{g(x)}$ into partial fractions when g(x) contains non repeated linear factors, repeated linear factors, repeated and non-repeated irreducible quadratic factors

Module II **8 hours**

Trigonometry: Trigonometric functions, graphs, periodicity, trigonometric ratio of compound angles, multiple and sub multiple angles, transformations, trigonometric equations. Brief introduction of inverse Trigonometric, Hyperbolic and inverse hyperbolic function.

Module III **8 hours**

Complex numbers: Complex number as an ordered pair of real numbers, representation of z = (a, b) in the form (a+ ib), conjugate complex numbers, modulus and amplitude of a complex number, geometrical representation of a complex number, Argand plane, Argand diagram. Demoiver's theorem for integral index and rational index (without proof), n^{th} roots of unity, Geometrical representation, cube roots of unity.

Module IV **10 hours**

Definition of right hand limit, left hand limit, limit. Limits of f + g, $\frac{f}{g}$, f o g (without proof), standard limits 1) $\lim_{x\to a}\frac{x^n-a^n}{x-a}$ 2) $\lim_{\theta\to 0}\frac{\sin\theta}{\theta}$ 3) $\lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n$ 4) $\lim_{x\to 0}\frac{e^x-1}{x}$ 5) $\lim_{x\to 0}\frac{a^x-1}{x}$ (without proofs). Definition of continuity and simple illustrations.

Differentiation

Introduction, definition, differentiation of a function at a point and on an interval, Derivative of a function, Differentiation of sum, difference, product and quotient of functions, Differentiation of algebraic, exponential, logarithmic functions, composite, implicit, parametric, hyperbolic and inverse hyperbolic functions, Logarithmic differentiation, derivative of a function with respect to another function. Derivatives of first and second order.

Module V **8 hours**

Co-ordinate Geometry – I

Locus: Definition and Equation of Locus

Straight lines: Recapitulation of general equation of a straight line, forms of equation of a straight line: slope intercept form, intercept form, point – slope form, Two point form. Normal form $x \cos \alpha + y \cos \alpha = P$, symmetric form $\frac{x-x_1}{\sin\theta} = \frac{y-y_1}{\cos\theta} = r$, Reduction of general equation into different forms, point of intersection of two straight lines, family of straight lines. Line passing through the point of intersection of two given lines, condition for concurrency of three straight lines, angle between two intersecting lines, condition for perpendicularity and parallelism, length of the perpendicular from a point to a straight line, distance between two parallel lines. (Proofs of the theorems are not required).

Text Book(s)

1. V. Venkateswara Rao, N. Krishna Murthy, B. V. S. Sharma, Intermediate Mathematics, Volume I & II, 1/e, S. Chand and Company Ltd.

,

References:

1. Chandrika Prasad, A first Course in Mathematics for Engineers, Prasad Mudranakya, Beli Avenue, Allahabad.

EMA104: FUNDAMENTAL OF MATHEMATICS-II

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Learners will be able to explain the basic concepts of matrices.
2. Learners will be able to explain the fundamental concepts of probability.
3. Learners will be able to teach the evaluation of definite and indefinite integrals.
4. Learners will be able to explain the concept of using partial fraction techniques to evaluate integrals.
5. Learners will be able to explain the concepts of straight lines and circles.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1							1	1		1	1	1		1	
CO2								1	1	1	1	1		1	
CO3				1		1	2	1	1	2	2	1	1	1	1
CO4				1		1	1	1	1	2	2	2	1	2	1
CO5						1			1	1	1	1		1	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Matrices: Matrices and Determinants, definition, types of matrices, algebra of matrices, properties of determinants of 2 X 2 and 3 X 3 order matrices, Inverse of a matrix, Solving simultaneous linear equations in 2 and 3 variables using matrix inverse method and Cramer's rule.

Module II **8 hours**

Permutations & Combinations: Definition of linear and circular permutations, number of permutations of n dissimilar things taken r at a time, number of permutations on dissimilar things taken r at a time when repetition of things is allowed any number of times, number of circular permutations of different things taken all at a time, number of permutations of n things taken all at a time when some of them are alike and the rest are dissimilar number of combinations of n dissimilar things taken r at a time. Introduction of Binomial theorem, expansion of $(x + a)^n$, $(1 + x)^{-1}$, $(1 - x)^{-1}$, $(1 + x)^{-2}$& $(1 – x)^{-2}$.

Module III **8 hours**

Indefinite Integrals: Integration as the inverse process of differentiation standard forms, properties of integrals, integration by method of substitution covering algebraic, trigonometric and exponential functions, Integration by parts, logarithmic functions, Inverse trigonometric functions.

Module IV **8 hours**

Integrals of special types and definite integrals: Integrals of the following types of functions.

Integration of rational functions using partial fractions.

Definite Integrals: Definition of a definite integral and its properties (without proof), Formulae $\int_0^{\pi/2} \sin^n\theta\, d\theta$, $\int_0^{\pi/2} \cos^n\theta\, d\theta$, $\int_0^{\pi/2} \cos^m\theta \sin^n\theta\, d\theta$ (without proofs)

Module V **10 hours**

o-ordinate Geometry – II Circles: Equation of a circle, standard form, centre and radius, equation of a circle with a given line segment as diameter, equation of a circle through 3 non collinear points, parametric equations of a circle, position of a straight line in the plane of the circle, condition for a straight line to be a tangent, chord joining 2 points on a circle, equation of the tangent at a point on the circle, point of contact, equation of normal. Relative positions of 2 circles, circles touching each other, externally, internally, of common tangents, angle between 2 intersecting circles, conditions for orthogonality. (Proofs of the theorems are not required).

Text Book(s)

1. V. Venkateswara Rao, N. Krishna Murthy, B. V. S. Sharma, Intermediate Mathematics, Volume I &II, 1/e, S. Chand & Company Ltd.

References

1. Chandrika Prasad, A first Course in Mathematics for Engineers, Prasad Mudranakya, Beli Avenue, Allahabad.

EMA202: NUMERICAL METHODS

L	T	P	C
3	0	0	3

Module I **8 hours**

Solution of Algebraic and Transcendental Equations: Bisection method, secant method, false position method, Newton Raphson method.

Module II **10 hours**

Interpolation: Difference operators and relations, difference tables, Newton's forward and backward interpolation formulae, divided difference formula, Lagrange's interpolation formula.

Module III **6 hours**

Linear System of Algebraic Equations: Iteration method, Jacobi method, Gauss - Seidal method, power method.

Module IV **10 hours**

Numerical Differentiation: Derivatives using forward, backward and central difference formulae.
Numerical Integration: Newton-cotes quadrature formula, trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule.

Module V **8 hours**

Numerical Solutions of Ordinary Differential Equations: Introduction-Picard's method, Taylor's series method, Euler's method, modified Euler's method, Runge - Kutta method, predictor - corrector method.

Text Book(s)

1. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 5/e, New Age International, 2007.

References

1. S.S. Sastry, Introductory methods of Numerical Analysis, 4/e, PHI Publications, 2009.

EMA 209: LINEAR ALGEBRA AND VECTOR CALCULUS

L	T	P	C
3	0	0	3

Module I **8 hours**

Linear Algebra-I: Rank of a Matrix, Elementary Transformations, Equivalent Matrices,Gauss Jordan method of finding inverse, Normal form of a matrix, consistency of linear system of equations, system of homogeneous and non homogeneous equations.

Module II **8 hours**

Linear Algebra-II: Eigenvalues and Eigenvectors of matrices, Cayley Hamilton theorem (without proof), Inverse and powers of matrix by Cayley Hamilton theorem, Reduction of quadratic form to canonical form.

Module III **8 hours**

Partial Differentiation: Functions of two or more variables, Partial derivatives, Homogeneous functions, Euler's theorem, Total derivative, Differentiation of implicit functions, change of variables, Jacobians Geometrical interpretation, tangent plane and Normal to the surface.

Module IV **10 hours**

Multiple Integrals: Double Integrals, Change of order of integration, Double integrals in polar coordinates, Areas enclosed by plane curves, Triple integrals, Volume of solids.

