INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM - CHENNAI
ACCREDITED BY NAAC WITH 'A' GRADE
Marching Beyond 30 Years Successfully

B. Tech
BIOTECHNOLOGY

Curriculum and Syllabus
Regulation 2022

(Based on Choice Based Credit System (CBCS)
and
Outcome Based Education (OBE))

Effective from the Academic year
2022-2023

Department of Bio-Engineering
School of Engineering

INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM - CHENNAI
ACCREDITED BY NAAC WITH 'A' GRADE
Marching Beyond 30 Years Successfully

School of Engineering
Department of Bio-Engineering
B.Tech– Biotechnology

Vision of the Department

- To be a Centre of excellence in the field of bioengineering equipped to create graduates who endeavour for the society and environment.

Mission of the Department

- To impart quality education for long lasting development and opportunity in an extensive career in the various fields of Biotechnology.
- To increase innovative learning to the needs of Industry and Society
- To provide quality education for professional growth and opportunity in a wide range of careers.
- To provide an extraordinary research environment that generates innovative solutions to practical problems in the fields of biotechnology.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO1: Graduates will have a strong research-based knowledge to design experiments, analyze and interpret data for scientific inquiry and life-long learning, which may involve post-graduate education as well as success in competitive exams.

PEO2: Graduates will demonstrate an ability to design, conduct and apply modern tools to interpret the data in chemical and biological systems.

PEO3: Graduates will have an effective in the concepts of Biosystems design and development, drug discovery and process optimization.

PEO4: Graduates will develop as a biotechnologist expertise in emerging areas of life sciences and engineering sciences.

PEO5: Graduates will design and implementation of a pilot scale to industrial process to meet the current needs with the appropriate consideration for public health, safety and environmental considerations.

PROGRAMME OUTCOME (PO)

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

PO2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4. 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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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

PO10. 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.

PO11. 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 multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOME (PSO)

This programme of study will enable the students

PSO1:To investigate challenging problems across various domains with appropriate Biological techniques, construct solutions systematically and evaluate their effectiveness.

PSO 2: Demonstrate the acquired professional and competitive skills for successful career, demonstrating the practice of Professional Ethics and the concerns for Social and Environmental impact technologies.

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.			
1.1	Demonstrate competence in mathematical modelling	1.1.1	Apply mathematical techniques such as Calculus, Linear Algebra, and Statistics to solve the problems.
		1.1.2	Apply advanced Biotechnological techniques to model and solve the problems in Biotechnology
1.2	Demonstrate competence in basic sciences	1.2.1	Apply laws of natural science to an engineering problem.
1.3	Demonstrate competence in engineering fundamentals	1.3.1	Apply fundamental engineering concepts to solve engineering and technological problems
1.4	Demonstrate competence in specialized engineering knowledge to the program	1.4.1	Apply Biotechnological concepts to solve engineering problems.
PO 2: Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.			
2.1	Demonstrate an ability to identify and formulate complex engineering problem	2.1.1	2.1.1 Articulate problem statements and identify objectives
		2.1.2	2.1.2 Identify engineering and technological systems, variables, and parameters to solve the problems
		2.1.3	2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.1	Reframe complex problems into interconnected sub-problems
		2.2.2	Identify, assemble and evaluate information and resources.
		2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
		2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3	Demonstrate an ability to formulate and interpret a model	2.3.1	Combine scientific principles and engineering concepts to formulate model/s of a system or process that is appropriate interms of applicability and required accuracy.
		2.3.2	Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.
2.4	Demonstrate an ability to execute a solution process and analyze results	2.4.1	Apply engineering mathematics and computations to solve mathematical models
		2.4.2	Produce and validate results through skillful use of contemporary engineering and technological tools and models
		2.4.3	Identify sources of error in the solution process, and limitations of the solution.
		2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis

PO 3: 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 public health and safety, and cultural, societal, and environmental considerations.			
3.1	Demonstrate an ability to define a complex/ open-ended problem in engineering terms	3.1.1	Recognize that need analysis is key to good problem definition
		3.1.2	Elicit and document, engineering requirements from stakeholders
		3.1.3	Synthesize engineering requirements from a review of the state-of-the-art
		3.1.4	Extract engineering requirements from relevant engineering and Technological Codes and Standards such as BRSI, Science and Engineering Board etc
		3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues
		3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2	Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions
		3.2.2	Build models/prototypes to develop a diverse set of design solutions
		3.2.3	Identify suitable criteria for the evaluation of alternate design solutions
3.3	Demonstrate an ability to select an optimal design scheme for further development	3.3.1	Apply formal decision-making tools to select optimal engineering and technological design solutions for further development
		3.3.2	Consult with domain experts and stakeholders to select candidate engineering design solution for further development
3.4	Demonstrate an ability to advance an engineering design to defined end state	3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)
		3.4.2	Generate information through appropriate tests to improve or revise the design
PO 4: 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.			
4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem, its scope and importance for purposes of investigation
		4.1.2	Examine the relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation
		4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical and Biological quantities
		4.1.4	Establish a relationship between measured data and underlying physical and biological principles.
4.2	Demonstrate an ability to design experiments to solve open-ended problems	4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures

		4.2.2	Understand the importance of the statistical design of experiments and choose an appropriate experimental design plan based on the study objectives
4.3	Demonstrate an ability to analyze data and reach a valid conclusion	4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data
		4.3.2	Analyze data for trends and correlations, stating possible errors and limitations
		4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions
		4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions
PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.			
5.1	Demonstrate an ability to identify/ create modern engineering tools, techniques and resources	5.1.1	Identify modern engineering tools and techniques and resources for engineering and technological activities.
		5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2	Demonstrate an ability to select and apply discipline- specific tools, techniques and resources	5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.
		5.2.2	Demonstrate proficiency in using discipline-specific tools
5.3	Demonstrate an ability to evaluate the suitability and limitations of tools used to solve an engineering problem	5.31	Discuss limitations and validate tools, techniques and resources
		5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.
PO 6: 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.			
6.1	Demonstrate an ability to describe engineering roles in a broader context, e.g. pertaining to the environment, health, safety, legal and public welfare	6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level
6.2	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.			
7.1	Demonstrate an understanding of the impact of engineering and industrial practices on social, environmental and in economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity
		7.1.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
7.2	Demonstrate an ability to apply principles of sustainable design and development	7.2.1	Describe management techniques for sustainable development

		7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.			
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
8.2	Demonstrate an ability to apply the Code of Ethics	8.2.1	Identify tenets of research sectors professional code of ethics.
		8.2.2	Examine and apply moral & ethical principles to known case studies
PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.			
9.1	Demonstrate an ability to form a team and define a role for each member	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
		9.1.2	Implement the norms of practice (e.g., rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.2	Demonstrate effective individual and team operations-- communication, problem-solving, conflict resolution and leadership skills	9.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
		9.2.2	Treat other team members respectfully
		9.2.3	Listen to other members
		9.2.4	Maintain composure in difficult situations
9.3	Demonstrate success inas team-based project	9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the 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			
10.1	Demonstrate an ability to comprehend technical literature and document project work	10.1.1	Read, understand and interpret technical and non-technical information.
		10.1.2	Produce clear, well-constructed, and well-supported written engineering documents.
		10.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear.
10.2	Demonstrate competence in listening, speaking, and presentation	10.2.1	Listen to and comprehend information, instructions, and viewpoints of others
		10.2.2	Deliver effective oral presentations to technical and non-technical audiences
10.3	Demonstrate the ability to integrate different modes of communication	10.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
		10.3.2	Use a variety of media effectively to convey a message in a document or a presentation
PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.			

11.1	Demonstrate an ability to evaluate the economic and financial performance of an engineering activity	11.1.1	Describe various economic and financial costs/benefits of an engineering activity
		11.1.2	Analyze different forms of financial statements to evaluate the financial status of an engineering project
11.2	Demonstrate an ability to compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.1	Analyze and select the most appropriate proposal based on economic and financial considerations.
	Demonstrate an ability to plan/manage an engineering activity within time and budget constraints	11.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
		11.3.2	Use project management tools to schedule an engineering project, so it is completed on time and on budget.
PO 12: Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.			
12.1	Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps	12.1.1	Describe the rationale for the requirement for continuing professional development
		12.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
12.2	Demonstrate an ability to identify changing trends in engineering knowledge and practice	12.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
		12.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.
12.3	Demonstrate an ability to identify and access sources for new information	12.3.1	Source and comprehend technical literature and other credible sources of information
		12.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.
PSO1:To investigate challenging problems across various domains with appropriate Biological techniques, construct solutions systematically and evaluate their effectiveness			
13.1	Demonstrate ability to investigate problems	13.1.1	Identify the biological problems in all the domains
		13.1.2	Formulate the Biological problems
13.2	Demonstrate ability to design solutions systematically and evaluate the effectiveness of solutions	13.2.1	Investigate alternative biological techniques and select the suitable one for problem solving
		13.2.2	Apply tools and validation methods to evaluate the solutions
PSO 2: Demonstrate the acquired professional and competitive skills for successful carrier, demonstrating the practice of Professional Ethics and the concerns for Social and Environmental impact technologies.			
14.1	Demonstrate ability to develop new innovative products	14.1.1	Conduct feasibility analysis and cost-effective methods
		14.1.2	Apply different innovative ideas in development of products
14.2	Demonstrate and create a new discovery in the different areas of research	14.2.1	Apply best practices to improve the quality of development in new discovery
		14.2.2	Develop new drug discovery, Environmental and industrial product discovery

INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM - CHENNAI
ACCREDITED BY NAAC WITH 'A' GRADE
Marching Beyond 30 Years Successfully

School of Engineering

Department of Bio-Engineering

Board of Members

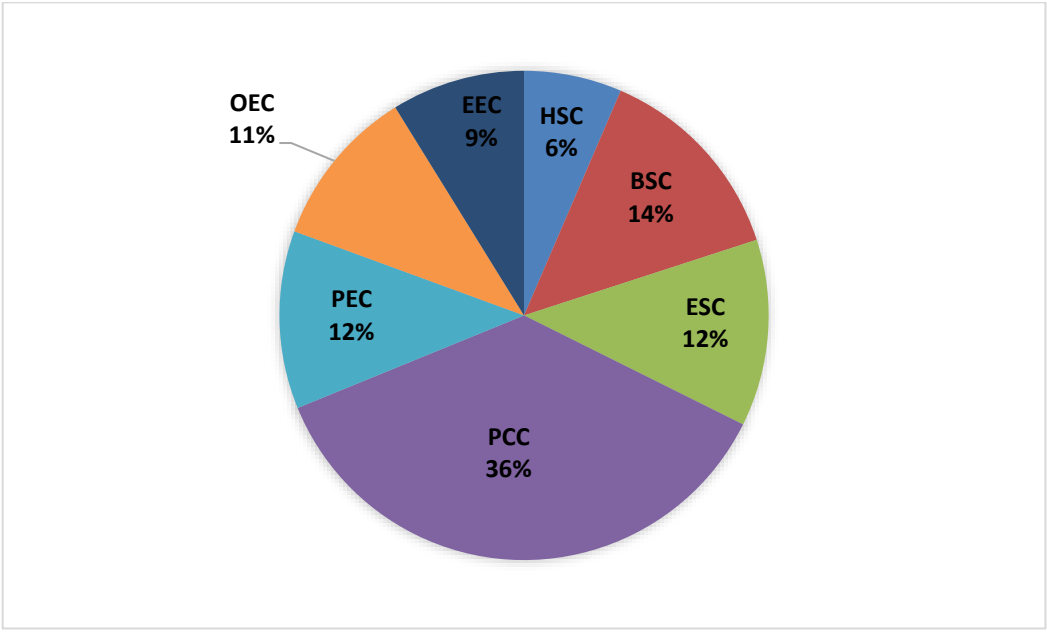
S. No	Name of the Board Member	Designation	Institute / Industry
Internal Members			
1	Dr.P.Brindha Devi	HOD & Chair person	Vels Institute of Science Technology and Advanced Studies, Chennai
2	Dr.P.Vivek	Assistant Professor	Vels Institute of Science Technology and Advanced Studies, Chennai
3	Mrs.R.Thiruchelvi	Assistant Professor	Vels Institute of Science Technology and Advanced Studies, Chennai
External Expert Members			
1.	Dr.Masilamani Selvam	Associate Professor	Sathyabama Institute of Science and Technology
2.	Dr. P. Arumugam	Managing Director	ArmatsBiotekPvt.Ltd, Guindy, Chennai
Student Members			
1.	Venkataragavan	Alumni	Doing his M.Tech Environmental Science and Engineering at Anna University
2.	Swetha	Alumni	Subject matter expert at Six red marbles, Chennai

Department of Bioengineering

Credit Distribution

S. No	Course Category	1	2	3	4	5	6	7	8	Total Credits
1	HSC	-	3	2	2	2	2	-	-	11
2	BSC	8	8	4	3	-	-	-	-	23
3	ESC	10	7	4	-	-	-	-	-	21
4	PCC	-	-	13	19	16	10	4	-	62
5	PEC	-	-	-	-	3	7	7	3	20
6	OEC	-	-	-	-	3	3	6	6	18
7	EEC	-	-	-	-	-	-	5	10	15
8	MC	-	-	-	-	-	-	-	-	0
	TOTAL	**18**	**18**	**23**	**24**	**24**	**22**	**22**	**19**	**170**

HSC	Humanities and Social Science Courses
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC	Professional Core Courses
PEC	Professional Elective Courses
OEC	Open Elective Courses
EEC	Employability Enhancement Courses
MC	Mandatory Courses



VELS INSTITUTE OF SCIENCE, TECHNOLOGY AND ADVANCED STUDIES (VISTAS)

B.TECH BIOTECHNOLOGY DEGREE COURSE

COURSES OF STUDY AND SCHEME OF ASSESSMENT

(MINIMUM CREDITS TO BE EARNED: 170)

Category	Course Title	Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER I								
BSC	Engineering Chemistry	3	-	-	3	40	60	100
BSC	Mathematics I	3	1	-	4	40	60	100
ESC	Programming for Problem Solving	3	-	-	3	40	60	100
ESC	Basics of Civil and Mechanical Engineering	3	-	-	3	40	60	100
ESC	Workshop and Manufacturing Practices	1	-	4	3	40	60	100
BSC	Engineering Chemistry Laboratory	-	-	2	1	40	60	100
ESC	Programming for Problem Solving Laboratory	-	-	2	1	40	60	100
MC	Student Induction Program	-	-	-	-	-	-	-
MC	Universal Human Values - 2	2	-	-	-	-	-	100
		15	**1**	**8**	**18**			
SEMESTER II								
HSC	English	2	-	-	2	40	60	100
BSC	Physics	3	-	-	3	40	60	100
BSC	Mathematics II	3	1	-	4	40	60	100
ESC	Basic Electrical and Electronics Engineering	3	-	-	3	40	60	100
ESC	Engineering Graphics and Design	1	-	4	3	40	60	100
HSC	English Laboratory	-	-	2	1	40	60	100
BSC	Physics Laboratory	-	-	2	1	40	60	100
ESC	Basic Electrical and Electronics Engineering Laboratory	-	-	2	1	40	60	100
MC	Constitution of India	**2**	**-**	**-**	**-**	-	-	100
		14	**1**	**10**	**18**			

Category	Course Title	Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER III								
BSC	Mathematics III	3	1	-	4	40	60	100
ESC	Chemical Reaction Engineering	3	1	-	4	40	60	100
PCC	Microbiology	3	1	-	4	40	60	100
PCC	Cell Biology	3	-	-	3	40	60	100
PCC	Biochemistry	3	-	2	4	40	60	100
PCC	Microbiology Laboratory	-	-	2	1	40	60	100
PCC	Cell Biology Laboratory	-	-	2	1	40	60	100
HSC	Personality Development I (Effective Technical Communication)	2	-	-	2	40	60	100
MC	Basic Life Skills	2	-	-	-	-	-	100
		19	**3**	**6**	**23**			
SEMESTER IV								
PCC	Bioprocess Engineering	3	1	-	4	40	60	100
PCC	Basic Industrial Biotechnology	3	-	-	3	40	60	100
PCC	Green Biotechnology and Pollution Abetment	3	-	-	3	40	60	100
PCC	Immunology and Immunotechnology	3	-	-	3	40	60	100
PCC	Bioinformatics and Computational Biology	3	-	2	4	40	60	100
PCC	Bioprocess Engineering Laboratory	-	-	2	1	40	60	100
PCC	Immunology and Immunotechnology Laboratory	-	-	2	1	40	60	100
HSC	Personality Development II	2	-	-	2	40	60	100
BSC	Environmental Science and Engineering	3	-	-	3	40	60	100
MC	Gender institution and society	2	-	-	-	-	-	100
		22	**1**	**6**	**24**			

Category	Course Title	Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER V								
PCC	Molecular Biology	3	1	-	4	40	60	100
PCC	Analytical Techniques	3	1	-	4	40	60	100
PEC	Professional Elective Course I	3	-	-	3	40	60	100
OEC	Open Elective Course I	3	-	-	3	40	60	100
PCC	Cheminformatics and Medicinal Chemistry	3	-	2	4	40	60	100
PCC	Analytical Techniques Laboratory	-	-	2	1	40	60	100
PCC	Molecular Biology	-	-	2	1	40	60	100
HSC	Personality Development III	2	-	-	2	40	60	100
PCC	Industrial Training/ Mini Project/ MOOC Course (NPTEL/SWAYAM/Course Era/Mathworks) - Minimum 4 weeks	-	-	4	2	-	-	100
	Industrial Visit	-	-	-	-	-	-	-
		17	**2**	**10**	**24**			
SEMESTER VI								
PCC	Bioseparation Engineering	3	-	-	3	40	60	100
PCC	rDNA technology and Genome Editing	3	1	-	3	40	60	100
PEC	Professional Elective Course II	3	-	-	3	40	60	100
PEC	Professional Elective Course III	3	-	2	4	40	60	100
OEC	Open Elective Course II	3	-	-	3	40	60	100
PCC	rDNA technology and Genome Editing Laboratory	-	-	2	1	40	60	100
PCC	Bioseparation Engineering Laboratory	-	-	2	1	40	60	100
HSC	Personality Development – IV	2	-	-	2	40	60	100
PCC	Summer Internship (4 weeks)	-	-	4	2	-	-	100
		17	**1**	**10**	**22**			