Module V **8 hours**

Vector Calculus: Scalar, vector fields. Del applied to scalar point function, Gradient, Del applied to vector point function, Divergence- Curl-Line integral, surface integral and volume integrals. (Introduction to orthogonal curvilinear coordinates, cylindrical, spherical and polar coordinates- Self study.)

Text Book(s)

1. B.S.Grewal, Higher Engineering Mathematics, 42/e. Khanna Publications, 2012.

References

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9/e, Wiley Eastern, 2013.
2. N.P.Bali and Manish Goyal, Textbook of Engineering Mathematics, 8/e, Laxmi Publications, 2011.

EMA 212: DIFFERENTIAL EQUATIONS AND LAPLACE TRANSFORMS

L	T	P	C
3	0	0	3

Module I **8 hours**

Differential Equations of First Order and Applications: Formation of differential equations, Equations of first order and first degree, Variables separable, Homogeneous equations, Linear equations, Bernoulli's equation, Newton law of cooling.

Module II **8 hours**

Linear Differential Equations: Definition, Operator D, Rules for finding complementary function, Inverse operator, Rules for finding particular integral, Method of variation of parameters.

Module III: **8 hours**

Partial Differential Equations: Formation of partial differential equations, Linear equations of first order, Homogeneous linear equations with constant coefficients, Rules for finding the complementary functions, Rules for finding the particular integral.

Module IV **10 hours**

Applications of Partial Differential Equations: Method of separation variables- Vibrations of a stretched string-wave equation-One-dimensional heat flow and Two-dimensional heat flow-Solution of Laplace equation

Module V **8 hours**

Laplace Transforms: Transforms of elementary functions, Properties of Laplace transforms, Existence conditions-Transforms of derivatives, Transforms of integrals, multiplication by t^n, division by t, Inverse transforms, Convolution theorem(without proof), Applications to Ordinary Differential equations.

Text Book(s)

1. B.S.Grewal, Higher Engineering Mathematics, 42/e. Khanna Publications, 2012.

References

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9/e, Wiley Eastern, 2013.
2. N.P.Bali and Manish Goyal, Textbook of Engineering Mathematics, 8/e, Laxmi Publications, 2011.

EME121: WORKSHOP

L	T	P	C
0	0	3	2

Course Objectives:

1. To acquire basic knowledge of various tools and their use in different trades of such as carpentry, tin-smithy, fitting and electrical wiring.
2. To introduce basis of drawing skills and accurate measurements of the job.
3. To learn how various joints are made in wood working
4. To impart knowledge on use of various tools in metal working.
5. To achieve basic electrical engineering knowledge in electrical wiring

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Identify and apply suitable tools for the preparation of various jobs in wood working, sheet metal working and fitting.
2. Differentiate the application of various joints in wood working.
3. Practice on manufacturing of components using workshop trades including wood working, sheet metal working and fitting.
4. Apply electrical engineering knowledge to make basic electrical circuits and connections.
5. Implement and demonstrate safety measures.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2		1	1		1	1				2	2	3
CO2	2	3	2		1	1		1	1				2	2	3
CO3			2		1	1		1	1				2	2	3
CO4	2	3			1	1		1	1				2	2	3
CO5	2	3			1	1			1				2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Wood Working: **3 Classes**

Familiarity with different types of woods used and tools used in wood working and make following joints
a) Half – Lap joint b) Mortise and Tenon joint c) Corner Dovetail joint or Bridle joint.

Sheet Metal Working: **3 Classes**

Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal jobs from GI sheets
a) Tapered tray b) Conical funnel c) Elbow pipe.

Fitting: **3 Classes**

Familiarity with different types of tools used in fitting and following fitting exercises
a) V – fit b) Dovetail fit c) Semi-circular fit

Electrical Wiring: **3 Classes**

Familiarity with different types of basic electrical circuit connections and make the following connections
a) Parallel and series b) Two way switch c) Godown lighting

d) Tube light e) Three phase motor

EME123: ENGINEERING GRAPHICS

L	T	P	C
1	0	3	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Students will able to utilize engineering graphics as the universal language of engineers.
2. Students will able to prepare drawings according to international standards.
3. Students will able to identify various engineering curves.
4. Students will able to solve plane geometry problems involving lines and plane figures.
5. Students will able to represent solids and sections graphically.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				2		2		2	2		2		2	2	3
CO2				2		2		2	2		2		2	2	3
CO3				2		2		2	2		2		2	2	3
CO4				2		2		2	2		2		2	2	3
CO5				3		3		3	2		3		2	2	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Manual Drawing

Module I **2L+6P**

Lettering, line types, dimensioning and scales. General construction method for polygons. Construction of pentagon and hexagon by special methods.
Conic Sections: Ellipse, parabola, hyperbola with eccentricity method, tangent and normal to these curves.
Cycloidal curves: Cycloid, epicycloid, hypocycloid, inferior and superior trochoid. Involute of a circle.

Module II **3L+9P**

Projections of Points: Projections of points in different quadrants.
Projections of Straight lines: Line parallel to one or both the planes, line contained by one or both the planes, line perpendicular to one of the planes, line inclined to one plane and parallel to the other, line inclined to both the planes, inclinations, true length of the line and its traces.
Projections of Planes: Types of planes, plane perpendicular to one plane and parallel to other plane, perpendicular to one plane and inclined to other plane.

Module III **2L+6P**

Projections of Solids: Types of solids, projection of prism, pyramid, cylinder and cone in simple positions, and axis inclined to one plane and parallel to other, axis inclined to both the planes.

Computer Based Drawing:

Module IV **5L+15P**

Introduction to CAD package software commands.
Free Hand Sketching: Free hand sketches of 2D.
Computer Aided Sketching: Creation of 2D sketches by CAD package.

Orthographic Projections: Principle of projection, orthographic projection, planes of projection, first angle and third angle projection. Orthographic views of geometric shapes.

Module V **2L+6P**

Free Hand Sketching: Free hand sketches 3D of simple solids.
Isometric Views: Pictorial drawing, isometric views of plane figures and simple solids represented by multi-view drawings.

Text Book(s)

1. M.B Shah and B.C Rana, Engineering Drawing, 2/e, Pearson Education, 2009.

References

1. N.D. Bhatt and V. M, Panchal,Engineering Drawing, 49/e, Charotar Publishing House, 2008.
2. K.L. Narayana and P. Kanniah, A text book on Engineering Drawing, SciTech publications, 2014.

EME403: OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

Module I **10 hours**

Basics of Operations Research: History, definition, operations research models, phases of implementing operations research in practice

Linear Programming: Introduction, formulation, graphical solution, simplex method, artificial variable techniques – Big M and two phase methods, duality principle, dual simplex method.

Module II **8 hours**

Transportation Model: Formulation, initial feasible solution, optimal solution – MODI method, unbalanced transportation problems, degeneracy in transportation problems.

Assignment Model: Formulation, optimal solution, Hungarian method, travelling salesman problem.

Module III **8 hours**

Queuing Models: Introduction, Kendall's notation, classification of queuing models, single server and multi server models, Poisson arrival, exponential service, infinite population.

Sequencing Models: Introduction, assumptions, processing n-jobs through two machines, n-jobs through three machines, n-jobs through m-machines, and graphic solution for processing 2 jobs through n machines with different order of sequence.

Module IV **8 hours**

Replacement Models: Introduction, replacement of items that deteriorate with time - value of money unchanging and changing, simple probabilistic model for replacement of items that fail completely.

Game Theory: Introduction, game with pure strategies, game with mixed strategies, dominance property, graphical method for 2xn and mx2 games, linear programming approach for game theory.

Module V **8 hours**

Inventory Models: Introduction, inventory costs, economic order quantity (EOQ) and economic batch quantity (EBQ) models with and without shortages, Inventory models with quantity discounts.

Project Management: Introduction, phases of project management, network construction, Fulkerson's rule, critical path method (CPM), project evaluation and review technique (PERT).