Category	Course Title	Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER VII								
PCC	Nanobiotechnology	3	-	-	3	40	60	100
OEC	Open Elective Course III	3	-	-	3	40	60	100
OEC	Open Elective Course IV	3	-	-	3	40	60	100
PEC	Professional Elective Course IV	3	-	-	3	40	60	100
PEC	Professional Elective Course V	3	-	2	4	40	60	100
PCC	Nanobiotechnology Laboratory	-	-	2	1	40	60	100
EEC	Project Phase I	-	-	10	5	40	60	100
		12	**0**	**14**	**22**			
SEMESTER VIII								
PEC	Professional Elective Course VI	3	-	-	3	40	60	100
OEC	Open Elective Course V	3	-	-	3	40	60	100
OEC	Open Elective Course VI	3	-	-	3	40	60	100
EEC	Project Phase II	-	-	20	10	40	60	100
		9	**0**	**20**	**19**			

List of Humanities and Social Sciences Courses

Code	List of Humanities and Social Sciences Courses	L	T	P	C
HSC 01	English	2	-	-	2
HSC 02	English Laboratory	-	-	2	1
HSC 03	Personality Development I	2	-	-	2
HSC 04	Personality Development II	2	-	-	2
HSC 05	Personality Development III	2	-	-	2
HSC 06	Personality Development IV	2	-	-	2

List of Basic Science Courses

Code	List of Basic Science Courses	L	T	P	C
BSC 01	Engineering Chemistry	3	-	-	3
BSC 02	Mathematics I	3	1	-	4
BSC 03	Engineering Chemistry Laboratory	-	-	2	1
BSC 04	Physics	3	-	-	3
BSC 05	Mathematics II	3	1	-	4
BSC 06	Physics Laboratory	-	-	2	1
BSC 07	Mathematics III	3	1	-	4
BSC 08	Environmental Science and Engineering	3	-	-	3

List of Engineering Science Courses

Code	List of Engineering Science Courses	L	T	P	C
ESC 01	Programming for Problem Solving	3	-	-	3
ESC 02	Basics of Civil and Mechanical Engineering	3	-	-	3
ESC 03	Workshop and Manufacturing Practices	1	-	4	3
ESC 04	Programming for Problem Solving Laboratory	-	-	2	1
ESC 05	Basic Electrical and Electronics Engineering	3	-	-	3
ESC 06	Engineering Graphics and Design	1	-	4	3
ESC 07	Basic Electrical and Electronics Engineering Laboratory	-	-	2	1
ESC 08	Chemical Reaction Engineering	3	1	-	4

List of Professional Core Courses

Code	List of Professional Core Courses	L	T	P	C
PCC 01	Microbiology	3	1	-	4
PCC 02	Cell Biology	3	-	-	3
PCC 03	Biochemistry	3	-	2	4
PCC 04	Microbiology Laboratory	-	-	2	1
PCC 05	Cell Biology Laboratory	-	-	2	1
PCC 06	Bioprocess Engineering	3	1	-	4
PCC 07	Basic Industrial Biotechnology	3	-	-	3
PCC 08	Green Biotechnology and Pollution Abetment	3	-	-	3
PCC 09	Immunology and Immunotechnology	3	-	-	3

PCC 10	Bioinformatics	3	-	2	4
PCC 11	Bioprocess Engineering Laboratory	-	-	2	1
PCC 12	Immunology and Immunotechnology Laboratory	-	-	2	1
PCC 13	Molecular Biology	3	1	-	4
PCC 14	Analytical Techniques	3	1	-	4
PCC 15	Cheminformatics and Medicinal Chemistry	3	-	2	4
PCC 16	Analytical Techniques Laboratory	-	-	2	1
PCC 17	Molecular Biology Laboratory	-	-	2	1
PCC 18	Summer Internship	-	-	4	2
PCC 19	Bioseparation Engineering	3	-	-	3
PCC 20	rDNA Technology and Genome Editing	3	1	-	3
PCC 21	rDNA Technology and Genome Editing Laboratory	-	-	2	1
PCC 22	Bioseparation Engineering Laboratory	-	-	2	1
PCC 23	Summer Internship (4 weeks)	-	-	4	2
PCC 24	Nanobiotechnology	3	-	-	3
PCC 25	Nanobiotechnology Laboratory	-	-	2	1

List of Professional Elective Courses

Code	List of Professional Elective Courses	L	T	P	C
PEC 01	Good Manufacturing and Laboratory Practice	3	-	-	3
PEC 02	Marine Biotechnology	3	-	-	3
PEC 03	Waste management and Upcycling	3	-	-	3
PEC 04	Creativity, innovation and new product development	3	-	-	3
PEC 05	Neurobiology and Cognitive Sciences	3	-	-	3
PEC 06	Aquaculture	3	-	-	3
PEC 07	Biosimilars Technology	3	-	-	3
PEC 08	Molecular Pathogenesis of Infectious Diseases	3	-	-	3
PEC 09	Lifestyle Diseases	3	-	-	3
PEC 10	Gene Expression and Transgenics	3	-	-	3
PEC 11	Bio business	3	-	-	3
PEC 12	Tissue Engineering	3	-	-	3
PEC 13	Cancer Biology and Informatics	3	-	-	3
PEC 14	Food Biotechnology	3	-	-	3
PEC 15	Developmental Biology and Regenerative Medicine	3	-	-	3
PEC 16	Biological Spectroscopy	3	-	-	3
PEC 17	Structural Biology	3	-	-	3
PEC 18	Biotechnology in Healthcare	3	-	-	3
PEC 19	Medical Microbiology	3	-	-	3
PEC 20	Precision medicine and Wellness	3	-	-	3
PEC 21	Industrial Enzymology	3	-	2	4
PEC 22	Biostatistics	3	-	2	4
PEC 23	Rational Drug Discovery	3	-	2	4
PEC 24	Bioorganic Chemistry	3	-	2	4
PEC 25	Animal and Plant Biotechnology	3	-	2	4

List of Open Elective Courses

Code	List of Open Electives	L	T	P	C
OEC 01	Biology for Engineers	3	-	-	3
OEC 02	Food and Nutrition Technology	3	-	-	3
OEC 03	Bioterrorism and National Security	3	-	-	3
OEC 04	Bioethics and Biosafety	3	-	-	3
OEC 05	Clinical Trials	3	-	-	3
OEC 06	Stem Cell Technology	3	-	-	3
OEC 07	Bioentrepreneurship	3	-	-	3

Project/Dissertations

Code	List of Mandatory Courses	L	T	P	C
EEC 01	Project Phase I	-	-	10	5
EEC 02	Project Phase II	-	-	20	10

List of Mandatory Courses

Code	List of Mandatory Courses	L	T	P	C
MC 01	Universal Human Values	2	-	-	-
MC 02	Constitution of India	2	-	-	-
MC 03	Basic Life Skills	2	-	-	-
MC 04	Gender institution and society	2	-	-	-

Syllabus

Semester I

Course Code	Course	L	T	P	C
BSC 01	Engineering Chemistry	3	0	0	3

Course Objectives:

1. To learn about the molecular orbitals, ionic interactions and periodic properties.
2. Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electro negativity.
3. List major chemical reactions that are used in the synthesis of molecules.

UNIT I Atomic and molecular structure, Intermolecular forces and potential energy surfaces 9hours

Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbitals of butadiene, benzene and aromaticity. Valence Bond Theory and the energy level diagrams for transition metal ions and their magnetic properties. Ionic, dipolar and van Der Waals interactions, potential energy surfaces of H_3, H_2F and HCN.

UNIT II Spectroscopic techniques and applications 9hours

Principles of spectroscopy and selection rules. Electronic spectroscopy. Vibrational, rotational spectroscopy of diatomic molecules, Morse equations and Mossbauer spectroscopy. Applications. Diffraction and scattering

UNIT III Use of free energy in chemical equilibria 9hours

Thermodynamic functions: energy, entropy, free energy and fugacity. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion.

UNIT IV Periodic properties 9hours

Variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, diagonal relationship, anomalous behaviour of Lithium, carbon and Nitrogen, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries

UNIT V Organic reactions and synthesis of a drug molecule 9hours

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

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane.

T2. Fundamentals of Molecular Spectroscopy, by C. N. Banwell.

T3. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.

REFERENCES

R1. Physical Chemistry, by P. W. Atkins.

R2. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition

R3. University chemistry, by B. H. Mahan

WEBLINKS

W1 https://onlinecourses.nptel.ac.in/noc23_cy42/preview

W2 https://onlinecourses.nptel.ac.in/noc23_cy59/preview

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Analyze microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.	**K2**
CO2	Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.	**K3**
CO3	Analyze bulk properties and processes using thermodynamic considerations.	**K4**
CO4	Classify the properties and reactivity of different types of elements based on the periodic table.	**K3**
CO5	Apply the basic terms involved in an Organic reactions and synthesis of a drug molecule.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓		✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓					

Course Code	Course	L	T	P	C
BSC 02	MATHEMATICS-I (FUNDAMENTALS OF MATHEMATICS)	3	1	0	4

Course Objectives:

1. To learn various concept in matrix and vector algebra.
2. To apply the fundamental concept of differentiation to find the derivatives and to solve differential equations with constant coefficients.
3. To apply the fundamental concept of integration to evaluate area and volume of the given surface.

UNIT I MATRICES 12 hours

Matrices - types of matrices - operations on matrices-determinants - adjoint matrix -inverse of a matrix -solution of a system of linear equations by matrix method–Cramer's rule-elementary transformations –rank of a matrix - consistency and inconsistency of system of equations.

UNIT II DIFFERENTIAL CALCULUS 12 hours

Limits and Continuity-Differentiation of functions of single variable –differentiation of implicit function – higher order derivatives –Radius of curvature (Cartesian coordinates)-maxima and minima for functions of a single variable.

UNIT III INTEGRAL CALCULUS 12 hours

Partial fractions - Integration- integration techniques- integration by parts- definite integrals -properties- evaluation of area and volume by integration

UNIT IV LINEAR ORDINARY DIFFERENTIAL EQUATIONS 12 hours

Differential equations-definition and examples- formation of differential equation- solving differential equations of first order-solving second order homogenous differential equations with constant coefficients.

UNIT V VECTOR ALGEBRA 12 hours

Vectors–operations on vectors-angle between two vectors-projection of one vector on another vector–equations of plane, straight line and sphere in vector forms-shortest distance between two skew lines- equation of a tangent plane to a sphere.

Total Lecture hours: 60 hours

TEXT BOOKS

T1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson, Reprint,2002.

T2. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11, Reprint,2010

T3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

REFERENCES

R1. P. Sivarama krishna Das and C. Vijayakumari, Mathematics-I, First Edition, Pearson India Education services Pvt. Ltd.

R2. VeerarajanT., Engineering Mathematics for first year, Tata McGraw-Hill, NewDelhi, 2008.

R3. D.Poole, Linear Algebra: A Modern Introduction,2nd Edition, Brooks/Cole, 2005.

R4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 36thEdition, 2010.

WEBLINKS

W1 https://onlinecourses.nptel.ac.in/noc23_ma88/preview

W2 https://onlinecourses.nptel.ac.in/noc23_ma90/preview

W3 https://onlinecourses.nptel.ac.in/noc23_ma74/preview

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Apply the concept of Matrix and solving simultaneous equations	**K3**
CO2	Understand the concept of limits, continuity and to evaluate derivatives	**K4**
CO3	Apply the concept of Integration to find the areas and volumes	**K3**
CO4	Evaluate linear ODE of second order with constant coefficients.	**K5**
CO5	Apply the concept of vector algebra to find the shortest distance between lines and tangent plane.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓		✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓				✓	

Course Code	Course	L	T	P	C
ESC 01	PROGGRAMMING FOR PROBLEM SOLVIN	3	0	0	3

Course Objectives

- To understand the basic concepts of programming – Flow chart, Pseudocode.
- To learn the fundamentals of C programming - declarations, operators, expressions and control statements.
- To learn the manipulation of strings, functions, pointers and file operations.
- To understand the concepts of arrays, basic sorting and searching algorithms.
- To find the order of time complexity of basic algorithms

UNIT I INTRODUCTION TO PROGRAMMING 9 hours

Introduction to Programming (Flow chart/pseudo code, compilation etc.), Variables (including data types), Input / Output - Arithmetic expressions and precedence, Conditional Branching and Loops -Writing and evaluation of conditionals and consequent branching - Iteration and loops

UNIT II ARRAYS AND BASIC ALGORITHMS 9 hours

Arrays (1-D, 2-D), Character arrays and Strings, Searching, Basic Sorting Algorithms, Finding roots of equations, Notion of order of time complexity through example programs

UNIT III FUNCTIONS AND POINTERS 9 hours

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference, Recursion with example programs such as Finding Factorial, Fibonacci series, etc. Pointers
- Defining pointers, Use of Pointers in self-referential structures

UNIT IV STRUCTURES AND UNIONS 9 hours

Structures - Defining structures and Array of Structures, Structures containing Pointers, Unions - Storage classes: auto, static, extern, register – Dynamic memory allocation

UNIT V STRING FUNCTIONS AND FILES 9 hours

Strings - library string functions, pointers in strings, pointers and function arguments, Files - file Operations, processing a file, Preprocessor directives, use of typedef, Command line arguments, Enumerated data types.

TOTAL : 45 hours

Text Books:

T1: E. Balaguruswamy, “Programming in ANSI C”, Tata McGraw-Hill
T2: Byron Gottfried, “Schaum's Outline of Programming with C”, McGraw-Hill

Reference Books:

R1: Brian W. Kernighan and Dennis M. Ritchie, “The C Programming Language”, PrenticeHall of India
R2: YashavantKanetkar, “Let Us C”, BPB Publications
R3: Ashok.N.Kamthane, “Computer Programming”, Pearson Education (India)

Web Links:

W1. https://onlinecourses.nptel.ac.in/noc23_cs121/preview

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Determine a pictorial representation with a stepwise procedure for solving complex problems	**K2**
CO2	Develop a high-level programming code using c languages.	**K3**
CO3	Evaluate the various functional operations for solving problem.	**K4**
CO4	Make use of various c operations like array, pointer, strings and searching method	**K3**
CO5	Develop a C module for a given set of instruction.	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT1	CAT2	ModelExam	End SemesterExams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/Presentation**
			✓	

Course Code	Course	L	T	P	C
ESC 02	BASICS OF CIVIL AND MECHANICAL ENGINEERING	3	0	0	3

Course Objectives:

1. To provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.
2. To help students acquire knowledge in the basics of surveying and the materials used for Construction.
3. To provide an insight to the essentials of components of a building and the infrastructure Facilities.
4. To explain the component of power plant units and detailed explanation to IC engines their Working principles.
5. To explain the Refrigeration & Air-conditioning system.

UNIT I PART A: OVERVIEW OF CIVIL ENGINEERING 5 hours

Civil Engineering contributions to the welfare of Society - Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering – National building code – terminologists: Plinth area, Carpet area, Floor area, Buildup area, Floor space index - Types of buildings: Residential buildings, Industrial buildings.

UNIT I PART B: OVERVIEW OF MECHANICAL ENGINEERING 4 hours

Overview of Mechanical Engineering - Mechanical Engineering Contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering – Manufacturing, Automation, Automobile and Energy Engineering - Interdisciplinary concepts in Mechanical Engineering.

UNIT II SURVEYING AND CIVIL ENGINEERING MATERIALS 9 hours

Surveying: Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours. Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel - Timber – Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, Water Proofing Materials. Modern uses of Gypsum, Pre-fabricated Building component (brief discussion only)

UNIT III BUILDING COMPONENTS AND INFRASTRUCTURE 9 hours

Building plans – Setting out of a Building - Foundations: Types of foundations - Bearing capacity and settlement – Brick masonry – Stone Masonry – Beams – Columns – Lintels – Roofing – Flooring – Plastering. Types of Bridges and Dams – Water Supply Network - Rain Water Harvesting – Solid Waste

Management - Introduction to Highways and Railways - Introduction to Green Buildings.

UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 9 hours

Classification of Power Plants- Working principle of steam, Gas, Diesel, Hydro -electric and Nuclear Power plants- Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines. Working principle of Boilers-Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps, Concept of hybrid engines. Industrial safety practices and protective devices

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 9 hours

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner. Properties of air - water mixture, concepts of psychometric and its process

Total Lecture hours: 45 hours

TEXT BOOKS

T1. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018

REFERENCES

R1. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018.
R2. Ramamrutham S., "Basic Civil Engineering", Dhanpat Rai Publishing Co.(P) Ltd, 2013.
R3. Seetharaman S., "Basic Civil Engineering", Anuradha Agencies, 2005.
R4. Shantha Kumar SRJ., "Basic Mechanical Engineering", Hi-tech Publications, Mayiladuthurai, 2000.