Text Book(s)

1. Gupta P K, Hira D.S, Operation Research, 6/e, SChand Publishers, 2006.
2. Paneerselvam R, Operations Research, 2/e, Prentice Hall of India, 2010.

References

1. Taha H.A., Operations Research, 9/e, Prentice Hall of India, 2010.
2. Harvey M.Wagner, Principles of Operations Research: With Applications to Managerial Decisions, 2/e, Prentice Hall of India, 1975.
3. KantiSwarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research, 7/e, Sultan Chand & Sons, 2005.
4. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7/e, Tata McGraw Hill, 2009.

EOE202: GERMAN FOR BEGINNERS (Elective)

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L	T	P	C
3	0	0	3

Module I **9 hours**

Introduction to the German language, grammar and pronunciation.
Language: Greetings; Introducing oneself; Asking the way; Giving directions.
Grammar: The nouns, gender distinctions, cases, definite and indefinite articles.
Pronunciation: Vowels.

Module II **8 hours**

Language: Asking for and giving information; Discussing home and the household.
Grammar: Conjugation of verbs, verbs with separable and inseparable prefixes, modal verbs.
Pronunciation: Vowels.

Module III **8 hours**

Language: Describing people and their qualities;Describing shape, size and colour of objects.
Grammar: Personal pronouns, possessive pronouns, reflexive pronouns.
Pronunciation: Consonants.

Module IV **8 hours**

Language: The working world; returning faulty goods to a shop; Asking someone to repeat Something; Refusing or declining politely.
Grammar: Cases - Nominative. Accusative and Dative.
Pronunciation: Diphthongs.

Module V **9 hours**

Language: Making comments and suggestions; Asking for and giving opinions.
Grammar: Structure of sentence and categories of sentences; subordinate clause - causative and conditional sentences.
Pronunciation: Umlaut.

References

1. Deutsch als Fremdsprache IA Grundkurs

2. Ultimate German Beginner - Intermediate (Coursebook). 2004. Living Language.

EOE204: CHINESE FOR BEGINNERS (Elective)

L	T	P	C
3	0	0	3

Module I **9 hours**

Introduction to the Chinese language and pronunciation system; Tones; Chinese numbers;
Language: Saying hello; Greetings
Pronunciation: Initials: b p m n l h; Finals: a o e I u ü / ao en ie in ing uo; First tone

Module II **8 hours**

Language: Asking what someone wants; Identifying people; Asking someone's name and nationality
Grammar: Word order in Chinese sentence
Pronunciation: Initials: d t g k f; Finals: ei ou an ang eng iao iou(iu); Second tone

Module III **8 hours**

Language:Introducing oneself; Asking for permission
Grammar: Sentence with an adjectival predicate; "Yes-no" question
Pronunciation: Initials: zh ch sh r; Finals : -I / ai uai ong; Thirdtone

Module IV **8 hours**

Language: Introducing oneself; Asking for permission
Grammar: Questions with an interrogative pronoun
Pronunciation: Initials: j q x; Finals: ia ian iang / uei(-ui) uen(-un) üe üan; Fourth tone

Module V **9 hours**

Language: Making comments and suggestions; Asking someone to repeat something; Refusing or declining politely
Grammar: Sentences with a verbal predicate
Pronunciation: Initials: z c s; Finals:-i er iong ua uan uang ün; Neutral tone; Retroflex ending

*The course will focus on the pronunciation system, the introduction of common Chinese expressions and every-day phrases in the context of communicative activities.

Reference:

1. Liu, Yuehua. Integrated Chinese: Simplified Characters Textbook, Level 1, Part 1. Cheng & Tsui Company, Inc. Boston. 2008

EOE206: INTRODUCTION TO MUSIC (Elective)

L	T	P	C
3	0	0	3

Module I

8 hours

Introduction to Indian Classical Music: Heritage- Contribution of various races and tribes to the evolution of music in India; Technical Aspects of Indian Classical Music; Influences- Persian music especially on Hindustani Music; Significance of music in bringing about social change.

Module II **9 hours**

History of Indian music: Origin- Vedas, Scriptures and Bharata's Natyasastra; Traditions- Hindustani and Carnatic; Basic elements: Shruthi, Swara, Raaga and Taala; Similarities and Variations in Hindustani, Carnatic and Western classical music; Octave; Semitones; Introduction to Shruthi, Swara, Raaga and Taala; Fundamental Ragas; Importance of Taala in Indian Music; Introduction to Pallavi, Anupallavi and Charana.

Module III **8 hours**

Hindustani Music: Brief history of Hindustani Music; Hindustani- Concepts of Raaga & Taala; Introduction to various Gharanas- Classification of music (Folk, Semi-classical, Bhajans, Light); Appreciation of Music.

Module IV **8 hours**

Carnatic Music: History of Carnatic music; Traditions: The Musical Trinity- Syama Sastri, Thyagaraja, Muthuswami Dikshitar; Introduction to technical terms in Carnatic music; Compositional forms/ strategies.

Module V **9 hours**

Connections - Music, Art and Culture: Musical Oral tradition as a transmitter of culture; Music as an expression of societal change; Music as a means of communication across cultures.

References:

1. Rangaramanuja Iyengar,R. History of South Indian (Carnatic) music, from Vedic times to the present. Wilco Pub. House, 1972.
2. Swami Prajnanananda. The Historical Development of Indian Music: A Critical Study. Firma K.L. Mukhopadhyaya, 1973.
3. G.H. Ranade. Hindustani Music. Popular Prakashan, 1971.

EOE208: GANDHIAN PHILOSOPHY (Elective)

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Understand the life and works of Gandhi.
2. Understand and appreciate the political contributions of Gandhi.
3. Analyse the contemporary issues and connect it with Gandhian solutions.
4. Analyse the issues related to world peace and to think about possible alternatives.
5. Understand and appreciate the role of eminent world leaders towards non-violent social and political transformation.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	1	2	3	3	3	3	1	3	3	3	2	3	3
CO2	1	2	1	2	3	3	2	3	2	1	3	3	1	3	2
CO3	3	2	2	1	3	3	3	3	1	2	3	3	1	2	3
CO4	2	3	1	1	3	3	2	3	2	3	3	3	1	3	1
CO5	3	3	2	1	3	3	2	3	2	2	3	3	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **8 hours**

Gandhi -The Man and His Times: Early life and education; Lessons learnt from his wife; In South Africa; Influence of Thoreau, Tolstoy and other thinkers; Return to India; Sabarmati Ashram; Role in the Indian National Movement; His impact during his life time

Module II **8 hours**

Interpretation and Pursuit of Truth: Learning through trial and error; Power of introspection; Truth in thought, speech and action; Pursuit of truth as true devotion to God; Truth leads to courage and victory

Module III **8 hours**

Peace and Conflict Resolution: Ahimsa as practical idealism - the means to the goal of truth; Non-violent civil resistance; Living faith in the power of nonviolence; Prerequisites for practice - faith, courage and humility; Prevention of structural violence; Two pronged approach - conflict resolution and establishing peace; Examples of methods and practices

Module IV **8 hours**

Transformation of the Individual: Liberating the mind from dogmatism; Control of the senses, thoughts and actions; Respect for all faiths and universalism; A few strategies - Anasakta Karma, non-discrimination, simple living and self-sufficiency

Module V **10 hours**

Contemporary Relevance: Gandhi's social, political and economic thought; Sarva Dharma Sambhava - tolerance, respect towards all religions; Educational reform – basic education and adult education; Social

equality - Sarvodaya - removal of untouchability, communal unity, women empowerment, prohibition, service of backward classes, village sanitation; Political solutions - Swaraj, decentralization of power, democracy of enlightened majority; Economic solutions - Swadeshi, trusteeship,khadi and village industries, decentralization of wealth; Sustainable development and equal opportunity; Youth as agents of change

References:

1. Gandhi, M.K. (Author), Mahadev H. Desai (Translator) Gandhi An Autobiography: The Story of My Experiments With Truth. Beacon Press.1993.
2. Fischer, Louis. The Essential Gandhi: An Anthology of His Writings on His Life, Work, and Ideas. Vintage Books.1983.
3. http://www.mkgandhi.org/main.htm
   Comprehensive Website by Gandhian Institutions-Bombay Sarvodaya Mandal & Gandhi Research Foundation

EOE210: PHILOSOPHICAL FOUNDATIONS OF EDUCATION (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Introduction: Philosophy's relevance to education; Philosophical roots of education;

Education as transmission of knowledge; Education as the fostering of inquiry or reasoning skills; Education as an agent of social change or personal liberation; Liberal education and vocational education.