WEBLINKS

W1. https://nptel.ac.in/courses/105106201
W2. https://geekztrainerblog.wordpress.com/basic-civil-and-mechanical-engineering/

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Understanding profession of Civil and Mechanical engineering.	**K2**
CO2	Summarise the planning of building, infrastructure and working of Machineries.	**K2**
CO3	Apply the knowledge gained in respective discipline	**K3**
CO4	Illustrate the ideas of Civil and Mechanical Engineering applications.	**K2**
CO5	Appraise the material, Structures, machines and energy.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT1	CAT2	ModelExam	End SemesterExams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/Presentation**
✓		✓		✓

Course Code	Course	L	T	P	C
ESC 03	**WORKSHOP AND MANUFACTURING PRACTICES**	1	0	4	3

COURSE OBJECTIVES:

1. To study bench fitting drawings for making male and female fittings as per the given dimensions and Tolerances.
2. To study sheet metal development drawings for making common metal parts/components as per the given dimensions.

DETAILED CONTENTS:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 lectures)
2. CNC machining, Additive manufacturing (1 lecture)
3. Fitting operations & power tools (1 lecture)
4. Electrical &Electronics (1 lecture)
5. Carpentry (1 lecture)
6. Plastic moulding, glass cutting (1 lecture)
7. Metal casting (1 lecture)
8. Welding (arc welding & gas welding), brazing (1 lecture)

WORKSHOP PRACTICE:

1. Machine shop **9**

Machining: Basics of Machining Processes Equipment, Simple turning of cylindrical surface on MS rod using lathe machine tool, To make Facing and plain turning, step turning, drilling in the lathe

2. Fitting shop **9**

To make square, V joint in bench fitting as per the given dimensional tolerances, Tools and demonstration of producing model

3. Carpentry **9**

Basics of Carpentry operations, Equipments, To make half lap joint, dovetail, TEE Lap joint, Cross halving joint of two wooden pieces at perpendicular direction,

4. Welding shop **9**

To make single, butt, lap and T fillet joint by arc welding with the back hand and fore hand welding techniques as per the given dimensions. To make simple Dust pan, Rectangular trays in sheet metal with the jigs as per the given Dimensions.

5. Plumbing Works **9**

Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings. Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

TOTAL : 45 hours

TEXT BOOKS:

1. Jeyachandran K., Natarajan S. & Balasubramanian S., A Primer on Engineering Practices Laboratory, Anuradha Publications, 2007
2. Jeyapoovan T., Saravanapandian M. & Pranitha S., Engineering Practices Lab Manual, Vikas Publishing House Pvt.Ltd, 2006.

REFERENCE BOOKS

3. Bawa H.S., Workshop Practice, Tata McGraw, 2007. 4. Rajendra Prasad A. & Sarma P.M.M.S., Workshop Practice, Sree Sai Publication, 2002

WEBLINK:

W1. https://learnengineering.in/ge8261-engineering-practices-lab-manual/

COURSE OUTCOMES

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Experiment with facing, Turning and various types of fitting joint	**K1**
CO2	Develop the half lap joint, TEE Lap joint carpentry and welding.	**K5**
CO3	Practice casting, moulding, & smithy trades	**K2**
CO4	Developments of sheet metal jobs from GI sheets, knowledge of basic concepts of soldering	**K5**
CO5	Make a Basic pipe connections for Mixed pipe material connection and Pipe connections with different joining components	**K1**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT1	CAT2	Model Exam	End Semester Exams	Assignments
			✓	✓
Quiz	**MCQ**	**Case studies**	**Seminars**	**Demonstration/Presentation**
		✓		

Course code	Course	L	T	P	C
BSC 03	ENGINEERING CHEMISTY LABORATORY	0	0	2	1

Course Objectives:

- The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.
- The students will learn to:
    1. Estimate rate constants of reactions from concentration of reactants/products as a function of time.
    2. Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc
    3. Synthesize a small drug molecule.

LIST OF EXPERIMENTS

1. Determination of the rate constant of a reaction.
2. Determination of the partition coefficient of a substance between two immiscible liquids.
3. Determination of surface tension and viscosity.
4. Thin layer chromatography.
5. Determination of chloride content in water.
6. Determination of cell constant and conductance of solutions.
7. Synthesis of a polymer/drug.
8. Determination of saponification / acid value of an oil.
9. Determination of redox potentials and emf by Potentiometric method.
10. Estimate the adsorption of acetic acid by charcoal.

Total Practical hours: 30 hours

REFERENCES

R1. S. Sundaram and K. Raghavan "Practical Chemistry", S. Viswanathan. Co. 3rd edition 2011.

R2. Gnanaprakasam, Ramamurthy, "Organic Chemistry Lab Manual" S. Viswanathan Pvt. Ltd. 3rd edition 2011

R3. Vogel's – "Textbook of qualitative organic Analysis", Longmann, 12th edition, 2011

R4. J. N. Gurtu and R. Kapoor "Advanced experimental Chemistry", S. Chand and Co. 6th edition, 2010.

WEBLINKS

W1. www.khanacademy.org/science/ap-chemistry-beta/x2eef969c74e0d802:kinetics/x2eef969c74e0d802:introduction-to-rate-law/v/experimental-determination-of-rate-laws

W2. https://www.youtube.com/watch?v=qdmKGskCyh8

W3. https://www.youtube.com/watch?v=7_6_dKlo67k

COURSE OUTCOMES

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Estimate the rate constants of reactions and partition coefficient of immiscible liquids.	**K1**
CO2	Find the viscosity and to test the purity of the compound.	**K5**
CO3	Estimate the amount of chlorine content present in drinking water and to know the conductance of a solution.	**K2**
CO4	Develop a small drug molecule and to know the saponification of an oil.	**K5**
CO5	Find out the unknown element by Potentiometric method and to remove some of the toxic chemical by charcoal method.	**K1**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	0	1	1	3	1	0	0	0	0	0	0	0	0	0
CO2	0	1	1	2	1	0	0	0	0	0	0	0	0	0
CO3	0	1	2	3	2	3	3	0	0	0	2	0	1	2
CO4	0	1	2	3	3	3	3	0	0	0	2	0	1	3
CO5	0	1	1	2	3	2	1	0	0	0	0	0	1	2

ASSESSMENT METHODS

CAT1	CAT2	Model Exam	End Semester Exams	Observation
		✓	✓	✓
Quiz	**Record**	**Viva**	**Seminars**	**Demonstration/Presentation**
	✓	✓		✓

Course Code	Course	L	T	P	C
ESC 04	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	0	0	2	1

Course Objectives:

To design and develop C Programs for various applications.

List of Experiments:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems
5. 1D Array manipulation
6. Matrix problems
7. String operations
8. Simple functions
9. Solving Numerical methods problems
10. Recursive functions
11. Pointers and structures
12. File operations

Total Practical hours: **30 hours**

Text Books:

T1: E. Balaguruswamy, “Programming in ANSI C”, Tata McGraw-Hill

T2: Byron Gottfried, “Schaum's Outline of Programming with C”, McGraw-Hill

Reference Books:

R1: Brian W. Kernighan and Dennis M. Ritchie, “The C Programming Language”, PrenticeHall of India

R2: Yashavant Kanetkar, “Let Us C”, BPB Publications

R3: Ashok.N.Kamthane, “Computer Programming”, Pearson Education (India)

Web Links:

W1. https://www.edx.org/course/c-programming-getting-started

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Determine the advanced features of the C language	**K5**
CO2	Develop the model data using primitive and structured types.	**K5**
CO3	Construct programs that demonstrate effective use of C features including arrays, structures, pointers and files.	**K4**
CO4	Develops the ability to analyze a problem, develop an algorithm to solve it.	**K5**
CO5	Develops the use of the C programming language to implement various algorithms, and develops the basic concepts and terminology of programming in general.	**K6**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Observation**	**Case Studies**
		✓	✓	✓	
Record	**MCQ**	**Projects**	**Viva**	**Demonstration/ Presentation**	**Open book test**
✓			✓	✓	

Syllabus

Semester II

Course Code	Course	L	T	P	C
BSC 04	PHYSICS (OSCILLATIONS, WAVES AND OPTICS)	3	0	0	3

Course Objectives:

- To learn the basic ideas of oscillations, waves-optics, and lasers.
- To apply these fundamental principles to solve practical problems involving optical systems used in engineering applications.

UNIT I Oscillations 9hours

Harmonic oscillator – Differential equation and solution of simple harmonic oscillator – Simple pendulum – damped harmonic oscillator: Equation of motion and its solution, qualitative description of heavy, critical and light damping - Differential equation for forced harmonic oscillator – Forced oscillations.

UNIT II Non-dispersive transverse and longitudinal waves 9hours

Waves, travelling waves - Characteristics of a waves - Longitudinal and transverse waves- Acoustics, waves and speed of sound- Characteristics of musical sound, quality of tone, decibel- Noise pollution- Acoustics of buildings - Reverberation - Reverberation time – Sabine's formula for reverberation time (derivation).

UNIT III Geometric optics 9hours

Fermat's principle of stationary time - Fresnel equations, reflectance and transmittance - Brewster's angle - Total internal reflection – Dispersion - Dispersive power of prism - Defect of lenses - spherical aberration in lens - coma- Achromatic lenses.

UNIT IV Wave optics 9hours

Huygens' Principle - Superposition of waves - Young's double slit experiment- Newton's rings- Michelson interferometer - Mach Zehnder interferometer - Fraunhofer diffraction from a single slit and a circular aperture - Plane diffraction grating - Dispersion power and resolving power of grating

UNIT V Lasers 9hours

Introduction - Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles - Einstein's theory of matter radiation interaction and A and B coefficients - Population inversion - Different types of lasers: gas lasers (He-Ne, CO_2), solid-state lasers (ruby, Neodymium), dye lasers - Applications of lasers in science, engineering and medicine.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Mechanics, D. S. Mathur and P. S. Hemne, S. Chand & Co. Pvt Ltd., New Delhi

T2. A text book of waves and oscillations, Brij Lal and N. Subrahmanyam, Vikas Publishing

T3. A text book of optics, M. N. Avadhanulu, Brij Lal and N. Subrahmanyam, S. Chand & Co. Pvt .Ltd. New Delhi

REFERENCES

R1. I A. Ghatak, "Optics", McGraw Hill Education, 2012.

R2. H. J. Pain, The physics of vibrations and waves, Wiley, 2006.

R3. E. Hecht, "Optics", Pearson Education, 2008.

R4. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.

WEBLINKS

W1 https://nptel.ac.in/courses/115102124

W2 https://nptel.ac.in/courses/122106034

COURSE OUTCOMES

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

CO1: Analyze the basic concepts of simple harmonic oscillator.
CO2: Identify the remedies for acoustic of building.
CO3: Analyze the different types of aberration in lens.
CO4: Distinguish between Fresnel and Fraunhofer diffraction.
CO5: Classify the different types of lasers and their applications.

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	1	2	1	0	0	0	0	0	0	0	1	1
CO2	1	1	1	1	1	3	1	0	0	0	0	0	1	2
CO3	1	1	1	2	1	2	0	0	0	0	0	0	1	2
CO4	1	1	1	1	0	0	0	0	0	0	0	0	1	1
CO5	1	1	2	2	3	2	3	0	0	0	0	0	2	2
Average	1	1	1.2	1.6	1.2	1.4	0.8	0	0	0	0	0	1.2	1.6

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**
•	•	•	•	•
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration / Presentation**
			•	•

Course Code	Course	L	T	P	C
BSC 05	MATHEMATICS-II (CALCULUS AND VECTOR ALGEBRA)	3	1	0	4

Course Objectives:

1. To learn various concepts in matrices and vectors.
2. To apply the idea of differentiation to find the derivatives and to solve various types of equations.
3. To apply the idea of Integration to solve double and triple integration.

UNIT I MATRICES 12 hours

Introduction on Symmetric, skew-symmetric and orthogonal matrices- Determinants- Eigen values and eigenvectors- Cayley-Hamilton Theorem -Diagonalization of matrices and Orthogonal transformation.

UNIT II Multivariable Calculus (Differentiation) 12 hours

Introduction to partial derivatives-Total derivatives-Maxima and minima - saddle points- Method of Lagrange multipliers-Taylor's series and Maclaurin's series.

UNIT III Multivariable Calculus (Integration) 12 hours

Multiple Integration: Double integrals (Cartesian)- change the order of integration in double integrals- Triple integrals (Cartesian) -Applications: areas and volumes.

UNIT IV Ordinary differential equations of higher orders 12 hours

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

UNIT V Vector Differentiation and Integration 12 hours

Introduction-Scalar point functions-Vector point functions-Vector differential operator ∇, Gradient-Divergence-Curl-Solenoidal- Irrotational-identities- Simple problems-line integrals-Theorems of Green, Gauss and Stokes (Statement only)-Simple problems.

Total Lecture hours: 60 hours

TEXT BOOKS

T1. G.B.Thomas and R.L.Finney, Calculus and Analytic geometry,Ninth Edition ,Pearson ,Reprint,2002.

T2. Ramana B.V., Higher Engineering Mathematics,TataMcGrawHillNew Delhi, 11,Reprint,2010

T3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

REFERENCES

R1. P. Sivaramakrishna Das and C. Vijayakumari, Mathematics-I, First Edition, Pearson India Education services Pvt. Ltd.

R2. VeerarajanT., Engineering Mathematics for firstyear, TataMcGraw-Hill, NewDelhi,2008.

R3. D.Poole, Linear Algebra: A Modern Introduction,2nd Edition, Brooks/Cole,2005.

R4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers,36thEdition,2010.

WEBLINKS

W1 https://nptel.ac.in/courses/111107112

W2 https://nptel.ac.in/courses/111105121

W3 https://nptel.ac.in/courses/111108081

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Identify and discuss the applications of matrices and utilizes.	**K3**
CO2	Analyse the concept of differential calculus and to evaluate the curvatures.	**K4**
CO3	Apply the concept of Integral calculus and to evaluate the area of region.	**K3**
CO4	Evaluate linear ODE of second order with variable coefficients.	**K5**
CO5	Identify the key terminology, concept tools and techniques used in Vector Differentiation to solve various problems.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	-	-	-	-	-	-	1	-	1
CO2	3	3	1	2	2	-	-	-	-	-	-	1	-	2
CO3	2	2	1	2	0	-	-	-	-	-	-	1	-	1
CO4	3	1	1	1	1	-	-	-	-	-	-	1	-	-
CO5	2	1	1	1	1	-	-	-	-	-	-	1	-	-

ASSESSMENT METHODS

CAT1	**CAT2**	**ModelExam**	**EndSemesterExams**	**Assignments**
		✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration /Presentation**
			✓	✓

Course Code	Course	L	T	P	C
ESC 05	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	3	0	0	3

Course Objectives:

1. To obtain basic knowledge on electrical quantities such as current, voltage, power and energy.
2. To provide employability skill of adequate working knowledge on basic DC and AC circuits used in electrical and electronic devices. To understand the working principle, construction, applications of DC machines, AC machines & measuring instruments.

UNIT I DC Circuits 12 hours

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, Mesh and Nodal analysis, Analysis of simple circuits with dc excitation, Wye↔Delta Transformation, Superposition, Thevenin and Norton Theorems.

UNIT II AC Circuits 12 hours

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT III Transformers 12 hours

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

UNIT IV Electrical Machines & Power Converters 12 hours

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Construction of Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. DC-DC buck and boost converters, duty ratio control. Single phase Bridge Rectifier, Single Phase voltage source inverters.

UNIT V Basics of Electronics 12 hours

Intrinsic semiconductors, Extrinsic semiconductors – P-type and N-type, P-N junction, VI Characteristics of PN junction diode, Zener effect, Zener diode, Zener diode Characteristics. Binary Number System — Boolean Algebra theorems– Logic gates- Introduction to sequential Circuits– Flip-Flops.

Total Lecture hours: 60 hours

TEXT BOOKS

T1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.

T2. D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.

T3. John Bird, “Electrical Circuit theory and technology”, Routledge; 5th edition,2013

REFERENCES

R1. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.

R2. 4. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.

R3. 5. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989 Text book 1

WEBLINKS

W1 https://www.electricaltechnology.org/category/basic-electrical-fundamentals

W2 https://www.electrical4u.com/electrical-engineering-articles/basic-electrical/

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Understand and analyse DC circuits	**K2**
CO2	Understand and analyse AC circuits	**K2**
CO3	Explain the construction, operation and characteristics of transformer and classify the types of three – phase transformer connections.	**K3**
CO4	Understand and examine the various electrical machines and converter circuits	**K2**
CO5	Identify the basics of electronics	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓	✓	

Course Code ESC 06	ENGINEERING GRAPHICS & DESIGN	1	-	4	3

Course Objectives

- To familiarize the students in basic concept of conic sections, projections and developments of objects.
- To develop the imagination and drafting skills of studentsand pictorial projections.

UNIT I DIMENSIONING AND GEOMETRICAL CONSTRUCTION 12 hours

BIS - Lettering - Two systems of dimensioning, Conics – Construction of ellipse, Parabola and hyperbola by eccentricity method – Construction of cycloid, Epicycloid, Hypocycloid – construction of involutes of squad and circle – Drawing of tangents and normal to the above curves.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 12 hours

Orthographic projection- Principles-Principal Planes-First angle projection-projection of points.Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of truelengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 12 hours

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method

UNIT IV SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES 12 hours

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones

UNIT V ORTHOGRAPHIC PROJECTION AND ISOMETRIC PROJECTION 12 hours

General principles of orthographic projection – Need for importance of multiple views and their placement - layout views – Developing visualization skills through free hand sketching of multiple views from pictorial views of objects. Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones.

TOTAL : 60 hours

Text Books:

T1. Bhatt N.D. and Panchal V.M., ―Engineering Drawing, Charotar Publishing House, 50th Edition, 2010.

T2. Parthasarathy N.S. and Vela Murali, ―Engineering Drawing, Oxford University Press, New Delhi, 1 stEdition,2015

Reference Books:

1. Natarajan K.V., ―A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 31st Edition,2018.
2. Basant Agrawal and Agrawal C.M., ―Engineering Drawing, Tata McGraw Hill Publishing Company Limited, New Delhi, 2nd Edition, 2013.

Web Links:

1. https://nptel.ac.in/courses/112103019
2. https://alison.com/course/diploma-in-engineering-drawing-and-computer-graphics

COURSE OUTCOMES

CO1:	Sketch the drawing standards, conventions and practices in engineering drawing	**K1**
CO2:	Draw the orthographic projections of points, straight lines and plane surfaces for solving some of the engineering problems in day-to-day applications.	**K1**
CO3:	Sketch the orthographic projections for the points, straight lines or solids using the change of position method.	**K1**
CO4:	Draw projections of sectioned solids and development of lateral surfaces and apply the concept to simple sheet metal work.	**K6**
CO5:	Draw the isometric projections for the given solids and combination of solids using box method and create 3D models	**K6**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	2	0	2	0	0	0	0	3	0	2	2	1
CO2	2	3	2	0	2	0	0	0	0	3	0	3	2	3
CO3	2	2	2	0	2	0	0	0	0	3	0	2	2	2
CO4	2	2	2	0	2	0	0	0	0	3	0	2	2	2
CO5	2	2	2	0	2	0	0	0	0	3	0	3	2	2
	2	2	2	0	2	0	0	0	0	3	0	2.4	2	2

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓		✓		✓	

Course code	Course	L	T	P	C
BSC 06	PHYSICS LABORATORY	0	0	2	1

Course Objectives:

1. To enable the student to explore the field of Properties of Matter and Optics.
2. To gain knowledge in the scientific methods and learn the process of measuring different Physical variables.

LIST OF EXPERIMENTS

1. Determination of Rigidity Modulus – Torsional pendulum
2. Determination of wavelength and particle size using laser
3. Ultrasonic Interferometer
4. Determination of band gap of a semiconductor material
5. Hooke's law – Determination of spring constant
6. Determination of Young's Modulus – Uniform Bending
7. Determination of Young's Modulus – Non Uniform Bending
8. Determination of Viscosity of a liquid - Poiseuille's method
9. Spectrometer – Grating
10. Deflection Magnetometer - Tan A position
11. Deflection Magnetometer - Tan B position
12. Potentiometer - Calibration of low range Voltmeter

TEXT BOOK:

T1. M N Avadhanulu, "A Text book of Enginnering Physics" S. Chand Publications, 2008

REFERENCES:

R1. 1. C. C. Ouseph, U. J. Rao, V. Vjiayendran, Practical Physics,1st Edition, 2015.

R2. Biswajit Saha, Practical Physics Book, LAP LAMBERT Academic Publishing, 1st Edition, 2020

R3. G.L. Squires, Practical Physics, 4th Edition, Cambridge University Press, 2001.

R4. D. Chattopadhyay, P.C. Rakshit, B. Saha, "An Advanced Course in Practical Physics", 2nd ed., Books & Allied Ltd., Calcutta, 1990.

WEBLINKS

W1. http://amrita.olabs.edu.in/?sub=1&brch=5&sim=155&cnt=2

W2. https://vlab.amrita.edu/index.php?sub=1&brch=280&sim=1509&cnt=4

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Measure the wavelength and particle size of semiconductor diode laser.	**K5**
CO2	Analyze the wavelength of spectral lines using spectrometer	**K4**
CO3	Estimate the band gap energy of given semi conductor material.	**K5**
CO4	Determine the compressibility of the liquid using ultrasonic interferometer.	**K4**
CO5	Measure the Young's modulus of the given solid materials.	**K5**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT1	CAT2	Model Exam	End Semester Exams	Observation
		✓	✓	✓
Record	**MCQ**	**Projects**	**Viva**	**Demonstration/Presentation**
			✓	✓

Course Code	Course	L	T	P	C
ESC 07	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY	0	0	2	1

COURSE OBJECTIVES:

- To provide comprehensive idea about AC and D C circuit analysis, working principles and applications of basic machines in electrical engineering.
- To expose the students to learn experimental skills about Transformers,DC Motor, Converters.

LIST OF EXPERIMENTS

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter,ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification.
3. Loading of a transformer: measurement of primary and secondary voltages and currents, and power
4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line- line voltage, phase-to-neutral voltage, line and phase currents).
5. Load Characteristics of a DC Motor
6. Torque - Slip Characteristic of an Induction motor
7. Three phase induction motors – Direction reversal by change of phase-sequence of connections.
8. Demonstration of DC-DC Converter.
9. Demonstration of DC-AC converter.
10. Demonstration of AC-DC converter.

TOTAL: 30 hours

Text Books:

T1: 1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
T2: 2. D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.
T3: John Bird, “Electrical Circuit theory and technology”, Routledge; 5th edition,2013

Reference Books:

R1: 1. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
R2: 2. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
R3: Basic Industrial Biotechnology V. D. Toro, “Electrical Engineering Fundamentals”, Prentice all India, 1989.

Web Links:

1. https://www.electricaltechnology.org/category/basic-electrical-fundamentals
2. https://www.electrical4u.com/electrical-engineering-articles/basic-electrical/

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Understand the basic safety precautions and learn to make use of measuring instruments	**K2**
CO2	Analyse the steady state response of R-L, R-C circuits	**K3**
CO3	Experiment with loading of transformer to measure the primary and secondary voltages, currents and power and classify the different types of transformer connections	**K3**
CO4	Understand and Experiment with single phase induction motor and three phase induction motor	**K2**
CO5	Demonstrate DC-DC, DC-AC and AC-DC converters	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Observation**	**Case Studies**
		✓	✓	✓	
Record	**MCQ**	**Projects**	**Viva**	**Demonstration/ Presentation**	**Open book test**
✓			✓	✓	

Syllabus

Semester III

Course Code	Course	L	T	P	C
BSC 07	MATHEMATICS-III (NUMERICAL METHODS)	3	1	0	4

Course Objectives:

1. Using appropriate numerical methods, determine approximate solutions to ordinary differential equations.
2. Analyze the errors obtained in the numerical solution of problems.

UNIT I Solution of Equations 14 hours

Solution of algebraic and transcendental equations – Newton Raphson method –Regula falsi Method – Solution of linear system of equations- Gauss elimination method – Gauss-Jordon method–Gauss Seidel Method–Gauss Jacobi Method –Matrix Inversion by Gauss Jordon method.

UNIT II Interpolation and Approximation 10 hours

Interpolation with unequal intervals – Lagrange's interpolation –Inverse Lagrange's interpolation–Newton's divided difference interpolation– Interpolation with equal intervals– Newton's forward and backward difference formulae.

UNIT III Numerical Differentiation and Integration 12 hours

Numerical Differentiation: Approximation of derivatives using interpolation polynomials – Numerical integration: Trapezoidal– Simpson's 1/3 and 3/8 rule – Romberg's method – Double integral of Trapezoidal –Simpson's Rule.

UNIT IV Initial Value Problems for Ordinary Differential Equations 12 hours

Single step methods: Taylor series method – Euler's method–Modified Euler's method– Second order Runge – Kuttamethod and Fourth order Runge – Kutta method for solving first order equations

UNIT V Boundary Value Problems in Ordinary and Partial Differential Equations 12 hours

Finite difference methods for solving two-point linear boundary value problems – Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain.

Total Lecture hours: 60 hours

TEXT BOOKS

T1. Grewal, B.S. and Grewal,J.S., " Numerical methods in Engineering and Science",9th Edition, Khanna Publishers, New Delhi, 2012

T2. Gerald, C. F. and Wheatley, P.O., "Applied Numerical Analysis", 6th Edition, Pearson Education, Asia, New Delhi, 2006.

T3. Siva RamakrishnaDas.P and Vijayakumari.C, Numerical Analysis, 2014, Pearson EducationLimited in South Asia

REFERENCES

R1. Chapra, S. C and Canale, R. P., "Numerical Methods for Engineers",Tata McGraw-Hill, New Delhi, 5th Edition, 2007.

R2. Sankara Rao K, "Numerical Methods for Scientists and Engineers", Prentice Hall of India, New Delhi, 3rd Edition,2007.

WEBLINKS

W1 https://nptel.ac.in/courses/122102009

W2 https://onlinecourses-archive.nptel.ac.in/noc18_ma11/preview

W3 https://bit.ly/3O5aYl3

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Apply numerical methods to obtain approximate solutions to mathematical problems.	**K3**
CO2	Demonstrate numerical methods for various mathematical interpolation problems.	**K2**
CO3	Evaluate differentiation and integration solutions using numerical methods.	**K5**
CO4	Determine the initial value problem for Ordinary differential Equations.	**K5**
CO5	Summarize the boundary value problem for Ordinary differential equations and Partial	**K2**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
ESC 08	CHEMICAL REACTION ENGINEERING	3	1	0	4

Course Objectives:

1. To impart the knowledge of reaction rate theories and reaction mechanisms to derive expressions for rate equations mass and energy balances.
2. To provide a core foundation for the analysis and design of chemical reactors.

UNIT I SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING 12 hours

Broad outline of chemical reactors; rate equations; concentration and temperature dependence; integral methods of analysis – irreversible reaction – Zero order, first order and second order; Differential method; Industrial scale reactors.

UNIT II IDEAL REACTORS 12 hours

Ideal reactors and Case studies; Performance equation for Batch reactor, Performance equation for continuous stirred tank reactor, Performance equation for plug flow reactor.

UNIT III IDEAL FLOW AND NONIDEAL FLOW 12 hours

Residence Time Distribution in non-ideal flow – Step input method, pulse input method; state of aggregation of fluid, earliness and lateness of fluid mixing in the vessel.

UNIT IV GAS-SOLID, GAS-LIQUID REACTIONS 12 hours

Resistances and rate equations; Models for non-catalytic reactions, Diffusion through gas film control, diffusion through ash layer control and diffusion through chemical reaction control.

UNIT V FIXED BED AND FLUID BED REACTORS 12 hours

Trickle bed reactors, slurry reactors; fluidized bed reactor; continuous stirred tank reactors; tank reactors – Principle, flow diagram and its applications

Total Lecture hours: 60 hours

TEXT BOOKS

T1. Levenspiel O. “Chemical Reaction Engineering”, 3rd Edition. John Wiley.1999.

T2. Fogler H.S. “Elements Of Chemical Reaction Engineering”, Prentice Hall India.2008

T3. K.A.Gavhane. “Chemical Reaction Engineering – I & II”, NiraliPrakashan, 2019, 2014.

REFERENCES

R1. Missen R.W., Mims C.A., Saville B.A. “Introduction To Chemical Reaction Engineering And Kinetics”, John Wiley.1999.

WEBLINK

W1 https://archive.nptel.ac.in/courses/103/103/103103153/

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Interpret an experimental investigation in order to determine rate equations	**K2**
CO2	Solve material and energy balance to analyze the performance of a reactor	**K3**
CO3	Develop the flow pattern using different methods	**K3**
CO4	Identify the rate equations of heterogeneous reactions	**K3**
CO5	Construct the reactors to optimize the operating conditions	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓	✓	

Course Code	Course	L	T	P	C
PCC 01	MICROBIOLOGY	3	1	0	4

Course Objectives:

1. To introduce students to know the importance of Microbiology to emphasize structure and biochemical aspects of various microbes.
2. To help the students to know the application of microbes in industry.

UNIT I Introduction 9hours

Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

UNIT II Microbes Structure and Multiplication 9hours

Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.

UNIT III Microbial Nutrition, Growth & Metabolism 9hours

Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

UNIT IV Control of Microorganisms 9hours

Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.

UNIT V Industrial and Environmental Microbiology 9hours

Primary metabolites; secondary metabolites and their applications; preservation of food; production ofpenicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India. 2019

T2. Cruger, Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing, 2010.

T3. Ananthanarayan, R and Paniker C.K.J.2000. A text book of microbiology. 6th edition. Orient Longman Ltd 2016

REFERENCES

R1. Prescott L.M. HarleyJ.P. Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2016.

R2. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 2019.

WEBLINKS

W1 General Microbiology - Course (swayam2.ac.in)

W2 Learn Microbiology with Online Courses, Classes, & Lessons | edX

W3 https://nptel.ac.in/courses/102103015

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	outline the classification and identification of micro-organism	**K2**
CO2	Show structural organization and multiplication of microorganism	**K1**
CO3	Explain in detail about the microbial nutrition requirements and their metabolism	**K2**
CO4	Summarize the different control methods of microorganism	**K2**
CO5	Apply the knowledge of microorganism for the production of primary and secondary metabolites	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	PO2	PO 3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	P O 10	PO11	PO 12	PS O1	PSO2
CO1	-	1	1	2	-	-	-	-	1	-	-	-	3	3
CO2	-	1	2	3	2	-	-	-	-	-	-	-	3	3
CO3	-	1	1	2	-	-	-	-	1	-	-	-	3	2
CO4	-	1	1	2	-	-	-	-	1	-	-	-	3	2
CO5	-	1	1	2	-	-	-	-	1	-	-	-	3	2

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓					
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓					

Course code	Course	L	T	P	C
PCC 02	CELL BIOLOGY	3	0	0	3

Course Objectives:

1. To provide knowledge on the fundamentals of cell biology
2. To help students understand the signalling mechanisms

UNIT I Cell Structure and Function of the Organelles 9 hours

Eukaryotic, Prokaryotic cells, Subcellular Organelles and Functions Principles of membrane organization membrane proteins, cytoskeletal proteins eg. RBC cytoskeletal contractile proteins Actin, myosin, Actin Polymerization Act- myosin complex, mechanism of myosin- ATpase activity, contraction; microtubules, microfilaments activity in Organelle movement.

UNIT II Cell Division and Connection 9 hours

Cell cycle – Mitosis, Meiosis, Molecules controlling cell cycle, Extra cellular matrix, role of matrix in cell enthore: Gap junctions, Tight junctions, Desmosomes, Hemidesmosomes.

UNIT III Transport across Cell Membrane 9 hours

Passive and Active Transport, Permeases, Ion channels, ATP pumps. Na+ / K+ / Ca+2T pumps uniport, symport antiporter system. Ligand gated / voltage gated channels, Agonists and Antagonists.

UNIT IV Signal Transduction 9 hours

Receptors – extracellular signalling, Cell surface / cytosolic receptors and examples, Different classes of receptors autocrine / paracrine / endocrine models, Secondary messengers' molecules.

UNIT V Techniques Used to Study Cells 9 hours

Cell fractionation and flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy. Localization of proteins in cells – Immunostaining.

Total Lecture hours: 45 hours

TEXT BOOKS

T1 Lodish, Harvey etal., "Molecular Cell Biology," 6th Edition. W.H.Freeman, 2008

T2 Alberts, Bruce etal., "Essential Cell Biology", 2nd Edition, Garland Science, 2004

REFERENCES

R1 Alberts, Bruce, "Molecular Biology of Cell", 5th Edition, Garland Science, 2008.

R2 Cooper,G.M. "The Cell: A Molecular Approach, 4th Edition, ASM Press, 2007.

WEBLINK

W1 https://nptel.ac.in/courses/102103012

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Infer the fundamentals of cell and its organelles based on its structure and function	**K2**
CO2	Summarize the molecular mechanism behind the muscle contraction and relaxation	**K2**
CO3	Summarize the knowledge in cell cycle and its regulation at molecular level	**K2**
CO4	Describe the extracellular signalling and different classes of receptors.	**K2**
CO5	Illustrate the concept of cell-to-cell communication at molecular level.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO1	PSO 2
CO1	2	1	1	1	-	-	-	1	-	-	-	-	1	3
CO2	2	1	1	2	1	-	-	2	-	-	-	-	3	3
CO3	2	1	2	2	1	-	-	3	-	-	-	-	3	3
CO4	3	2	2	2	1	-	-	1	-	-	-	-	3	3
CO5	2	1	2	1	-	-	-	1	-	-	-	-	3	1

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course code	Course	L	T	P	C
PCC 03	BIOCHEMISTRY	3	0	2	4

Course Objectives

- It is intended to impart basic undergraduate level knowledge in the area of general Biochemistry.
- Students would be able to understand the biochemical basis of cellular functions and organism physiology.
- They would also be able to assimilate recent research findings, advancement and development in the relevant subject.

UNIT I Introduction to Buffers 9 hours

Introduction to biological buffers and its importance in biochemistry, pH, water, basics of amino acids, pK and pI values of amino acids, pK values of the ionizable groups of proteins, Preparation of different types of buffers and its applications.

UNIT II Structure and Properties of Biomolecules-Carbohydrates and Lipids 9 hours

Carbohydrates –classification, properties. starch, glycogen, dextrin, inulin, cellulose, Lipids – Classification, properties. sterols, essential fatty acids, eicosanoids, phospholipids, sphingolipids

UNIT III Structure and Properties of Biomolecules-Proteins and Nucleic acid 9 hours

Proteins and amino acids – Classification, properties, biosynthesis of amino acids and proteins, essential amino acids, Nucleic acids –genetic code, nucleic acids, and structure of DNA and RNA

UNIT IV Metabolism and Bioenergetics 10 hours

Introduction to metabolism- metabolism of carbohydrates – gluconeogenesis, glycolysis. citric acid cycle and its biological significance, pentose phosphate pathway, Lipids- metabolism of lipids, oxidation of fatty acids, α,β - oxidation and biosynthesis of ketone bodies, cholesterol biosynthesis, metabolism of bile pigments.

Proteins and amino acids- metabolism of amino acids and proteins, Nitrogen balance.

Bioenergetics- High energy compounds, electronegative potential of compounds, Electron transport chain, ATP cycle, Calculation of ATP during oxidation of glucose and fatty acids.

UNIT V Biochemistry of Clinical Diseases 8 hours

Haemoglobins and Immunoglobulins. The biochemical basis of human diseases Diabetes mellitus, atherosclerosis, fatty liver, and obesity, hormonal disorders, aging, inborn errors of metabolism organ function tests.