Module II **9 hours**

Philosophical Concepts Related to Education: Indian: From the Vedic to the modern - an overview; Western: an overview - metaphysics - naturalism or supernaturalism; Epistemology - reason or faith; Human nature - dualism, reductive materialism or integrationism; Ethics – egoism, predation or altruism; Idealism, Realism, Pragmatism, Behaviorism, Existentialism.

Module III **9 hours**

Knowledge and Wisdom: Interrelation between education, science, technology, society and environment; Galileo to today - an overview.

Module IV **8 hours**

Purposes of Education: Personal growth or self-improvement; Intellectual purposes; Political purposes; Economic purposes such as job preparation; Social purposes such as the development of social and moral responsibility.

Module V **8 hours**

A Few Thinkers on Education and Their Impact on Education: Eastern and Western - Confucius, Socrates, Plato, Aristotle, Michel Foucault, Bertrand Russel, Rabindranath Tagore, Sri Aurobindo, Swami Vivekananda, J. Krishnamurti, S. Radhakrishnan, M.K. Gandhi.

References:

1. Sharma, A.P. Indian & Western Educational Philosophy. Pustak Mahal. 2010.
2. Ozmon, Howard. Philosophical Foundations of Education. Prentice-Hall. 2011.
3. Palmer, Joy; Bresler, Liora; Cooper, David; (Ed) Fifty Major Thinkers on Education: From Confucius to Dewey. Routledge. 2001.
4. Noddings, N. *Philosophy of Education.* Boulder, CO: Westview Press. 1995.
5. Gailbraith D. Analyzing Issues: Science, Technology, & Society. Toronto: Trifolium Books. Inc. 1997.

EOE212: ANALYTICAL ESSAY WRITING (Elective)

L	T	P	C
3	0	0	3

Module I **9 hours**

Mechanics of Essay Writing: Framework of an Essay - Introduction -hypothesis/ statement of claim; Body - claims and counter claims; refuting or disproving the opposing position with reasons and examples; providing evidence and examples that prove or support one's claim; Conclusion - restatement of the claim and summary of the main ideas; Paragraphing; Discourse Markers.

Module II **9 hours**

Analyzing an Argument: Terms and definitions - statement, argument, claim, truth value, premise; identifying premises and claims/conclusions, strengths and weaknesses of an argument; discussion on the validity of a claim; scope for counter-argument if any; critiquing an argument.

Module III **8 hours**

Analyzing an Issue: An issue statement or statements followed by specific task instructions; discussing the extent to which one agrees or disagrees with the statement; rationale for the position one takes; developing and supporting one's position; discussion on the validity of the given statement/claim; addressing the different views that are presented; remaining unbiased in assessing a claim; taking a stand and justifying it; writing a response.

Module IV **9 hours**

Writing an argumentative essay on a topic of contemporary interest: Planning, writing and revising; Clear, concise, and defined thesis statement that occurs in the **introduction;** Clear and logical transitions; **Body paragraphs that include evidential support (**factual, logical, statistical, or anecdotal); Conclusion that does not simply restate the thesis, but readdresses it in light of the evidence provided.

Module V: **7 hours**

Peer Review: Preparing a template for peer review that is derived from the response rubric given to the student and assessment rubric used for evaluation; Formulating and communicating constructive feedback on a peer's work; Responding to feedback on one's work; Checklist for peer review - lead strategy use in the introduction, thesis statement, supporting details given in the body, the writer's acknowledgement of a counterargument and his/her response to it, closing strategy used in the conclusion.

References:

1. Bailey. S. Academic Writing: A Handbook for International Students. London and New York: Routledge. 2001.
2. Jordan, R.R. Academic Writing Course.London: Nelson/Longman. 1999.
3. Hamp-Lyons, L. and Heasley, B. Study Writing. Cambridge University Press. 2006.

EOE214: INDIAN ECONOMY (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Structure of Indian Economy: Meaning of economic growth and development, features of Indian economy, changing structure of Indian economy, trends in national income, sources of growth, agriculture, industry and service sectors.

Module II **8 hours**

Demography, Poverty and Unemployment in India: Demography**:** Population size and growth rates, age and gender distribution, trends of urbanization, occupational distribution of labour force. Poverty**:** Nature of poverty causes for poverty, measures to eradicate poverty. Unemployment:Nature and types of unemployment, causes for unemployment, remedial measures of unemployment.

Module III **8 hours**

Public Finance: Sources of Govt. revenue, Indian tax structure, direct and indirect taxes, composition of the government expenditure, role of monetary and fiscal policies, federal finance in India, 14th finance commission.

Module IV **8 hours**

Foreign Trade: Importance, composition and directionof foreign trade, foreign direct investment, BoPs equilibrium, Foreign Exchange Management Act (FEMA).

Module V **8 hours**

Economic Reforms in India: Industrial policy 1991 – Economic reforms: Liberalization, Privatization, and Globalization.

Text Book(s)

1. V.K Puri and SK Misra. Indian Economy. 31/e edition. Himalaya Publishing House. 2014.

References

1. RC Dutt and KPM Sundaram. Indian Economy, S. Chand &Co.
2. A.N. Agarwal, Indian Economy, New Age International Ltd.
3. I.C Dhingra, Indian Economy, Sultan Chand & Co.

EOE216: PUBLIC ADMINISTRATION (Elective)

L	T	P	C
3	0	0	3

Module I **10 hours**

Introduction: Meaning, Scope and Significance of Public Administration; Evolution of the Discipline and its present status; Challenges of liberalisation, privatization and globalization; Good Governance; Electronic Governance - Concepts and Applications; New Public Management (NPM)

Module II **8 hours**

Administrative Thought: Scientific Management Theory; Classical Theory; Bureaucratic Theory; Human Relations Theory System Theory

Module III **8 hours**

Accountability and Control: Legislative, Executive and Judicial control over administration; Role of Media; Interest Groups; NGOs; Civil Society; Right to Information Act (RTI); Social Audit; Citizen Chapters

Module IV **8 hours**

Union and State Governments Administration: President; Prime Minister; Council of Ministers; Cabinet; Central and State Secretariats; Boards and Commissions; Governor; Chief Minister and Council of Ministers; Central- State Relations; Finance Commission; NEETI AYOG

Module V **8 hours**

Civil Services: Recruitment, training and other condition of services; District Administration; Role of Collector; Local self Governing Institutes - 73rd and 74th Constitutional Amendments Act

Text Book(s)

1. Avasti and Maheswari.Public Administration. Lakshmi Narain Agarwal Books.Agra,India. 31/E, 2014.
2. Bl Fadia and Kuldeep Fadia. Indian Administration. Sahitya Bhawan.Agra,India.8/E,2014.

References

1. Nicholas Henry.Public Administration and Public Affairs.PHI Learning. Delhi, India.12/E.
2. Prasad and Prasad.Administrative Thinkers. Sterling Pub. New Delhi, India.2/E.
3. D.D. Basu. Introduction to the Indian Constitution. LexisNexis. Gurgaon, India.21/E.
4. Ramesh K. Arora and Rajni Goyal. Indian Public Administration. New Age International Publishers. New Delhi, India. 3/E.

EOE218: ENVIRONMENT AND ECOLOGY (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Basic Concepts: Environment types, features of environment, structure of atmosphere, Earth's four spheres, ecology, ecological principles, photosynthesis, components of ecosystem, carbon and oxygen cycles, nitrogen, hydrological, sedimentary, phosphorous and energy cycles.

Module II **8 hours**

Biomes: Terrestrial biomes, Aphine Tundra biomes, extinction of species Bio-diversity: Biodiversity in American contents, Europe, Central Asia and Africa. Categorization of species, biogeograpic zones of India, biodiversity conservation, strategies, biodiversity conservation in India.