Practical Exercise:15 hours

1. Estimate quality and quantity of the carbohydrates

2. Analyse quality and quantity of the lipids

3. Analyse quality and quantity of the DNA, RNA

4. Estimate quality and quantity of the proteins

5. Estimate lysozyme enzymatic activity

6. Estimate quantity of sugar from given sample

TOTAL : 60 hours

Text Books:

T1: Principles of Biochemistry by David L. Nelson and Michael M. Cox

T2: Biochemistry by Geoffrey Zubey

T3: Biochemistry. 9th edition. Berg JM, Tymoczko JL, Stryer L. New York: W H Freeman; 2019

Reference Books:

R1: Essentials of Glycobiology [Internet]. 3rd edition. Varki A, Cummings RD, Esko JD, Cold Spring Harbor (NY): Cold Spring Harbor Laboratory Press; 2015- 2017.

R2: Basic Neurochemistry: Molecular, Cellular and Medical Aspects. 7th edition. Siegel GJ, Agranoff BW, Albers RW, et al, editors. Philadelphia: Lippincott-Raven; 2005.

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Define the chemical basis of life which involves the importance of water, biological buffers and biomolecules.	**K1**
CO2	Comprehend the structure and functions of Carbohydrates and Lipids.	**K2**
CO3	Understand the Structure and Functions of Proteins and Nucleic Acid.	**K2**
CO4	Relate and realize the interconnection of different metabolic pathways and Bioenergetics.	**K2**
CO5	Understand the Various Clinical diseases involved and the biochemistry of it.	**K2**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PCC 04	MICROBIOLOGY LABORATORY	0	0	2	1

Course Objectives:

1. To introduce students to know the importance of Microbiology to emphasize structure and biochemical aspects of various microbes.
2. To help the students to know the application of microbes in industry.

LIST OF EXPERIMENTS

1.Microbial Good Lab Practices and Biosafety

2. Media preparation, sterilization and disinfection

3. Microscopic examination of different groups of microorganisms

4. Total count and viable count determination

5. Microbial simple and differential staining methods

6. Isolation of pure culture and its preservation

7. Microbial Growth Curve Determination

8. Effect of physical and chemical environment on growth

9. Biochemical tests for microbial identification

10. Antibiotic Sensitivity of Microorganisms

Total hours: 30 hours

LIST OF EQUIPMENTS

- Autoclave -1
- Hot Air Oven -1
- Incubators- 2
- Light Microscopes- 4
- Incubator Shaker- 1
- Colorimeter- 2
- Laminar Flow Chamber- 2
- Glassware, Chemicals, Media as required

TEXTBOOK

T1. Cappuccino, J.G. and N. Sherman "Microbiology: A Laboratory Manual", 4th Edition AddisonWesley,2019.

REFERENCES

R2. Collee, J.G. et al., "Mackie & McCartney Practical Medical Microbiology" 4th Edition, Churchill Livingstone, 2016.

R3 Michael J. Leboffe Microbiology: Laboratory Theory & Application, Morton Publishing Company; 3rd edition 2016

WEBLINK

W1 https://dth.ac.in/medical/courses/Microbiology/block-1/2/index.php

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Experiment with the preparation of different Media, sterilization and disinfection	**K3**
CO2	Illustrate various examination of different groups of microorganisms and total counts	**K2**
CO3	Demonstrate various methods of simple and differential staining methods	**K2**
CO4	Identify Microbial Growth Curve Determination	**K3**
CO5	Analyze the effect of Biochemical tests and antibiotic Sensitivity of microorganism	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**	**PO8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**-**	**1**	**3**	**2**	**2**	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**3**	**3**
CO2	**-**	**1**	**3**	**2**	**2**	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**3**	**3**
CO3	**-**	**1**	**3**	**2**	**2**	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**3**	**3**
CO4	**-**	**1**	**3**	**2**	**2**	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**3**	**3**
CO5	**-**	**1**	**3**	**2**	**2**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**3**	**3**

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
				✓	

Course code	Course	L	T	P	C
PCC 05	CELL BIOLOGY LABORATORY	0	0	2	1

Course Objectives:

To demonstrate various techniques to learn the morphology, identification and propagation of cells

LIST OF EXPERIMENTS

1. Introduction to principles of sterile techniques and cell propagation
2. Principles of microscopy, phase contrast and fluorescent microscopy
3. Good Laboratory Practices
4. Identification of given plant, animal and bacterial cells and their components by microscopy
5. Gram's staining
6. Leishman Staining
7. Giemsa Staining
8. Thin Layer Chromatography
9. Separation of Peripheral Blood Mononuclear Cells from blood
10. Osmosis and Tonicity

Total hours: **30 hours**

LIST OF EQUIPMENTS

1. Autoclave -1
2. Hot Air Oven -1
3. Incubators- 2
4. Light Microscopes- 4
5. Incubator Shaker- 1
6. Colorimeter- 2
7. Laminar Flow Chamber- 2
8. Glassware, Chemicals, Media as required

TEXT BOOKS

T1. Davis, J.M. "Basic Cell Culture: A Practical Approach", IRL, 1994.

REFERENCES

R1. Rickwood, D. and J.R. Harris "Cell Biology: Essential Techniques", John wiley, 1996.

WEBLINK

W1 https://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Infer the laboratory sterilization techniques and cell propagation	**K2**
CO2	Infer how to handle microbes, its identification and characterization	**K2**
CO3	Explain the cell staining techniques to study about the morphological characteristics	**K2**
CO4	Employ basic chromatography techniques	**K3**
CO5	Illustrate the separation of Peripheral Blood Mononuclear Cells from blood	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PSO2
CO1	3	1	1	1	-	-	-	-	3	-	-	-	3	3
CO2	3	1	2	2	-	-	-	-	2	-	-	-	3	3
CO3	3	3	2	3	3	-	-	-	3	-	-	-	3	3
CO4	3	3	3	3	3	-	-	-	3	-	-	-	3	3
CO5	3	2	1	2	3	-	-	-	2	-	-	-	3	3

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

Syllabus

Semester IV

Course code	Course	L	T	P	C
PCC 06	BIOPROCESS ENGINEERING	3	1	0	4

Course Objectives:

1.The Course Objective is to provide basic concepts of bioprocess engineering to the students.

2.They will learn engineering principles that can be applied to processes involving cell or enzyme catalysts with applications in the industry.

3.The students will learn the basics of bioreactor design and operation control that have been applied to a variety of bioprocess industries and also conduct related experiments for better understanding

UNIT I MICROBIAL GROWTH KINECTIS AND ENZYME CATALYSIS 12 hours

Microbial growth kinetics, substrate utilization, and product formation kinetics, stoichiometry, principles of enzyme catalysis, enzyme kinetics, Media Preparation, Media design and optimization. Microbial growth patterns and kinetics in batch culture, Microbial growth parameters, Environmental conditions affect growth kinetics, Kinetics of thermal death of microorganisms, Heat Generation by microbial growth, Quantitative analysis of microbial growth by direct & indirect methods.

UNIT II BIOREACTORS 12 hours

Ideal Reactor Operation: Batch, Fed Batch & Continuous operation of mixed bioreactors, Microbial pellet formation, Kinetics and dynamics of pallet formation. Chemostate with immobilized cells, Chemostate with cell recycle, substrate utilization and product formation in bioreactor, Scale up of Bioreactors, Immobilized cell systems, solid-state fermentations

UNIT III ENERGY BALANCE 12 hours

Energy balance and mass transfer, operation and control of bioreactors (aeration, agitation, heat transfer, scale-up and scale-down), Stoichiometric calculations, Theoretical prediction of yield coefficients, Stoichiometry of growth and product formation, Maximum possible yield, Theoretical oxygen demand, Stoichiometry of single-cell protein synthesis.

UNIT IV PRODCUTION AND INSTRUMENTATION 12 hours

Bioprocesses for the production of antibiotics, proteins, polysaccharides, aroma etc. Instrumentation and monitoring, sterilization, process modelling, downstream processing

UNIT V INDUSTRIAL BIOPROCESS 12 hours

Plant/mammalian cell culture reactors, examples of industrial bioprocesses Case studies on production of antibiotics, enzymes, insulin, bio-ethanol.

Total Lecture hours: 60 hours

TEXT BOOKS

T1. Michael Shuler, Fikret Kargi, Matthew De-Lisa, Bioprocess Engineering: Basic Concepts, 3rd Edition, March 2017, Pearson Publisher, ISBN: 9780132901437

T2. Pauline Doran, Bioprocess engineering principles, Latest Edition, Academic Press, 2018

T3. Peter Stanbury, Allan Whitaker, Stephen J. Hall, Principles of Fermentation technology, 3rd Edition, ISBN: 9780080999531, 2016

T4. Roger Harrison et al., Bioseparation Science and Engineering, Oxford University Press, 2003

REFERENCES

R1 Bioreaction Engineering, Bioprocess Monitoring (Bioreaction Engineering) by Karl Schügerl, 1997

R2 Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.

WEBLINK

W1 https://nptel.ac.in/courses/102106053

W2 https://onlinecourses.nptel.ac.in/noc22_bt19/preview

COURSE OUTCOMES

Upon successful completion of the course, students will be able to		
CO1	Outline the basic concepts of microbial growth kinetics and enzyme catalysis	**K2**
CO2	Classify the different types of bioreactors for their commercial applications	**K2**
CO3	Solve stoichiometric calculations to estimate growth and product formation.	**K3**
CO4	Identify different methods of production and instrumentation control for commercial metabolites.	**K3**
CO5	Apply the knowledge of plant/animal cell bioreactors for commercial production of metabolites.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

‘

Course Code	Course	L	T	P	C
PCC 07	BASIC INDUSTRIAL BIOTECHNOLOGY	3	0	0	3

Course Objectives:

1. To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
2. The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures.

UNIT I INTRODUCTION TO INDUSTRIAL BIOPROCESS 10 hours

Fermentation - Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology - A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting - block diagrams, pictorial representation.

UNIT II PRODUCTION OF PRIMARY METABOLITES 9 hours

Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids, alcohols and vitamins.

UNIT III PRODUCTION OF SECONDARY METABOLITES 9 hours

Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics and Steroids.

UNIT IV PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 9 hours

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Bio preservatives, Biopolymers, Biodiesel, Cheese, Beer, SCP & Mushroom culture. Bioremediation.

UNIT V PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS 8 hours

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Satyanarayana, U. “Biotechnology” Books & Allied (P) Ltd., 2005.

T2. Kumar, H.D. “A Textbook on Biotechnology” 2nd Edition. Affiliated East West Press Pvt.Ltd., 1998.

REFERENCES

R1. Presscott, S.C. and Cecil G. Dunn, “Industrial Microbiology”, Agrobios (India), 2005.

R2. Cruger,Wulf and Anneliese Crueger, “Biotechnology: A Textbook of Industrial Microbiology”, 2nd Edition, Panima Publishing, 2000.

WEBLINK:

W1 https://archive.nptel.ac.in/courses/102/105/102105058/

W2 https://onlinecourses.nptel.ac.in/noc19_bt20/preview

COURSE OUTCOMES

CO1	Outline the upstream and downstream processing of industrial bioprocess	**K2**
CO2	Explain the production of primary metabolites	**K2**
CO3	Explain the production of secondary metabolites	**K2**
CO4	Examine production of enzymes and other bioproducts	**K4**
CO5	List out the production of modern biotechnology products	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO2
CO1	-	-	2	2	2	-	-	-	-	-	-	-	3	3
CO2	2	1	2	3	3	-	-	-	-	-	-	-	3	3
CO3	2	1	1	2	1	-	-	-	-	-	-	-	3	3
CO4	2	3	3	3	3	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration / Presentation**	**Open book test**

Course Code	Course	L	T	P	C
PCC 08	GREEN BIOTECHNOLOGY AND POLLUTION ABETMENT	3	0	0	3

Course Objectives:

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

UNIT I BIOLOGICAL WASTE TREATMENT 9 hours

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

UNIT II BIODEGRADATION OF XENOBIOTIC COMPOUNDS 9 hours

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

UNIT III BIOTRANSFORMATIONS AND BIOCATALYSTS 9 hours

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

UNIT IV BIOREMEDIATION AND BIORESTORATION 9 hours

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

UNIT V ECO-FRIENDLY BIOPRODUCTS FROM RENEWABLE SOURCES 9 hours

Fundamentals of composting process: scientific aspects and prospects of biofuel production: bioethanol, biohydrogen and biodiesel; biofertilizers and biopesticides. Biotechnology in Environment Protection: Current status of biotechnology in environment protection and its future, release of genetically engineered organisms in the environment.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Energy Technology – O.P. Gupta, Khannabooks, 2018.

T2. Elements of Water Pollution Control Engineering – O.P. Gupta, Khannabooks, 2019.

T3. Industrial Wastewater Treatment, 2017 by A.D. Patwardhan- PHI Learning; 2nd edition

REFERENCES

R1. Environmental Biotechnology, B.C. Bhattacharya &Ritu Banerjee, Oxford Press, 2007.

R2. Environmental Biotech, PradiptaKrimar, I.K. International Pvt. Ltd., 2006.

R3. Environmental Microbiology & Biotechnology, D.P. Singh, S.K. Dwivedi, New Age International Publishers, 2004.

WEBLINKS

W1 https://www.biologydiscussion.com/pollution/biotechnological-approaches-for-the-abatement-of-pollution/10909

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the basics of biological waste and solid waste treatment methods	**K2**
CO2	Demonstrate the concept of biodegradation of xenobiotic compounds	**K2**
CO3	Identify the concept of organic reaction mechanisms to know the biotransformation and biocatalysis processes	**K3**
CO4	Apply the concepts of different types of bioremediations and biorestoration methods for improving soil fertility.	**K3**
CO5	Identify the role of biotechnology in environment protection and eco-friendly bioproducts from renewable sources	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓				

Course Code	Course	L	T	P	C
PCC 09	IMMUNOLOGY AND IMMUNOTECHNOLOGY	3	0	0	3

Course Objectives:

1. This course will introduce the students with basic principles of immunology and recent advancements in the field of adaptive immunity.

UNIT I OVERVIEW OF THE IMMUNE SYSTEM 9 hours

Immune cell types, Haematopoiesis, B and T lymphocytes, NK cells, Lymphoid organs (primary and secondary), Features of/introduction to inflammation, Humoral immunity/Cell-mediated immunity, Pro-inflammatory and anti-inflammatory cytokines, Innate Immune system, cell polarization/activation (classical/alternate), Adaptive immune system.

UNIT II IMMUNOGLOBULIN STRUCTURE AND FUNCTIONS 9 hours

Antibody structure, Generation of antibody diversity, (Somatic hypermutation), Major histocompatibility complex, Antigen presentation, APCs, Germinal center, Plasma Cells.

UNIT III T-CELL & B-CELL MATURATION, ACTIVATION & DIFFERENTIATION 9 hours

BCR signalling, B-cell maturation/activation, T-cell development, negative/positive selection, TCR rearrangement, co-stimulatory molecules. T cell subtypes: Th1, Th2, Th17, Tregs etc., Vaccines, memory B and T cell responses, active immunization, passive immunization. Immunity without infection (autoimmunity, hypersensitivity, host vs graft reaction)

UNIT IV IMMUNE CHECKPOINTS 9 hours

Immune checkpoints: PD1, CTLA4, TIM3 etc. Design of recombinant antibodies, Commercial production of polyclonal and monoclonal antibodies, Antibodies in diagnostics, Immuno-therapy in cancer, checkpoint therapy, Vaccine production, Plant immunology.

UNIT V IMMUNOLOGICAL TECHNIQUES 9 hours

Immunological techniques: Immuno-diffusion assay, ELISA, Immuno-blotting, ELISPOT assay, Immuno-Histochemistry, Flow Cytometry, FACS sorting, Immuno-precipitation.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Kuby Immunology by Thomas J. Kindt, Barbara A. Osborne, Richard Goldsby, 2006

T2. Introduction to Medical Immunology by Gabriel Virella, 2000

REFERENCES

R1. Coico, Richard “Immunology: A Short Course” 6th Edition. John Wiley, 2008.

R2. Khan, Fahim Halim “Elements of Immunology” Pearson Education, 2009.

WEBLINK:

W1 https://onlinecourses.nptel.ac.in/noc20_bt43/preview

W2 https://books.google.co.in/books/about/Immunology_and_Immunotechnology.html?id=443qAAAACAAJ&redir_esc=y

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Classification of Immunity, immune cells and organs of immune system and inflammatory response	**K2**
CO2	Explain Immunoglobulins structure and its functions	**K2**
CO3	Explain B cell and T cell maturation, activation and differentiation	**K2**
CO4	Model recombinant antibodies and production of vaccines	**K3**
CO5	Application of immunological techniques	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	-	-	1	2	2	-	-	-	-	-	-	-	3	3
CO2	2	1	2	3	3	-	-	-	-	-	-	-	3	3
CO3	2	1	1	2	1	-	-	-	-	-	-	-	3	3
CO4	2	3	3	3	3	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

Course code	Course	L	T	P	C
PCC 10	BIOINFORMATICS AND COMPUTATIONAL BIOLOGY	3	0	2	4

Course Objectives:

1. This course is beneficial for students to understand the principles of analysing biological data, building models and testing hypotheses using computer science algorithms.
2.This course is a survey of algorithms and tools in biological sequence analysis, genome-wide disease association, and precision medicine.
3.Basic concept machine learning and its application in analysis of biological data are also included in this course.
4.It will also introduce information technology practices in the field of biotechnology. The course will provide a basic overview of various information repositories widely used in biological sciences; and tools for searching or querying those databases.
5.This course will build foundation of sequence alignment techniques and to find evolutionary connections.
6. It will help students to analyse mRNA expression data and gene annotations**.**

UNIT I BIOLOGICAL DATABASES 9 hours

Biological databases and tools: Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases; Protein databases- UniProt, Protein Data Bank.Patent database, in silico tools for rDNA technology, Entrez, Ensembl-Biomart.

UNIT II ALGORITHMS 9 hours

Sequence Analysis, Pairwise alignment- Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm string similarity, Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Database searching: BLAST and its types - BLAST, PSIBLAST and PHIBLAST algorithms.

UNIT III PHYLOGENY 9 hours

Dynamic and heuristic methods, Relevance to inferences about evolution, introduction to molecular phylogeny. Concept of trees- phylogenetic trees - Distance based trees UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping.

UNIT IV GENOME INFORMATICS 9 hours

Genome informatics: Genome sequencing technologies and analysis methods; transcription factor regulation and motif finding. Computational Epigenetics: Epigenetics and its role in transcription regulation, development, and diseases. Genomic variations and its associations: Linking genes, variations and diseases; Introduction to biomarkers and personalized medicine.

UNIT V SYSTEMS BIOLOGY 9 hours

Machine learning techniques: Artificial Neural Networks, Hidden Markov Models, Microarray analysis, DNA computing. Network biology and human diseases: Genome-wide association studies of human diseases, Genome editing tools and applications to human diseases, in-silico tools for drug designing (Molecular modelling, Docking, Molecular dynamics simulations).

Practical's:

1. Accessing databases from NCBI.
2. Extracting protein and nucleotide sequences from NCBI.
3. Database Search Tools.
4. Similarity search using BLAST.
5. Pairwise sequence alignment.
6. Multiple sequence alignment.

Total hours: 45 hrs theory + 15 hrs practical=**60 hrs**

TEXT BOOKS

T1. Pevsner J. Bioinformatics and functional genomics. John Wiley & Sons; 2015 Aug 17.

T2. Gibson G, Muse SV. A Primer of Genome Science De BoeckSupérieur; 2004 Jan 28.

T3. Essential Bioinformatics, JinXiong, Cambridge University Press; 1st edition 2006.

T4. Bioinformatics: methods and applications, S. C. Rastogi, PHI learning; 4th edition, 2013.

T5. The Dictionary of Genomics, Transcriptomics and Proteomics, Günter Kahl, Willey VCH, 2015.

REFERENCE

R1 Singh GB. Fundamentals of bioinformatics and computational biology. Cham: Springer International Publishing. 2015:159-70.

WEBLINK:

W1 -https://nptel.ac.in/courses/102106065

COURSE OUTCOMES

Upon successful completion of the course, students will be able to		
CO1	Show the types of DNA, protein sequences available in database and categorize them	**K2**
CO2	Compare different algorithms to perform sequence alignments	**K2**
CO3	Construct different phylogenetic trees to develop evolutionary relationship between organisms	**K3**
CO4	Identify the role of genome informatics in modern world	**K3**
CO5	Make use of different tools and techniques of machine learning for drug designing	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

Course code	Course	L	T	P	C
PCC 11	BIOPROCESS ENGINEERING LABORATORY	0	0	2	1

Course Objectives:

- To train the students on enzyme characterization, immobilization and medium optimization methods.
- To train on methods to investigate the growth of microorganisms in different systems under different conditions

LIST OF EXPERIMENTS

1. Microbial growth kinetics and estimation of cell mass
2. Growth inhibition kinetics
3. Operation of pH control and dissolved oxygen measurement
4. Enzyme immobilization techniques
5. Bioconversion using immobilized enzyme preparation
6. Aerobic and anaerobic bioconversion process
7. Product formation kinetics in a fermentation process
8. Online analyses of process parameters
9. Effect of mixing and agitation in bioreactors
10. Mass transfer in immobilized cell

Total hours: **30 hours**

LIST OF EQUIPMENTS

1. Autoclave -1
2. Hot Air Oven -1
3. Incubators- 2
4. Light Microscopes- 4
5. Incubator Shaker- 1
6. Colorimeter- 2
7. Laminar Flow Chamber- 2
8. Glassware, Chemicals, Media as required

TEXT BOOKS:

T1. Bailey JE, Ollis DF. Biochemical engineering fundamentals. McGraw-Hill; 2018 Nov 1.

T2. Michael Shuler, Fikret Kargi, Matthew De-Lisa, Bioprocess Engineering: Basic Concepts, 3rd Edition, March 2017, Pearson Publisher, ISBN: 9780132901437

REFERENCES:

R1. Pauline Doran, Bioprocess Engineering Calculations, Academic Press, 2013.

R2. Peter Stanbury, Allan Whitaker, Stephen J. Hall, Principles of Fermentation technology, 3rd Edition, ISBN: 9780080999531, 2016

WEBLINK:

W1 http://38.100.110.143/model/index.html

COURSE OUTCOMES

Upon successful completion of the course, students will be able to		
CO1	Show the mechanism of microbial growth and inhibition kinetics.	**K2**
CO2	Illustrate various immobilization techniques and control of various process parameters	**K2**
CO3	Demonstrate various methods of aerobic and anaerobic bioconversion process	**K2**
CO4	Identify product formation kinetics and analyses of process parameters	**K3**
CO5	Analyze the effect of mass transfer in bioreactors with respect to mixing and agitation	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

Course code	Course	L	T	P	C
PCC 12	IMMUNOLOGY AND IMMUNOTECHNOLOGY LABORATORY	0	0	2	1

Course Objectives:

Provides an opportunity to experimentally verify the theoretical concepts already studied. It also helps in understanding the theoretical principles in a more explicit and concentrated manner.

LIST OF EXPERIMENTS

1. Isolation of Monocytes from blood
2. Isolation and microscopic visualization of T-cells and B-cells
3. Isolation of peripheral blood mononuclear cells
4. Use a commercially available immune diagnostic strip test
5. Immunodiffusion – Ouchterlony Double Diffusion
6. Determination of binding affinity of antigen-antibody complex
7. Demonstration of ELISA
8. Testing for typhoid antigens by Widal test
9. PBMC preparation and their enumeration
10. Immuno electrophoresis – Rocket or Counter Current Immuno electrophoresis

Total hours: **30 hours**

LIST OF EQUIPMENTS

1. Elisa reader
2. Microscopes
3. Microwave oven
4. Hot plate
5. Vortex mixer
6. Table top refrigerated Centrifuge
7. Fluorescent microscope

TEXT BOOK:

1. David Male, Victoria Male, Ray Stokes Peebles “Immunology”, 2020

REFERENCES

R1. Roitt I, Male, Brostoff. Immunology, Mosby Publ., 2002.

R2. Kuby J, Immunology, WH Freeman & Co., 2000.

WEBLINK:

1. https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Outline the laboratory techniques for isolation of different blood cells	**K2**
CO2	Explain Immunodiffusion techniques	**K2**
CO3	Identify antigen-antibody interactions by using different techniques	**K3**
CO4	Simplify PBMC preparation and their enumeration	**K4**
CO5	Categorize different Immuno electrophoresis	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	2	1	1	2	-	-	-	-	-	-	-	-	3	3
CO2	2	1	2	3	-	-	-	-	-	-	-	-	3	3
CO3	2	3	1	2	-	-	-	-	-	-	-	-	3	3
CO4	2	3	3	3	1	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	1	-	-	-	-	-	-	-	3	3

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

BSC08	ENVIRONMENTAL SCIENCE AND ENGINEERING (For B.Tech. Biotech)	L	T	P	C
		3	0	0	3

Course Objectives

- At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future
- To provide understanding of component of environment, their function, quality, issues related to environment, effect of quality degradation on human beings and their solutions

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 9

Definition – Scope and importance – Need for public awareness – Concepts of an Ecosystem – Structure and Function of an Ecosystem –Producers, Consumers and Decomposers – Energy Flow in the Ecosystem – Ecological Succession – Food Chains, Food Webs and Ecological Pyramids – Introduction, Types, Characteristic Features, Structure and Function of the (A) Forest Ecosystem (B) Grassland Ecosystem (C) Desert Ecosystem (D) Aquatic Ecosystems (Ponds, Streams, Lakes, Rivers, Oceans, Estuaries) – Introduction to Biodiversity – Definition: Genetic, Species and Ecosystem Diversity – Bio-geographical Classification of India – Value of Biodiversity: Consumptive Use, Productive Use, Social, Ethical, Aesthetic and Option Values – Biodiversity at Global, National and Local Levels – India as a Mega-Diversity Nation – Hot-Spots of Biodiversity – Threats to Biodiversity: Habitat Loss, Poaching of Wildlife, Man-Wildlife Conflicts – endangered and Endemic Species of India – Conservation of Biodiversity: In-Situ and Ex-Situ conservation of Biodiversity.Field Study of Common Plants, Insects and Birds.

Field study of simple ecosystems - pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 9

Definition – Causes, Effects and Control Measures of (A) Air Pollution (B) Water Pollution (C) Soil Pollution (D) Marine Pollution (E) Noise Pollution (F) Thermal Pollution (G) Nuclear Hazards – Solid Waste Management:- Causes, Effects and Control Measures of municipal solid Wastes – Role of an Individual in Prevention of Pollution – Pollution Case Studies – disaster Management - Floods, Earthquake, Cyclone and Landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 9

Forest resources -Use and over – Exploitation – Deforestation – Case studies – Timber extraction –Mining – Dams and their ground water – Floods – Drought – Conflicts over water –Dams – Benefits and Problems – Mineral Resources- Use and Exploitation, Environmental Effects of Extracting and Using Mineral Resources, Case Studies – Food Resources: World Food Problems, Changes caused by Agriculture and Overgrazing, Effects of Modern Agriculture, Fertilizer-Pesticide Problems, Water Logging, salinity, Case Studies – Energy Resources:- Growing Energy Needs, Renewable and Non Renewable Energy Sources, Use of Alternate Energy Sources, Case Studies – Land Resources - Land as a Resource, Land Degradation, Man Induced Landslides, Soil Erosion and Desertification – Role of an Individual in Conservation of Natural Resources – Equitable use of Resources for Sustainable Lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9

From Unsustainable To Sustainable Development – Urban Problems Related to energy – Water conservation, Rain Water Harvesting, Watershed Management – Resettlement and Rehabilitation of People, its Problems and Concerns, Case Studies Role of non – governmental organization - Environmental Ethics- Issues and Possible Solutions – Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust, Case Studies – Wasteland Reclamation – Consumerism and Waste Products – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and Control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act –enforcement machinery involved in environmental Legislation – Central and state pollution control boards - Public Awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 9

Population Growth, Variation among Nations – Population Explosion Family Welfare Programme – environment and Human Health – Human Rights –Value Education – HIV /AIDS – Women and Child Welfare – Role of Information Technology in Environment and Human Health – Case Studies.

TOTAL: 45 HOURS

Text Books:

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw- Hill,NewDelhi, (2006).

Reference Books

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol.I and II, Enviro Media.

2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005)

Web Links:

1. https://onlinecourses.nptel.ac.in/noc20_ge16/preview
2. https://ggn.dronacharya.info/APSDept/Downloads/QuestionBank/ENVIRONMENTAL-STUDIES/NPTEL-Link.pdf
3. http://eagri.org/eagri50/ENVS302/pdf/lec14.pdf
4. https://onlinecourses.nptel.ac.in/noc19_ge22/preview

COURSE OUTCOMES

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

CO1: Understand the core concepts, methods of ecological and physical sciences, their application in environmental problem-solving.

CO2: Apply system concepts and methodologies to analyse, understand the interactions between social and environmental processes.

CO3: Apply the ethical, cross-cultural, and historical context of environmental issues and the link between human and natural systems.

CO4: Develop the understanding based on the observations and illustration, drawn from the experiences of physical, biological, social and cultural aspects of life, rather than abstractions.

CO5: Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	PO2	PO3	P O4	PO5	PO6	PO7	PO 8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	1	1	-	-	-	-	-	1	1	1	-	1	-	-
CO2	1	1	-	-	-	-	-	1	1	-	-	-	-	-
CO3	-	1	-	-	-	-	-	2	-	1	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO5	1	-	-	1	-	-	-	2	1	1	-	1	1	1

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

Semester V

Course code	Course	L	T	P	C
PCC 13	MOLECULAR BIOLOGY	3	1	0	4

Course Objectives

- Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes. This will be needed for any project work in modern biotechnology.

UNIT I Chemistry of Nucleic Acids 12 hours

Introduction to nucleic acids: Nucleic acids as genetic material, Structure and physicochemical properties of elements in DNA and RNA, Biological significance of differences in DNA and RNA. Primary structure of DNA: Chemical and structural qualities of 3',5'-Phosphodiester bond. Secondary Structure of DNA: Watson & Crick model, Chargaff's rule, X–ray diffraction analysis of DNA, Forces stabilizes DNA structure, Conformational variants of double helical DNA, Hogsteen base pairing, Triple helix, Quadruple helix, Reversible denaturation and hyperchromic effect. Tertiary structure of DNA: DNA supercoiling.

UNIT II DNA Replication & Repair 12 hours

Overview of Central dogma. Organization of prokaryotic and eukaryotic chromosomes. DNA replication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments, Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication, Telomere replication in eukaryotes. D-loop and rolling circle mode of replication. Mutagens, DNA mutations and their mechanism, various types of repair mechanisms.

UNIT III Transcription 12 hours

Structure and function of mRNA, rRNA and tRNA. Characteristics of promoter and enhancer sequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteins of RNA synthesis, Fidelity of RNA synthesis, Inhibitors of transcription, Differences in prokaryotic and eukaryotic transcription. Basic concepts in RNA world: Ribozymes, RNA processing: 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.

UNIT IV Translation 12 hours

Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post- translational modifications and its importance.

UNIT V Regulation of Gene Expression 12 hours

Organization of genes in prokaryotic and eukaryotic chromosomes, Hierarchical levels of gene regulation, Prokaryotic gene regulation –*lac* and *trp* operon, Regulation of gene expression with reference to λ phage life cycle.

TOTAL : 60 hours

Text Books:

T1: Friefelder, David. "Molecular Biology." Narosa Publications, 1999.

T2: Weaver, Robert F. "Molecular Biology" 2nd Edition, Tata McGraw-Hill,2003

T3: Karp, Gerald "Cell and Molecular Biology: Concepts and Experiments" 4th Edition, John Wiley, 2005.

T4: Lewin's GENES XI, Published by Jones & Bartlett Learning; 11 edition (January 15, 2013).

T5: Friefelder, David and George M. Malacinski "Essentials of Molecular Biology" 2nd Edition, Panima Publishing, 1993

Reference Books:

R1: Glick , B.R. and J.J. Pasternak. "Molecular Biotechnology: Principles and Applications of Recombinant DNA" 4th Edition. ASM, 2010.

R2: Tropp, Burton E. "Molecular Biology : Genes to Proteins". 3rd Edition. Jones and Bartlett, 2008.

COURSE OUTCOMES

Upon completion of this course the students will be able to,		
CO1	Define the basic structure and biochemistry of nuclear components	**K1**
CO2	Demonstrate the replication mechanism inside the Cell	**K2**
CO3	Outline the RNA synthesis inside the cell	**K2**
CO4	Understand the mechanism of protein synthesis and localization	**K2**
CO5	Comprehend the Gene regulation and Expression inside the cell	**K2**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	1	1	-	1	-	-	-	-	-	1	-
CO2	-	1	-	2	2	-	-	-	-	-	2	-	3	-
CO3	-	1	-	2	2	-	-	-	-	-	2	-	3	2
CO4	-	1	-	2	2	-	-	-	-	-	2	-	3	3
CO5	-	2	1	2	3	-	-	1	-	-	0	-	3	3

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course code	Course	L	T	P	C
PCC 14	ANALYTICAL TECHNIQUES	3	1	0	4

Course Objectives:

To learn different modern analytical techniques used in biotechnology

UNIT I Introduction to Spectrometry **9hours**

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio

UNIT II Spectroscopic Techniques **9hours**

Light spectroscopy and Microscopy-Absorption, IR, Scattering (Raman and Rayleigh), Resonance Raman, Fluorescence (steady-state and time resolved) Principle, Instrumentation and Applications

UNIT III Separation Methods **9hours**

Chromatography- Principle, Instrumentation and applications of Ion-Exchange, Affinity, Hydrophobic, Size exclusion, FPLC, HPLC, GC. Ultracentrifugation, Electrophoresis, Solution- and solid-state NMR spectroscopy, X-ray crystallography

UNIT IV Mass Spectroscopy **9hours**

Mass spectroscopy-MALDI, LC-MS, GC-MS, MS-MS, MALDI-Mass imaging, Proteomics, MS and NMR based Metabolomics

UNIT V Analytical Techniques for gene **9hours**

DNA and RNA sequencing for genomics, PCR for transcriptomic, Real time PCR, Droplet PCR, Calorimetry, Surface Plasmon Resonance (SPR), Bio-layer interferometry (BLI), High content screening.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. Biophysical Chemistry, Vol II by Charles R. Canter and Paul R. Shimmel. 2002

T2. Protein Purification: Principles and Practice by Robert K. Scopes (Narosa). 1994

T3. Principles of Fluorescence Spectroscopy by Joseph R. Lakowicz. 2006

T4. Infrared Spectroscopy Fundamentals and Applications by Barbar Stuart. 2004

T5. Mass Spectrometry Basics by Christopher G. Herbert and Robert W. Johnstone. 2002

T6. Chromatographic methods by A Braithwaite and F. J. Smith (Kluwer Academic Publishers).1999

REFERENCES

R1 Raman Spectroscopy for Chemical Analysis by RICHARD L. McCREERY. 2000

R2 NMR spectroscopy by Harald Gunther (John Wiley). 201

WEBLINK:

1. https://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Extend the principles involved in the functioning of various instruments and the cause of uncertainties in instrumental measurements	**K2**
CO2	Summarize the use of the various microscopy used in biological and electrochemical analysis	**K2**
CO3	Distinguish the various chromatography and spectroscopy instruments for analysis of biological samples such as DNA, RNA, and Proteins.	**K2**
CO4	Demonstrate the different chromatography and Mass spectroscopy methods for separation of biological products	**K3**
CO5	Illustrate the various analytical techniques used in biotechnological applications	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO1	PO2	PO 3	PO 4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PO1 1	PO 12	PSO1	PSO2
CO1	3	1	1	1	-	-	-	-	-	-	-	-	3	3
CO2	3	2	1	2	-	-	-	-	-	-	-	-	3	3
CO3	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO4	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO5	3	3	3	2	-	-	-	-	-	-	-	-	3	3

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
PCC 15	CHEMINFORMATICS & MEDICINAL CHEMISTRY	3	0	2	4

Course Objectives:

1. This course for biotechnology students introduces the small molecule-ligand-oriented in silico physio-chemical aspects of rational drug design.
2. Topics include in silico representation of chemical information, chemical databases and data mining, molecular drawing and interactive visualization, computer-aided drug design, building ligand ab initio or from similar ligands, with and without known macromolecules, assessing activity and toxicity and durability.