Module III **8 hour**

Environmental Degradation and Management: Greenhouse effect and global warming, acidification, world distribution of acid rain, impact of acid of precipitation, ozone depletion, Antarctic ozone hole, some basic facts about ozone depletion, salinisation, desertification or desertisation , soil erosion, types of soil erosion, soil conservation, deforestation, waste disposal, sustainable development.

Module IV **8 hours**

Natural Hazards and Disaster Management: Disaster, natural hazards; Earthquakes in India: Seismic zones of India, Earthquake prediction, tsunami, landslides; types of landslides, avalanches; Cyclones: thunderstorms, tornadoes, surge, sea-surge or storm surge; Floods: floods in India, flood disaster management; Drought hazards: causes of droughts, consequences of droughts, biological hazards and disasters, famines, wildfire (forest fire), forest fires in India.

Module V **8 hours**

Climate Change: Evidence of global warming. consequences of climatic change, consequences of climate change in India. **Biodiversity and Legislation:** Earth summit, the five earth summit agreements, the Montréal protocol, Kyoto protocol on climatic change

.

Text Books:

1. Majid Husain, Environment and Ecology, 2/e Access publishing, New Delhi, 2014.

References:

1. S V S Rana, Essentials of Ecology and Environmental Science, Prince Hall India, New Delhi, 2011.

EOE220: INDIAN HISTORY (Elective)

L	T	P	C
3	0	0	3

Module I **10 Hours**

Ancient Indian History and Culture (Earliest times to 700 AD): Indus Valley Civilisation: Origin- Significance- Art and Architecture; Aryans and Vedic Period: Expansions of Aryans in India – Significance of the Vedic age – Evolution of monarchy and varna System; Political conditions and administration under Mauryas – Guptas – Social and Economic conditions in ancient India – Philosophy and Religions in ancient India.

Module II **8 Hours**

Medieval Indian History and Culture: Delhi Sultanate - Great Mughals – Bahumanis – Rise of south supremacy and conflicts: Pallava, Chalukya, Chola and Rasthrakutas.

Module III **8 Hours**

Modern Indian History and Culture: European penetration into India: The Portuguese and the Dutch; The English and the French East India Companies; Their struggle for supremacy - The Battle of Plassey and its significance – Consolidation of British rule in India.

Module IV **8 Hours**

Impact of British Colonial Rule:Economic: Commercialization of agriculture - Dislocation of traditional trade and commerce-De-industrialisation - Decline of traditional crafts - Drain of wealth- Famine and poverty in the rural interior. **Social and Cultural Developments:**The state of indigenous education and its dislocation- Orientalist-Anglicist controversy - Introduction of western education in India- The rise of print media, literature and public opinion- The rise of modern vernacular literature - Progress of science – Rail and road connectivity .

Module V **8 Hours**

The Rise of Indian National Movement: Indian Response to British Rule:The Great Revolt of 1857 - The Peasant movements of the 1920s and 1930s - The Foundation of the Indian National Congress: The Moderates and Extremists - the Partition of Bengal (1905) - The Swadeshi movement in Bengal - the Economic and Political aspects of Swadeshi movement. Gandhian Nationalism: Gandhi 's popular appeal - Rowlett Act - Satyagraha - the Khilafat movement - the Non-co operation movement - Civil disobedience movement - Simon Commission - The Peasant and Working Class movements - Cripps Mission - the Quit India movement – Declaration of Independence.

Text Book(s)

1. Romila Thapar.A History of India Vol. I. Penguin Books. Reprint Edition (September 1, 2013).
2. R.C.Majumdar.The History and Culture of the Indian Peopel: Volume 1, The Vedic Age.Bharatiya Vidya Bhavan (2010).
3. B.L. Grover.Modern Indian History: From 1707 to The Modern Times.S.Chand.New edition (1 July 1998).
4. R.C. Majumdar.History of the Freedom Movement in India. South Asia Books (1June 1988).

References

1. D.N. Jha. Ancient India in Historical Outline. Manohar Publishers and Distributors (January 2, 2001).
2. G.S. Chabra. Advanced Study in the History of Modern India. Lotus Press (30 October 2007).
3. M.K. Gandhi.Hind Swaraj. Rajpal & Sons Edition.
4. W.W. Hunter.History of British India.Asian Educational Services, India, N/E (November15, 2008).
5. A.R. Desai.Social Background of Indian Nationalism. Popular Prakashan, 6/e.

EOE301: INDIAN CONSTITUTION (Elective)

L	T	P	C
3	0	0	3

Module I **10 Hours**

Introduction to Indian Constitution: Constitutional History; Constituent Assembly; Salient Features of the Constitution; Significance of Preamble; Amending Process of the Constitution.

Module II **8 Hours**

Rights and Duties: Citizenship; Fundamental Rights and Directive Principles; Fundamental Duties

Module III **8 Hours**

Union Government: President and Vice President - Election, Removal and Powers; Prime Minister and Council of Ministers; Parliament; Supreme Court; Union; State Relations; Emergency Provisions

Module IV **8 Hours**

State and Local Governments: Governor; State Legislature - Assembly and Council; Chief Minister and Council of Minsters; High Court; Rural and Urban Local Governments with special reference to 73rd and 74th Constitutional Amendment Acts

Module V **8 Hours**

Other Constitutional and Statutory Bodies: Comptroller and Auditor General; Election Commission; Finance Commission; Attorney General and Advocate General; Union Public Service Commission (UPSC); State Public Service Commissions (SPSCS); Tribunals; National Human Rights Commission (NHRC)

Text Book(s)

1. J.C Johari. Indian Government and Politics.Vishal Publications, Delhi.
2. M.V. Pylee. India’s Constitution. Asia Publishing House.Mumbai.

References

1. D.D. Basu. Introduction to the Indian Constitution. 21/e LexisNexis. Gurgaon, India.
2. Subhas C. Kashyap. Our Constitution. 2/e National Book Trust India, New Delhi.

EOE303: JAPANESE FOR BEGINNERS (Elective)

L	T	P	C
3	0	0	3

Module I **9 hours**

Introduction to Japanese Language: Simple Explanation of Writing and Pronunciation Systems; Characteristics of Japanese Grammar.
Meeting People: Introductions, Exchanging Business Cards; Identifying People and Things
Useful Daily Expressions.

Module II **8 hours**

Asking about Business Hours, Shopping; Time and numbers, large numbers, counters.
Grammar: Pronouns and Noun Modifiers.
Useful Daily Expressions.

Module III **8 hours**

Getting around; confirming schedules (including going / coming); visiting another company (including month/week/day).
Grammar: Motion Verbs.
Useful Daily Expressions.

Module IV **8 hours**

Existence of people and things; asking / telling location; dining out; making plans for a weekend.
Grammar: State of being/existence, basic verbs.
Useful Daily Expressions.

Module V **9 hours**

Giving and Receiving; Expressing Gratitude; Talking about Plans (Usage of Te-Form).
Grammar: Adjectives - present form of i-adjective, present form of na-adjective, past forms of i-adjective and na-adjective; the te-form.
Useful Daily Expressions.