UNIT I INTRODUCTION TO DRUG DESIGN 9 hours

Chemistry & Information technology: History and evolution of cheminformatics, Overview of Rational Drug Design, Ligands, Targets and their interactions, in-silico representation of chemical information, Use of cheminformatics, Prospects of cheminformatics.

UNIT II CHEMICAL DATABASES 9 hours

Chemical Databases: Data Mining, Chemical / biochemical data collation, retrieval, analysis & interpretation. SMILES coding, Molecular Drawing (Chemsketch, chemdraw etc.) and Interactive Visualization (PyMOL, Discovery Studio etc.): Building molecules on a computer, Molecular Modeling and structure elucidation.

UNIT III COMPUTER-AIDED DRUG DESIGN 9 hours

Overview, Methods of computer aided drug design: Structure and ligand based drug design, Structural Homology: Target identification, lead optimization and validation, Homology Modeling Tools, Docking and Screening Tools,

UNIT IV STEREOCHEMISTRY AND SIMULATION 9 hours

Stereochemistry and mechanism, stereoisomerism, Introduction to molecular dynamic simulation, steps and simulation methods for molecules and materials, applications, advantages and disadvantages of molecular dynamic simulation

UNIT V ORGANIC CHEMISTRY OF DRUG DESIGN AND ACTION 9 hours

Logic in organic synthesis, QSAR-Steps, Tools, Evaluation of QSAR models, pharmacological screening, chemistry of drug action, Pharmaceutical Preformulation, Solid State Pharmaceutics, Drug metabolism, pharmacokinetics, pharmacodynamics

Total Lecture hours: 45 hours

CHEMINFORMATICS AND MEDICINAL CHEMISTRY PRACTICALS 15 hours

1. In silico selection of compound from an NCI library against a target protein.
2. Homology Modeling and validation of Protein Structure: Ramachandran Plot
3. Docking and Energy minimization
4. Structure based drug design against a target protein such HIV-1 protease using crystal structure from Protein Data Bank
5. Analysis of PK and PD data of a drug candidate

Total hours: 45 hrs theory + 15 hrs Practical= 60 hours

TEXT BOOKS

T1. Muthukumarasamy Karthikeyan and Renu Vyas. Practical chemoinformatics. Springer, soft-cover ISBN 9788132234913, 2014.

T2. Silverman, Richard B., and Mark W. Holladay. The organic chemistry of drug design and drug action. Academic Press, 2014.

T3. Bajorath, Jurgen. Chemoinformatics for Drug Discovery. John Wiley & Sons, 2013.

T4 Cramer CJ. Essentials of computational chemistry: theories and models. John Wiley & Sons; 2013

T5 Lemke TL, Zito SW, Roche VF, Williams DA. Essentials of Foye's Principles of Medicinal Chemistry. Wolters Kluwer; 2017.

T6 Graham L. Patrick. An introduction to medicinal chemistry. Oxford university press; 2013

T7 Lal B. Medicinal Chemistry by Ashutosh Kar. Indian Journal Of Chemistry Section B. 1993;32:1200.

REFERENCES

R1. Oprea TI, Mannhold R, Kubinyi H, Folkers G, editors. Chemoinformatics in drug discovery. Wiley-VCH;

WEBLINKS

W1 https://archive.nptel.ac.in/courses/104/101/104101095/

COURSE OUTCOMES

Upon completion of the course, the students will be able to,		
CO1	Classify small ligand molecules to be used as drugs against macromolecules for rational drug design	**K2**
CO2	Compare he databases and tools to categorize, organize, and search the structures of chemicals and build models	**K2**
CO3	Make use of a range of computational tools available for computer aided drug designing	**K3**
CO4	Apply the stereo chemical aspects of coordination compounds for drug development	**K3**
CO5	Build novel drugs using various chemistry principles, techniques and tools in drug designing	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course code	Course	L	T	P	C
PCC 16	ANALYTICAL TECHNIQUES LABORATORY	0	0	2	1

Course Objectives:

To have a practical hands-on experience on Absoprtion Spectroscopic methods

To acquire experience in the purification by performing chromatography

To validate and analysis using spectrometric and microscopic techniques

LIST OF EXPERIMENTS

1. Measurement of IR and Raman spectra of small molecules
2. Measurement of excitation and emission spectra of a fluorophore and their wavelengths for maximum excitation and emission
3. Purification of a compound from a mixture using HPLC
4. Protein purification using affinity, ion-exchange and gel filtration chromatography
5. Analysis of NMR spectra and structure determination of a bio-active compound like cyclosporine.
6. Analysis of SPR and ITC data and calculation of binding affinities.
7. Demonstration of analysis of genomics data
8. Chromatography analysis using TLC.
9. Chromatography analysis using column chromatography.

Total hours: **30 hours**

LIST OF EQUIPMENTS

1. Colorimeter 2 No.
2. Glassware, Chemicals, Media as required

TEXT BOOK:

1. Skoog, D.A. etal. “Principles of Instrumental Analysis”, 5th Edition, Thomson / Brooks – Cole,1998

REFERENCES

R1. Braun, R.D. “Introduction to Instrumental Analysis”, Pharma Book Syndicate, 2002.

R2. Willard, H.H. etal. “Instrumental Methods of Analysis”, 6th Edition, CBS, 2001.

WEBLINK:

W1. https://onlinecourses.swayam2.ac.in/cec20_bt22/preview

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Infer the spectroscopic methods used in the analysis of biological samples	**K2**
CO2	Explain the different analytical techniques for the analysis of samples	**K2**
CO3	Infer the appropriate technique for the protein purification	**K2**
CO4	Explain the analysis of genomics data	**K2**
CO5	Apply the various chromatographic methods used in biotechnological applications	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	2	1	1	2	2	-	-	-	1	-	-	-	3	2
CO2	3	2	1	2	1	-	-	-	2	-	-	-	3	3
CO3	3	3	3	3	3	-	-	-	3	-	-	-	3	3
CO4	3	3	3	3	3	-	-	-	3	-	-	-	3	3
CO5	3	3	3	3	3	-	-	-	3	-	-	-	3	3

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

Course Code	Course	L	T	P	C
PCC 17	MOLECULAR BIOLOGY LABORATORY	0	0	2	1

Course Objectives

1. Provides an opportunity to experimentally verify the theoretical concepts already studied.
2. It also helps in understanding the theoretical principles in a more explicit and concentrated manner

List of Experiments

1. Safety Measure and Good Laboratory Practices
2. Preparation of Agarose Gel
3. Isolation of Genomic DNA from Bacterial Source
4. Isolation of Genomic DNA from Plant Source
5. Isolation of Genomic DNA from Animal Source
6. SDS PAGE Electrophoresis
7. Preparation of Competent Cells
8. Transformation of Bacterial Cells
9. Lac Operon Gene Regulation
10. PCR

TOTAL : 30 hours

List of Equipments:

1.Agarose Gel Electrophoresis-1

2. UV Transilluminator-1

3. SDS Gel Electrophoresis system-1

4. Centrifuge-1

5. Refrigerator-1

Reference Books:

R1: Molecular Cloning-A laboratory Manual-Third Edition, Sambrook and Russell.

COURSE OUTCOMES

Upon completion of this course the students will be able to,		
CO1	Understand the Safety measures and sterilization techniques in Molecular Biology Laboratory.	**K2**
CO2	Utilize the various methods for isolation of DNA in different sources	**K3**
CO3	Analyze nucleic acid molecules quantitatively and qualitatively	**K4**
CO4	Clone and express a gene and produce therapeutically valuable products.	**K4**
CO5	Perform protein expression and Gene Regulation studies.	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✓	✓		
Quiz	MCQ	Projects	Seminars	Demonstration/ Presentation	Open book test

Syllabus

Semester VI

Course Code	Course	L	T	P	C
PCC 19	BIOSEPARATION ENGINEERING	3	0	0	3

Course Objectives:

1. To cover the fundamentals, and design concepts of various downstream purification steps (unit operations) involved in a biochemical process.

UNIT I INTRODUCTION **9 hours**

Introduction to By-products and Bio separation: Range and characteristics of bio products, Characteristics of Fermentation Broth, Selection of unit operation with due consideration of physical, chemical and biochemical aspect of biomolecules. Stages of Downstream Processing.

UNIT II EXTRACTION PROCESS **9 hours**

Single-stage equilibrium extraction; types of equipment and design for extraction, continuous multistage counter current extraction, Design of towers for extraction; Adsorption, adsorbents, batch adsorption, design of fixed-bed adsorption columns, scale-up laboratory adsorption column

UNIT III SEPERATION TECHNIQUES **9 hours**

Primary Separation: Removal of insoluble and Biomass (and particulate debris) separation techniques, Flocculation and sedimentation, Centrifugation-Ultracentrifugation, Gradient centrifugation, Filtration: Theory of Filtration, Pre-treatment of Fermentation Broth, Filter Media and Equipment, Conventional and Cross-flow Filtration, Continuous Filtration, Filter cake resistance, specific cake resistance, Washing and dewatering of filter cakes

UNIT IV ABSORPTION **9 hours**

Gas Absorption: Solubility of gases in liquids, Effect of temperature and pressure on solubility, Ideal and Non-ideal solutions, Choice of solvent for gas absorption, absorption factor, stripping factor, minimum gas liq ratio, Single stage gas absorption Cross Current, Co- current, Counter current, Multistage Counter current Operation, Absorption with Chemical Reactions

UNIT V LIQUID – LIQUID SEPERATION **9 hours**

Liquid-Liquid Separation Process: Introduction to Liquid-Liquid Extraction, Choice of Solvent for Liquid-Liquid Extraction, Binodal solubility curve, Single Stage Operation, Equipment's for liquid-liquid extraction. Types of extraction processes: Reactive extraction, Aqueous two-phase systems, Reverse micellar extraction, Liquid liquid and solid-liquid extraction, Supercritical fluid Extraction. Design of extraction equipment. Different types of extractors and designing of extractors.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. B.Shivshankar, Bioseparations: Principles and Techniques, Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012

T2. Bioseparation& bioprocessing (2nd Ed) 2-Volume set, Ed SUBRAMANIAN Ganapathy, Wiley-VCH, (2007)

T3. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley Interscience Publication, 1988.

T4. J.E. Baileyand D.F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill, Inc., 1986.

T5. R. K. Scopes, Berlin, Protein Purification: Principles and Practice, Springer, 1982.

T6. Scopes Ak, Protein Purification, IRL Press, 1993

T7. Biotechnology: Bioprocessing, Rhem and Reed, Vol. 3, 1993

T8. Separation and purification techniques in biotechnology, FredreichDechow, 1989

T9. Asenjo J.A. and J.Hong (Eds), Separation Processes in Biotechnolgy, Taylor and Francis

REFERENCES

R1. TreybalR.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.

R2. McCabe W. L.and Smith J.C., Unit operation in chemical engineering, 5Ed., McGraw Hill New York 1993.

R3. Geankoplis C.J., Transport processed and unit operations, Prentice Hall, New Delhi 1997.

R4. Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, Oxford University Press, 2015.

WEBLINK:

W1. https://archive.nptel.ac.in/courses/102/106/102106022/

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the fundamentals of downstream processing for product recovery	**K2**
CO2	Outline the principles in production, extraction technique for bio-based products	**K2**
CO3	Develop the protocols for separation of biological macromolecules using different technologies	**K3**
CO4	Choose the best techniques for product enrichment and purification of bio-products	**K3**
CO5	Apply downstream processing concepts for Final Product Formulation and Finishing Operations of bio-products	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓				

Course Code	Course	L	T	P	C
PCC 20	rDNA TECHNOLOGY and GENOME EDITING	3	1	0	3

Course Objectives

- The course will provide the technical details and applications of modern tools for precision gene targeting and editing.
- The course will also provide information about recombinant DNA technology.

UNIT I **Introduction to recombinant DNA technology** **12 hours**

Introduction to recombinant DNA technology and its uses, Vectors: plasmid and bacteriophage, Vectors for yeast, insect and mammalian systems, Prokaryotic and eukaryotic expression host systems, Introduction of recombinant DNA in to host cells and selection methods.

UNIT II **Tools for Identification and Isolation of gene** **12 hours**

Tools for gene Identification and Isolation including PCR based methods. Amplification of DNA using PCR, Selection of restriction sites for cloning of an amplified DNA into selected vector, Maxam Gilbert's and Sanger Coulson's and automated methods of DNA sequencing.

UNIT III **Genomic Library** **12 hours**

Genomic and cDNA library Site directed mutagenesis RNA isolation and RT-PCR.

UNIT IV **Overview of traditional methods of Genome Editing** **12 hours**

Overview of traditional methods: homologues recombination for gene knockout. RNAi system, Cre-LoxP and Flp-FRT systems, types of therapeutic genome modifications-Gene disruption, non-homologous end joining - NHEJ gene correction.

UNIT V **Engineered enzyme systems & Its application** **12 hours**

Engineered enzyme systems: Zinc finger nucleases (ZFNs), transcription-activator like effector nucleases (TALEN), CRISPR/Cas9 system, Origins of CRISPR and CRISPR Editing in Animal Models, Ethics, safety and risk of targeted gene editing, Transgenic animals, Endogenous gene labeling, targeted transgene addition, GM plants and applications.

TOTAL : 60 hours

Text Books:

T4: CRISPR Gene Editing, Methods and Protocols, Editors: Luo, Yonglun

T5: Genome Editing and Engineering, From TALENs, ZFNs and CRISPRs to Molecular Surgery. Edited by KrishnaraoAppasani.

T6: Principles of Gene Manipulation and Genomics, Primrose & Twyman.

T7: Winnacker, Ernst L. (1987), From genes to clones: introduction to gene technology [Gene und Klone] (in German), Horst Ibelgaufts (trans.), Weinheim, New York: VCH, ISBN 0-89573-614-4.

Reference Books:

R1: Modern Genetic Analysis. Griffiths AJF, Gelbart WM, Miller JH, et al. New York: W. H. Freeman; 1999.

COURSE OUTCOMES

Upon completion of this course the students will be able to,		
CO1	Understand the vectors used in recombinant DNA technology	**K2**
CO2	Identify the tools and techniques involved in Gene Isolation and manipulation.	**K3**
CO3	Construct and screen the Genomic and cDNA Libraries	**K3**
CO4	Apply the traditional methods of Genome Editing	**K3**
CO5	Develop the engineered enzyme systems and animal model	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PCC 21	rDNA TECHNOLOGY & GENOME EDITING LABORATORY	0	0	2	1

Course Objectives

- Provide hands-on experience in performing basic recombinant DNA techniques.
- Introduce students to the theory behind in each technique and to describe common applications of each methodology in biological research.

LIST OF EXPERIMENTS

1. Good Laboratory Practices
2. Different Sterilization Techniques
3. Preparation of plasmid DNA
4. Elution of DNA from agarose gels
5. Ligation of DNA into expression vectors
6. Transformation
7. Optimisation of inducer concentration for recombinant protein expression
8. Optimisation of time of inducer for recombinant protein expression
9. SDS-PAGE
10. Western blotting

TOTAL : 30 hours

Reference Books:

Molecular Cloning-A laboratory Manual-Third Edition, Sambrook and Russell.

COURSE OUTCOMES

Upon completion of this course the students will be able to,		
CO1	Understand the safety measures and Sterilization techniques	**K2**
CO2	Develop and construct the engineered plasmids	**K3**
CO3	Analyze nucleic acid molecules quantitatively	**K4**
CO4	Clone and express a gene and produce therapeutically valuable proteins	**K4**
CO5	Perform protein expression and characterization	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓					

Course code	Course	L	T	P	C
PCC 22	BIOSEPARATION ENGINEERING LABORATORY	0	0	2	1

Course Objectives:

1. Understand the basic principles in Downstream process
2. Decide among different chromatography method for protein purification
3. Separate a protein from a mixture
4. Apply their knowledge to make crystals or dry powder of a bio-molecule

LIST OF EXPERIMENTS

1. Screening and selection of media for lipase production from a given bacteria
2. Isolation of the plant cell organelles using centrifugation methods.
3. Isolation and separation of the DNA, RNA and proteins using centrifugation and biochemical methods.
4. Separation of the proteins with suitable chromatography methods.
5. Apply filtration or ultrafiltration method for separation of proteins.
6. Use TLC for separation of the biolipids.
7. Isolation of the photosynthetic pigments using centrifugation methods
8. To study the drying kinetics of tomato.
9. Bacterial cell lysis by sonication.
10. Isolation of lycopene from tomato.