References:

1. Ajalt(Author). Japanese for Busy People: Romanized Version Volume 1 (Paperback) (1 Aug 2006 Edition).
   Paperback + CD Available at: http://www.amazon.in/Japanese-Busy-People-Romanized-Version/dp/1568363842/ref=sr_1_5_twi_2_pap?s=books&ie=UTF8&qid=1428168559&sr=1-5&keywords=japanese+for+busy+people

*Study through Romanized Textbook - No reading/writing in Japanese letters

EOE305: FRENCH FOR BEGINNERS (Elective)

L	T	P	C
3	0	0	3

Module I **9 hours**

Asking for and giving personal information; Asking for and giving directions; Gender and number
Grammar: Verbs “avoir” and “etre”, Present tense, Questions
Vocabulary: Countries and Nationalities, Professions, Family, Food

Module II **8 hours**

Asking and giving the time; Asking when something is open or someone is available; Asking for prices and describing what one wants
Grammar: Alphabet and numbers; Possessive Adjectives; Negative sentences
Vocabulary: Days of the week, Months, Money

Module III **8 hours**

Asking for information related to travel and accommodation; Expressing one’s wants/needs
Grammar: Present tense for verbs in -er, -ir and -re; Present tense of irregular verbs; Verbs: to be able to, to want , to know
Vocabulary: Food, shops, packaging and measures

Module IV **8 hours**

Talking about daily routine and the working day; Describing things; Expressing oneself when buying things
Grammar: Possessive Pronouns, Reflexive verbs
Vocabulary: Clothes, colours and shapes, weather

Module V **9 hours**

Describing places; visiting the doctor; Reading short advertisements; Describing places, feelings and symptoms
Grammar: Using *avoir aller, etre faire, vouloir pouvoir*
Vocabulary: Parts of the body, rooms and features of interior spaces

References

1. LE NOUVEAU SANS FRONTIÈRES - Textbook
2. LE NOUVEAU SANS FRONTIÈRES - Workbook
   CD & selected passages/ exercises

EOE307: CONTEMPORARY RELEVANCE OF INDIAN EPICS (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Reading the Texts: Reading for gist; Chapter summaries; Plot; Pair work and discussions in small groups.

Module II **8 hours**

Understanding the Texts: Basic themes; Characterization - major characters; Watching short videos followed by discussion, analysis and writing short reviews.

Module III **8 hours**

Story Retelling and Responsive Writing: Narrating short episodes; Enacting select scenes; Role play; Writing short paragraphs and short essays based on basic themes, plot and major characters.

Module IV **9 hours**

Exploring the Texts from Socio-cultural and Political Perspectives: Identifying examples of mutual co-existence;Duties and responsibilities of individuals in the context of family and society; Righteous action - Conflict between good and evil; possibilities of redefining cultural and political systems; Identifying spaces for reconciliation in conflict situations.

Module V **9 hours**

Contemporary Relevance of the Epics: Human relations; Team play; Leadership lessons; Resource management; Core competencies and competitiveness.

References:

1. C. Rajagopalachari .Ramayana. Bharatiya Vidya Bhavan/Mumbai/India; 44th edition. August 19, 1951.
2. C. Rajagopalachari. Mahabharata. Bharatiya Vidya Bhavan/Mumbai/India; 57th edition August 19, 2012.
3. R. K. Narayan. The Mahabharata: A Shortened Modern Prose Version of the Indian Epic (Penguin Modern Classics) Penguin Group(CA)January 1, 2009.
4. R. K. Narayan. The Ramayana; ASshortened Modern Prose Version of the Indian Epic (Suggested by the Tamil Version of Kamban) Penguin Classics; New Ed.August 29, 2006.

EOE309: INDIAN NATIONAL MOVEMENT (Elective)

L	T	P	C
3	0	0	3

Module I **9 hours**

Background: Early British colonialism in India; Early rebellions - Pazhassi Raja (The Cotiote War - Kerala, 18th century), Veerapandiyan Kattabomman (Tamilnadu/Madras Presidency – 18th century), Paik rebellion (Kalinga/Odisha, early 19th century), Vellore mutiny (early 19th century); The Sepoy Mutiny of 1857 and its consequences

Module II **8 hours**

Contributory Factors: Socio-political Consciousness; Growth of Western education and its impact on socio-religious movement; British economic policies and their impact

Module III **8 hours**

Rise of Organized Movements: Emergence of Indian National Congress, its policies and programmes; Partition of Bengal; Rise of radical nationalists, Bal-Lal-Pal; Formation of the Muslim League; Minto-Morley reforms; The National Movement during the First World War

Module IV **9 hours**

Gathering Momentum: Non-cooperation and civil disobedience; Emergence of Gandhi; Some prominent revolutionaries - Khudiram Bose, Prafulla Chaki, Bhupendra Nath Dutt, V. D. Savarkar, Sardar Ajit Singh, Lala Hardayal, Sardar Bhagat Singh, Raj Guru, Sukh Deo, Chandra Shekhar Azad; Development of Socialist ideas; Communal divide

Module V **8 hours**

Towards Independence: Constitutional developments; Provincial elections; Quit India Movement and after; Participation of women; National movement during the Second World War; Indian National Army, Naval Mutiny of 1946, Freedom and Partition; Impact on the world

References:

1. K. Majumdar, Advent of Independence, Bhartiya Vidya Bhavan, Mumbai, 1969.
2. R. Desai, Social Background of Indian Nationalism, 5th edition. Popular Prakashan. Mumbai. 1976.
3. Bandyopadhyay, Sekhar. (Ed). Nationalist Movement in India: A Reader. Oxford University Press.2008
4. Chandra, Bipin. Nationalism and Colonialism in Modern India. New Delhi. Orient Longman Ltd.1979.

EOE311: SCIENCE AND TECHNOLOGY (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Planet Earth: Introduction, the crust in motion, Earth quakes, mineral future, promise of Oceans, changing climate, green house effect, global environmental issues, meteorological science, preserving mother Earth.

Module II **8 hours**

Living State: Introduction, molecular genetics, Cell biology, Immunology, Neuro Sciences, Biology and Agriculture, Storage of Food grains, Agriculture products and their preservation, Biotechnology in food processing.

Module III **8 hours**

Energy: Introduction, some important time perspectives, mid-term energy options, mid-term supply strategies, hydro, wind, thermal, solar and nuclear energies, environmental and health effects in harvesting energy, long term energy options, some research needs

Module IV **8 hours**

Computer and Communications: Introduction, development of communication system, telegram, telephone, wireless communication, current technology and systems, theoretical computer science and contribution from mathematics, computer and communications, artificial intelligence, television and entertainment.

Module V **8 hours**

Materials and Processing: Materials in ancient India, development in materials, materials processing and manufacturing: recent concepts in materials, polymer materials, composites, Nano sciences and Nano technologies, super conductivity, laser and photonics.

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Text Book(s)

1. Ashok Singh, Science and Technology 2/e Access publishing, 2014.
2. W H Freeman and Company, National Academy of Sciences Washingtone, DC.1979.

References

1. K D Sharma and M A Qureshi (Editor) Science, Technology and Development, Sterlings Publishers Pvt, ltd, New Delhi, 1978.
2. B R Nanda (Editor), Science and Technology in India, Vikas Publishing House Pvt Ltd, 1977.

EOE313: PROFESSIONAL COMMUNICATION (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Internal Communication: Memo - structure, layout and style; e-mail - structure, style, content and etiquette; Notice – structure, content and layout; Conducting a Meeting -purpose and preparation, drafting agenda and minutes, conducting effective meetings, meeting etiquette.

Module II **9 hours**

Making a Business Presentation: Planning - define the purpose, analyze audience and occasion; Preparation – developing central idea, main ideas, gathering supporting materials, audio-visual aids; Organization – introduction, body and conclusion; Delivery - addressing the audience, body language, eye contact, use of appropriate language, style and tone.

Module III **8 hours**

Business Letters: Form and structure; Style and tone; Letters of enquiry; Letters placing orders/ giving instructions / urging action; Letters of complaint and adjustment.

Module IV **9 hours**

Proposals and Reports: Proposals - types, Structure, Prefatory parts, Body of the proposal, Supplementary parts; Reports - Types – informative, analytical, formal/informal, oral/written, individual/group; format and structure.

Module V **8 hours**

Resume, Cover Letter, Interview and Telephone Etiquette: Resume - design and structure; Cover letter - cover letters accompanying resumes - opening, body, closing; Interview - planning, purpose, pre-interview preparation, conversation, two-way interaction, projecting a positive image; Telephone etiquette - guidelines for telephone conversations in a professional context.

References:

1. Seely, John. Oxford Guide to Effective Writing and Speaking. Oxford University Press (India), 2013.
2. Olsen, Leslie & Huckin, Thomas. Technical Writing and Professional Communication for Non-native Speakers. McGraw-Hill. 1991.
3. Rizvi, M Ashraf. Effective Technical Communication. Tata McGraw Hill. 2005.

EOE315: ETHICS, INTEGRITY AND ATTITUDE (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Basic Concepts: Terminology - Morals, ethics, values, integrity and spirituality; Edicts - Religious, social and constitutional edicts; the question of universality; Personal and professional ethics; Emotional Intelligence; Dimensions of ethics

Module II **8 hours**

Rights and Responsibilities: As citizens; As professionals; Concepts of justice and fairness; Preservation, production, exchange for mutual fulfillment vs. storage for future use; Social responsibility and individual rights

Module III **9 hours**

Global Issues in Ethics: Technology and globalization; Business ethics; Corporate Social Responsibility; Environmental ethics; Media ethics; Protecting the common good while respectingthe values and beliefs of nations/ethnic groups; Issues of compliance and governance; Equal opportunities

Module IV **8 hours**

Ethical Integrity and Attitudes: Integrity as wholeness and consistency of character; Beliefs, actions, methods and principles - core group of values; Accountability; Prioritization; Subjectivity and objectivity; Attitude - Components (cognitive, behavioral & affective); Attitude formation and attitude change

Module V **9 hours**

Ethical Living: Needs of life - materialistic and non-materialistic, qualitative and quantitative; Harmony in living - self (physical and mental well being), family - (building trust, sharing of responsibilities, cultivating sense of security), society (peace, non-violence, diversity, multiculturalism and oneness), and nature (environmental sustainability; reorganizing living conditions, reappraising economic sectors and work practices, developing green technologies, ethical consumerism)

References:

1. G. Subba Rao, Roy Chowdhury, P.N. Ethics, Integrity and Aptitude: For Civil Services Main Examination Paper V. Access Publishing. 2013.
2. Singer, Peter. Practical Ethics. Cambridge University Press.1999. (first published 1979)
3. Swami Tathagatananda. Healthy Values of Living. Kolkata:Advaita Ashrama, 2010.
4. (Ed) Values and Ethics in the 21st Century. BBVA. Available at https://www.bbvaopenmind.com/wp-content/uploads/2013/10/Values-and-Ethics-for-the-21st-Century_BBVA.pdf

EOE317: PERSONALITY DEVELOPMENT (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Self Awareness: Know yourself: Have a snapshot of yourself; Assess your personal traits; Discover natural potential.

Activities and Tasks: Class Discussion, Questionnaires, Johari Window, SWOC analysis (Strengths, Weaknesses, Opportunities and Challenges).

Module II **8 hours**

Self Discipline: Importance of Self Discipline; Characteristics of a self disciplined achiever; Self discipline in personal life and career.

Activities and Tasks: Viewing short videos followed by discussion and analysis; Brainstorming in small groups; Creating an action plan to realize academic and career goals.

Module III **8 hours**

Motivating Oneself: Self motivation; Confidence building; Goal setting; Decision making

Activities and Tasks: Discussion and analysis of case studies; Completing self-assessment questionnaires.

Module IV **9 hours**

Managing Oneself: Handling emotions; Time management; Stress management; Change management.

Activities and Tasks: Discussion and analysis of case studies; Completing self-assessment questionnaires.

Module V **9 hours**

Interpersonal Behaviour: Attitude towards persons and situations; Team work; Leadership skills; Problem solving skills; Interpersonal adaptability; Cultural adaptability

Activities and Tasks: Team-building games and activities.

References

1. Hurlock, Elizabeth B. Personality Development. McGraw Hill Education (India). 1979.
2. Covey, Stephen R. The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change. Free Press.2004. (first published 1989)
3. Carnegie, Dale & Levine, Stuart.R. The Leader In You: How to Win Friends, Influence People and Succeed in a Changing World.Pocket Books. 1995.
4. Swami Vivekananda. Personality Development. Advaita Ashrama.

* This will be supplemented by materials and activities from internet-related sources.

EPH101: ENGINEERING PHYSICS

L	T	P	C
3	0	0	3

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Students will demonstrate proficiency in estimating forces, fields, and waves in both electrostatics and magnetostatics.
2. Students will apply principles of interference, diffraction, and polarization to analyze wave behaviors effectively.
3. Students will be capable of calculating the thermal properties of materials, encompassing concepts such as conductivity, heat capacity, and thermal expansion.
4. Students will adeptly apply Newtonian laws of motion to analyze and predict the behavior of macroscopic systems.
5. Students will be able to select appropriate sensing devices from a range of commonly used options, considering factors such as sensitivity, accuracy, and applicability to specific scenarios.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2				2	1		1		
CO2						2				2	1		1		
CO3						2				2	1		1		
CO4						2				2	1		1		
CO5						2				2	1		1		

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

Module I **10 hours**

Interference: Introduction, interference in thin films due to reflected light, interference in wedge shaped film, Newton's rings, Michelson's interferometer, Applications: To find the diameter of a wire, to find the wavelength of light and refractive index of liquids and thin transparent sheets, flatness of surface, thickness of thin-film coating, antireflection coatings.

Diffraction: Introduction, Fraunhoffer diffraction at single slit, diffraction due to Nslits (diffraction grating), highest possible orders, determination of wavelength of light with a plane transmission grating, resolving power of a grating, dispersive power of a grating.

Module II **8 hours**

Polarisation: Introduction, Double refraction, double refraction in calcite crystal, negative and positive crystals, Nicol's prism, Retarders (quarter and halfwave plates), production and detection of linearly, circularly and elliptically polarised lights, analysis of polarized light, applications: Sunglasses, photography, optical microscopy, liquid crystal display, photoelasticity.

Module III **8 hours**

Lasers: Introduction, spontaneous and stimulated emissions, population inversion, components of a laser, lasing action, types of lasers – ruby laser, HeNe laser, semiconductor laser, applications: in industry, medicine, new materials.

Fiber Optics: Introduction, structure of an optical fiber, principle of propagation, acceptance angle, numerical aperture, types of optical fibers, single mode and multimode step index fibers, multimode graded index fiber, classification of fibers based on materials, fibre optics in communication, applications of fiber optics.

Module IV **8 hours**

Modern Physics (Quantum Physics): Introduction, Matter waves & its properties, DavissonGermer experiment, GP Thomson experiment, Heisenberg's uncertainty principle, Schrodinger's time independent wave equation, Physical significance of wave function, Particle in a onedimensional infinite well, rectangular potential barrier (transmission coefficient), Band theory of solids (qualitative), distinction between metals, insulators and semiconductors, Introduction to MaxwellBoltzmann, FermiDirac and BoseEinstien statistics (qualitative only).

Module V **9 hours**

Ultrasonics: Introduction, properties of ultrasonic waves, production of ultrasonics by magnetostriction and piezoelectric effects, detection (Kundt's tube, sensitive flame, acoustic grating and piezoelectric methods), applications of ultrasonics.

Electromagnetism: Coulomb's law, Flux, Gauss' law of electrostatics in free space; significance of gradient, divergence, and curl operators; divergence of electric field, differential form of Gauss' law, Ampere's law, Gauss' law for magnetism, integral form of Faraday's law, equation of continuity, displacement current, Maxwell's equations.

Text Book(s)

1. M.N. Avadhanulu, and P.G. Kshirsagar, A Textbook of Engineering Physics, S.Chand, 2014.

References

1. Resnick, Halliday and Krane, Physics part I&II, 5/e, Wiley India, 2007.
2. A.Ghatak, Optics, Tata McGraw Hill Education, 4/e, 2008.
3. Arthur Bieser, Concepts of Modern Physics, 6/e, Tata McGraw Hill, 2009.
4. A Marikani, Engineering Physics, 2/e, PHI, 2013.

EPH104: SOLID STATE PHYSICS

L	T	P	C
3	0	0	3

Module I **9 hours**

Crystallography: Classification of solids, forces between atoms, bonding in solids, ionic, covalent and metallic bonding; Fundamental concepts of crystals, lattice points and space lattice, crystal systems, Bravais lattices, directions, planes and Miller indices, atomic packing fraction; Structure of simple cubic, body centered cubic (CsCl), face centered cubic (NaCl), hexagonal closed packed (HCP), diamond structure, X-ray diffraction, Bragg's law.

Module II **8hours**

Dielectric Properties: Introduction, fundamental definitions, local field, Claussius-Mossotti relation; different types of electric polarizations, electronic, ionic, and dipolar polarizations (qualitative and quantitative), dielectric loss, dielectric breakdown, piezoelectricity and ferroelectricity, spontaneous polarization in $BaTiO_3$, applications of dielectrics and ferroelectrics.

Module III **7 hours**

Magnetic Properties: Introduction, fundamental definitions, classification of magnetic materials, Weiss theory of ferromagnetism, domain theory of ferromagnetism, hysteresis, soft and hard magnetic materials, Eddy current losses, ferrites (structure and magnetic properties), Applications: transformer cores, magnetostrictive sensors, data storage.

Module IV **8 hours**

Semiconductors I: Introduction, Intrinsic and extrinsic semiconductors, carrier concentration in intrinsic semiconductors, carrier concentration in n-type and p-type semiconductors, conductivity of extrinsic semiconductors, variation of carrier concentration and conductivity with temperature, drift and diffusion currents in semiconductors, carrier transport phenomena.

Module V **10hours**

Semiconductors II: Recombination of electron hole pairs, p-n junction diode and junction layer formation, direct and indirect band gap of semiconductors, Hall effect and its applications, magneto resistance, optical and thermal properties of semiconductors, fundamentals of LED, photovoltaic cell (solar cell), tunnel diode.

Text Book(s)

1. M.N. Avadhanulu and P.G. Kshirsagar, A Text book of Engineering Physics, S.Chand, 2014.

References

1. Simon M. Sze and Kwok K. Ng, Physics of Semiconductor Devices, 3/e, John Wiley, 2006.
2. S O Pillai, Solid State Physics, 7/e, New Age International, 2014.
3. B.G. Streetman and S. Banerjee, Solid State Electronic Devices, 6/e, PHI Learning, 2006.
4. P.K. Palanisamy, Applied Physics, Scitech Publications, 2009.
5. Marius Grundmann, The Physics of Semiconductors, 2/e, Springer, 2010.

EPH121: ENGINEERING PHYSICS LABORATORY

L	T	P	C
0	0	3	2

Course Outcomes:

Upon completion of this course, the student should be able to:

1. Students will demonstrate proficiency in estimating forces, fields, and waves in both electrostatics and magnetostatics.
2. Students will apply principles of interference, diffraction, and polarization to analyze wave behaviors effectively.
3. Students will be capable of calculating the thermal properties of materials, encompassing concepts such as conductivity, heat capacity, and thermal expansion.
4. Students will adeptly apply Newtonian laws of motion to analyze and predict the behavior of macroscopic systems.
5. Students will be able to select appropriate sensing devices from a range of commonly used options, considering factors such as sensitivity, accuracy, and applicability to specific scenarios.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2				2	1		1		
CO2						2				2	1		1		
CO3						2				2	1		1		
CO4						2				2	1		1		
CO5						2				2	1		1		

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

List of Experiments:

1. J - by Callender and Barne's method.
2. Thermal conductivity of a bad conductor–Lee's method.
3. Magnetic field along the axis of a circular coil carrying current Stewart and Gee's galvanometer.
4. Hall effect– measurement of hall coefficient.
5. Carey Foster's bridge – laws of resistance and specific resistance.
6. Calibration of low range voltmeter - potentiometer bridge circuit.
7. Thickness of a paper strip – wedge method.
8. Newton's rings – radius of curvature of a plano convex lens.
9. Diffraction grating - normal incidence.
10. Determination of refractive indices (o and e) of a bi - refringent material (Prism).
11. Cauchy's constants - using a spectrometer.
12. Dispersive power of a prism–using a spectrometer.
13. Determination of Rydberg constant.
14. LASER - diffraction.
15. Determination of band gap in a semiconductor.
16. Optical fibres - numerical aperture and loss of signal.
17. VI characteristics of a pn - junction diode
18. Response of a series RLC circuit

List of Courses

42	EBT441	Renewable Energy Engineering	
43	EBT442	Metabolic Engineering	
44	EBT443	Biomedical Instrumentation	
45	EBT444	Cancer Biology	
46	EBT445	Thermal Operations in Food Processing	
47	EBT446	Dairy Process Engineering	
48	EBT447	Nanobiotechnology	
49	EBT448	Process Instrumentation	
50	EBT449	Bioprocess Modeling and Simulation	
51	EBT450	Applied Biocatalysis and Bioconversions	
52	EBT451	Molecular Diagnostics	
53	EBT452	Stem cells & Tissue Engineering	
54	EBT453	Food Handling, Packaging & Storage	
55	EBT454	Plant & Equipment Design	
56	EBT455	Systems Biology	
57	EBT456	Patent law & Drafting	
58	EBT491	Mini Project	
59	EBT492	Comprehensive Viva	
60	EBT493	Summer Internship	
61	EBT494	Project Work	
62	ECS362	Operating System Concepts (Elective)	
63	ECS364	Fundamentals of Data Structures (Elective)	
64	ECS461	Introduction to DBMS (Elective)	
65	ECS462	Fundamentals of software Engineering (Elective)	
66	ECS463	Introduction to Computer Networks (Elective)	
67	ECS464	Introduction to Web Technologies (Elective)	
68	ECY103	Physical and Inorganic Chemistry	
69	ECY108	Organic Chemistry	
70	ECY122	Organic Chemistry Lab	
71	ECY123	Physical and Inorganic Chemistry Lab	
72	EEE101	Basic Electrical Engineering	
73	EHS101	Communicative English-I	
74	EHS102	Communicative English - II	
75	EHS201	Environmental Studies	
76	EHS301	Engineering Economics and Management	
77	EHS302	Organizational Behaviour (Elective)	
78	EHS304	Business Ethics and Corporate Governance (Elective)	
79	EHS401	Project Management	
80	EHS402	Operations and Supply Chain Management (Elective)	
81	EHS403	Disaster Management (Elective)	
82	EHS404	Total Quality Management	
83	EHS405	Entrepreneurship Development (Elective)	
84	EHS407	Professional Ethics and Human Values	
85	EID101	Programming with C	
86	EID121	Programming with C Lab	

87	EIT362	Introduction to Programming with Java (Elective)	
88	EIT364	Fundamentals of Computer Organization & Architecture (Elective)	
89	EIT462	Introduction to Neural Networks and Fuzzy Logic (Elective)	
90	EMA103	Fundamentals of Mathematics-I	
91	EMA104	Fundamentals of Mathematics-II	
92	EMA202	Numerical Methods	
93	EMA209	Linear Algebra and Vector Calculus	
94	EMA212	Differential equations and Laplace Transforms	
95	EME121	Workshop	
96	EME123	Engineering Graphics	
97	EME403	Operations Research	
98	EOE 202	German for Beginners (Elective)	
99	EOE 204	Chinese for Beginners (Elective)	
100	EOE 206	Introduction to Music (Elective)	
101	EOE 208	Gandhian Philosophy (Elective)	
102	EOE 210	Philosophical Foundations of Education (Elective)	
103	EOE 212	Analytical Essay Writing (Elective)	
104	EOE 214	Indian Economy (Elective)	
105	EOE 216	Public Administration (Elective)	
106	EOE 218	Environmental Ecology (Elective)	
107	EOE 220	Indian History (Elective)	
108	EOE 301	Indian Constitution (Elective)	
109	EOE 303	Japanese for Beginners (Elective)	
110	EOE 305	French for Beginners (Elective)	
111	EOE 307	Contemporary Relevance of Indian Epics (Elective)	
112	EOE 309	Indian National Movement	
113	EOE 311	Science and Technology	
114	EOE 313	Professional Communication	
115	EOE 315	Ethics, Integrity and Attitude	
116	EOE317	Personality Development (Elective)	
117	EPH101	Engineering Physics-I	
118	EPH104	Solid State Physics	
119	EPH121	Engineering Physics Lab	

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