Total hours: **30 hours**

LIST OF EQUIPMENTS

1. TLC plates
2. Centrifugation
3. Incubators 2
4. Chromatography
5. Sonicator

Text Books:

T1. Shuler and Kargi, Bioprocess Engineering – Basic Concepts. Prentice Hall PTR, 2002

T2. Doran, Bioprocess Engineering Principles, Academic Press, 1995

REFERENCES

R1. Bailey and Ollis, Biochemical Engineering Fundamentals, 1986

R2. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2006.

R3. Roger Harrison et al., Bioseparation Science and Engineering, Oxford University Press, 2015.

WEBLINK:

W1. https://archive.nptel.ac.in/courses/102/106/102106022/

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Identify the downstream process technique for the separation of Biomolecules	**K2**
CO2	Construct the protocols for the separation of proteins using different chromatography method	**K3**
CO3	Select the Centrifugation method suitable for isolation	**K3**
CO4	Apply various downstream techniques for product isolation and separation	**K3**
CO5	Develop the processes for recovery and subsequent purification of target biological products	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

Course Code	Course	L	T	P	C
PCC 23	SUMMER INTERNSHIP	0	0	4	2

Course Objectives:

1. A practice-oriented and 'hands-on' working experience in the real world or industry to enhance the student's learning experience.
2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting.
3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real-world work environment.

COURSE OUTCOMES

Upon completion of the course, the students will be able to,		
CO1	Apply the knowledge and skill sets acquired from the course and workplace in the assigned job function	**K3**
CO2	Solve real life challenges in the workplace by analysing work environment and conditions, and selecting appropriate skill sets acquired from the course	**K3**
CO3	Take part in project planning in their Industrial In-plant Training Project work.	**K4**
CO4	Recommend ideas to improve work effectiveness and efficiency by analysing challenges and considering viable options	**K5**
CO5	Develop critical thinking and problemsolving skills by analysing underlying issues to challenges	**K6**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	3	3	1	3	3	1	2	3	3
CO2	-	2	2	2	-	-	2	1	3	1	1	1	-	1
CO3	3	3	2	3	3	3	3	3	3	3	2	3	3	3
CO4	3	3	2	3	3	3	3	1	3	2	1	2	3	3
CO5	-	3	2	2	3	3	3	1	3	2	1	2	3	3

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
		✓		✓	

Syllabus

Semester VII

Course code	Course	L	T	P	C
PCC 24	NANOBIOTECHNOLOGY	3	0	0	3

Course Objectives:

1.This course is designed to make students understand the intersection of nanotechnology and biology.
2.It will also acquaint students with nano-devices of biomedical applications.
3.Students will know about the use of nanotechnology in diagnostic biology and learn about health and environmental impacts of nanotechnology.

UNIT I BASICS OF QUANTUM MECHANICS AND ATOMIC STRUCTURE 9 hours

Duality of light, de Broglie waves, electrons in potential well, structure of hydrogen atom, classic atomic bonding, LCAO theory, band theory, energy bands for metals, semi-conductors and insulators Surface Science of Nanomaterials: crystal structure, close packed structures – FCC, HCP and BCC, surface structure for close-packed surfaces, surface reconfiguration (surface relaxation & surface reconstruction) adsorption, wetting, surface area in nanomaterials

UNIT II INTRODUCTION TO NANOSTRUCTURES 9 hours

Carbon nanotubes (CNT), fullerene ('C60'), quantum dots and semiconductor nanoparticles, metal-based nanostructures, nanowires, polymer-based nanostructures, gold nanostructures Nanomaterial Characterization: X-ray diffraction, electron microscopy, interaction between electron beam and solids, TEM, SEM, SPM (STM & AFM), AES, XPS, SIMS

UNIT III NANO BIOMATERIALS 9 hours

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

UNIT IV NANOTECHNOLOGY IN BIOMEDICAL APPLICATION 9 hours

Micro- and Nano electromechanical devices in drug delivery, other applications in drug delivery, photodynamic therapy in targeted drug administration, Nano biosensors, applications of quantum dots in biotechnology

UNIT V DNABASED NANOMATERIALS AS BIOSENSORS 9 hours

Health and Environmental Impacts of Nanotechnology Engineered nanomaterial of relevance to human health, routes of entry into the body, toxic effects on health, plants and microbes are nanofactories.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Fundamentals and applications of nanomaterials by Guo Z and Tan L, Artech house (2009).

T2. Nanobiotechnology by Balaji S, MJP Publishers (2010).

T3. Nanobiotechnology: concepts, applications and perspectives by Niemeyer CM and Mirkin CA, Wiley-VCH (2004).

T4. Introduction to Nanoscience by Lindsay SM, Oxford University Press (2010)

REFERENCE

R1. Prasad R, Kumar V, Kumar M, Choudhary DK, editors. Nanobiotechnology in bioformulations. Cham: Springer International Publishing; 2019 Jul 4.

R2. Lateef A, Gueguim-Kana EB, Dasgupta N, Ranjan S, editors. Microbial nanobiotechnology: principles and applications. Springer Singapore; 2021.

WEBLINK:

W1. https://archive.nptel.ac.in/courses/118/107/118107015/

COURSE OUTCOMES

Upon successful completion of the course, students will be able to		
CO1	Outline the basic concepts of quantum mechanics and atomic structure	**K2**
CO2	Compare different types of nanostructures and their characterization techniques	**K2**
CO3	Summarize different applications of biomimetic nanotechnology in cell study	**K2**
CO4	Explain the biomedical applications of nanotechnology	**K2**
CO5	Identify the environmental and health impacts of nanotechnology using DNA based nanomaterials	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course code	Course	L	T	P	C
PCC 25	NANOBIOTECHNOLOGY LABORATORY	0	0	2	1

Course Objectives:

1. Employ bionanomaterials for analysis and sensing techniques
2. Apprehend and explain the biomedical applications of nanotechnology

LIST OF EXPERIMENTS

1. Introduction to nanoscience and nanobiotechnology (Size comparative analysis)
2. Biological synthesis of silver nanoparticles; UV-Visible absorption of thecolloidal solution and estimation of size by curve fitting.
3. Biological synthesis of zinc nanoparticles; UV-Visible absorption of thecolloidal solution and estimation of size by curve fitting.
4. Biological synthesis of Iron nanoparticles; UV-Visible absorption of thecolloidal solution and estimation of size by curve fitting.
5. Antibacterial activities of silver nanoparticles, against bacterial culturesperformed by standard disc diffusion method.
6. Nano emulsion Technique with Plant sample
7. Nature of Interaction between nanoparticles & Bacterial Cell (E. coli and B. subtilis).
8. XRD technique-Demo
9. Zeta Potential-Demo
10. SEM and TEM- Theory and Principle

Total hours: **30 hours**

LIST OF EQUIPMENTS

Autoclave -1
Hot Air Oven -1
Incubators- 2
Light Microscopes- 4
Incubator Shaker- 1
Colorimeter- 2
Laminar Flow Chamber- 2
Glassware, Chemicals, Media as required

REFERENCES:

R1. Andrew Collins, "Nanotechnology Cookbook: Practical, Reliable and Jargon-free Experimental Procedures", Elsevier, 2012

R2. Challa, "Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact", Wiley – VCH, 2005.

WEBLINK:

W1. https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-bt18/

COURSE OUTCOMES

Upon successful completion of the course, students will be able to		
CO1	Demonstrate the biological synthesis of different metallic nanoparticles and their characterization.	**K2**
CO2	Illustrate various biological activities of silver nanoparticles	**K2**
CO3	Demonstrate the production of different types of nanoemulsions using natural sources	**K2**
CO4	Experiment with the nature of interaction between nanoparticles and bacterial cell	**K3**
CO5	Examine the nanoparticles using different characterization techniques	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

Course Code	Course	L	T	P	C
EEC 01	PROJECT PHASE I	0	0	10	5

Course Objectives:

- Understand the basic concepts & broad principles of Industrial projects
- Get capable of self-education and clearly understand the value of achieving perfection in project implementation & completion.
- Apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Demonstrate a sound technical knowledge of their selected project topic.	**K2**
CO2	Select new technologies & design techniques concerned for devising a solution for a given problem statement	**K5**
CO3	Choose the engineering solutions to complex problems utilising a systems approach.	**K5**
CO4	Plan and work with team mates, sharing knowledge and collectively apply effort for making project successful.	**K6**
CO5	Discuss the results and communicate technical information by means of written and oral reports	**K6**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
			✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
		✓		✓	

Syllabus

Semester VIII

Course Code	Course	L	T	P	C
EEC 02	PROJECT PHASE II	0	0	20	10

Course Objectives:

- Understanding the concepts & broad techniques in the fields of biotechnology
- Get capable of self-education and clearly understand the value of achieving perfection in project implementation & completion.
- Apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Apply the technical knowledge and the methods in the selected area of research.	**K3**
CO2	Interpret the various technologies to design the product.	**K5**
CO3	Determine a methodology in the specified area	**K5**
CO4	Plan and work with team mates, sharing knowledge and collectively apply effort for making project successful.	**K6**
CO5	Discuss the results and communicate technical information by means of written and oral reports	**K6**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
			✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
		✓		✓	

Syllabus

Professional Elective Courses

Course Code	Course	L	T	P	C
PEC 01	GOOD MANUFACTURING AND LABORATORY PRACTICE	3	0	0	3

Course Objectives:

1.Basic understanding of the regulatory requirements of cGMP and GLP.

UNIT I Introduction to GMP and GLP **9 hours**

Introduction to Good Manufacturing and Laboratory Practice, Requirement of GLP and GMP compliance for regulatory approval, Ethics in manufacturing and control,

UNIT II Quality by Design and Applications **9 hours**

Principles of quality by design (QBD) Introduction to the concept of Design of Experiment (DOE) Application of QBD principles in Biotech product development.

UNIT III Case studies of QBD and DOE **9 hours**

Case studies: Example of QBD and DOE in Process Development, Example of DOE in analytical development, Introduction to ICH guidelines and their usage.

UNIT IV Regulatory authorities **9 hours**

National and international regulatory authorities and their function, Pharmaceutical 83 Jurisprudence and Laws related to Product design, Drug Development & Approval Process, Regulation of Clinical and Preclinical Studies.

UNIT V Formulation and Computer simulation **9 hours**

Good Manufacturing Practices, Formulation Production Management, Authorization and marketing of drugs. Computer simulation on process design.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. cGMP starter guide: Principles in Good Manufacturing Practices for Beginners, Emmet P. Tobin, Createspace Independent Publishing Platform, April 2016.

T2. Good Manufacturing Practices for Pharmaceuticals: GMP in Practice, B Cooper, Createspace Independent Publishing Platform, July 2017.

T3. Sarwar Beg and Md Saquib Hasnain, Pharmaceutical Quality by design: Principles and application, Academic press, March 2019.

T4. Ron S. Kenett, Shelemyahu Zacks, Daniele Amberti, Modern Industrial Statistics: with applications in R, MINITAB and JMP, 2nd Edition, Wiley, January 2014

T5. N Politis S, Colombo P, Colombo G, M RekkasD.Design of experiments (DoE) in pharmaceutical development, Drug Dev Ind Pharm. 2017 Jun;43(6):889-901. doi: 10.1080/03639045.2017.1291672.

REFERENCES

R1. Andrew Teasdale, David Elder, Raymond W. Nims, ICH quality guidelines- An implementation guide, Dec 2017.

R2. Marc P. Mathieu, New Drug Development: A regulatory overview, Nov 2000.

WEBLINKS

W1 ICH guidelines available in the official website “https://www.ich.org”.

W2 https://nptel.ac.in/courses/112107219

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the Good Manufacturing and Laboratory Practice	**K2**
CO2	Illustrate the concept of Design of Experiment (DOE)	**K2**
CO3	Develop and Classify ICH guidelines and their usage.	**K3**
CO4	Choose and determine the Drug Development & Approval Process, Regulation of Clinical and Preclinical Studies	**K3**
CO5	Summarize and list the Management, Authorization and marketing of drugs.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO 2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
CO1	-	1	1	2	2	2	2	1	1	1	1	1	3	3
CO2	2	3	1	2	2	2	1	1	1	1	-	2	3	3
CO3	2	2	1	2	1	2	1	2	-	1	-	1	3	3
CO4	3	1	1	2	1	-	2	-	1	1	1	1	3	3
CO5	1	1	1	2	2	3	-	-	-	1	1	1	3	3

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PEC 02	MARINE BIOTECHNOLOGY	3	0	0	3

Course Objectives:

- To know the marine organisms of interest in biotechnology, their basic functions and role in the marine ecosystems
- To understand the essential elements related to aquaculture and fish genetics and to acquire knowledge on marine natural products and fishery by-products; and also, to apply biotechnological methods for the conservation and protection of marine environment

UNIT I Introduction to Marine Ecosystems and Microbial Diversity 9 hours

Physical and chemical properties of sea water. Zonation of sea: Euphotic zone, Bathyal zone, Abyssal zone, Benthic zone, Deep Sea. Marine ecosystems and biodiversity: Estuary, Seagrass, Seaweed, Salt marsh, Mangroves and Coral reef. Marine microbial diversity: Marine microbial habitats, Microbial distribution in the ocean, Factors that impact marine microbial diversity. Interactions between marine microbes and other living organisms.

UNIT II Aquaculture and Fish Genetics 9 hours

Aquaculture: Definition- Criteria of selection of aquaculture species. Culture practices of marine Fish, Shrimp, Crab, Lobster, Oyster, and Seaweed. Fish genetics: Gynogenesis, Androgenesis, Polyploidy, Artificial insemination, Eye stalk ablation and Cryopreservation of fish gametes.

UNIT III Economic Importance of Marine Organisms 9 hours

Production of live-feeds in marine aquaculture: Rotifers, Artemia, Copepods and Microalgae. Biofuel production. Marine enzymes, Production of omega-3 fatty acids from marine organisms. Marine pharmacology: New and novel antibiotics from marine organisms. Secondary metabolites from marine bacteria, actinomycetes and marine endophytic fungi. Prebiotics and Probiotics for aquaculture.

UNIT IV Marine and Fishery By-Products 9 hours

Marine algal by-products: Chitin, Chitosan, Agar, Alginates, Carrageenan and Heparin. Fishery by-products: Fish oil, Isinglass, Fish glue, Fish silage, Fin rays.

UNIT V Marine Environment Protection 9 hours

Marine Pollution. Human impacts on marine microbial diversity - Usage of marine microbes to ameliorate environmental deterioration. Control of oil spills and bioremediation. Effects of bio-fouling and bio-deterioration on marine structures. Protection methods against corrosion and fouling. Red tides: Causative factors and effects on the organisms of marine environment.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Marine Biotechnology, Guest Editors: Song Qin, W.E.G. Muller and Edwin L. Cooper. Hindawi Publishing Corporation, 2011.

T2. Grand Challenges in Marine Biotechnology, P. H. Rampelotto, A. Trincone (eds.). Springer International Publishing AG, part of Springer Nature, 2018

T3 Marine Biotechnology, Advances in Biochemical Engineering/Biotechnology, Le Gal Y., Ulber R. (Series editor: T. Scheper), Springer-Verlag Berlin Heidelberg, 2005.

T4 Jennie Hunter-Cevera, David Karl and Merry Buckley, Published by American Academy of Microbiology, San Francisco, California, 2005.

REFERENCES

R1. Advances in Marine and Brackish water Aquaculture, Santhanam Perumal, Thirunavukkarasu A.R., Perumal Pachiappan. Editors. Springer India. 2005.

R2. Arumugam, Aquaculture, Saras Publication, 2014. FAO.

R3. The State of World Fisheries and Aquaculture, Rome, 2018.

R4. T.V.R. Pillay & M..N.Kutty, Aquaculture: Principles and Practices, Wiley India Pvt. Ltd., 2nd Edition, 2011

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the marine microbial diversity	**K2**
CO2	Summarize different methods of selection of aquaculture species and Culture practices.	**K2**
CO3	Explain in detail about the Production of live-feeds in marine aquaculture	**K2**
CO4	Summarize different Marine algal by-products	**K2**
CO5	Apply the knowledge of Marine Pollution and environmental deterioration.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PEC 03	WASTE MANAGEMENT AND UPCYCLING	3	0	0	3

Course Objectives:

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

UNIT I WASTE MANAGEMENT 12 hours

The definition of waste and its classification in the context of EU legislation, policy and other drivers for change, including the planning and permitting regime for the delivery of waste management solutions Liquid waste collection, treatment and disposal systems: Segregation and mixing schemes; Pre-treatment and its role in the industrial wastewater management; Overview of wastewater treatment technologies and development of wastewater treatment schemes; Operation and maintenance of effluent treatment plants; and Case study of an industrial wastewater management system. Air Pollution management and treatment: Overview of industrial emissions; Air pollution control systems and overview of air pollution control technologies; Development of schemes for the collection, treatment and discharge industrial emissions

UNIT II TECHNOLOGIES FOR WASTE TREATMENT 8 hours

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

UNIT III RECYCLING AND RECOVERY TECHNOLOGIES 10 hours

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

UNIT IV WASTE AND RESOURCE MANAGEMENT 10 hours

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

UNIT V SUSTAINABLE WASTE MANAGEMENT 5 hours

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

Total Lecture hours: 45 hours

TEXT BOOKS

T1. O.P. Gupta, “Elements of Solid & Hazardous Waste Management”, Khanna Publishing House, New Delhi, 2019.

T2. George Tchobanoglous, “Integrated Solid Waste Management”, McGraw-Hill Publishers, Indian edition 2014.

REFERENCES

R1. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, “Waste Management”, Springer, 1994.

WEBLINKS

W1 https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=80577&printable=1

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the various wastewater treatment methods and its management	**K2**
CO2	Demonstrate the various treatment methods for waste incineration and energy production	**K2**
CO3	Outline the various recycling and recovery technologies for developing value added products	**K2**
CO4	Make use of decision support tools used in waste and resource management strategies implemented in different countries	**K3**
CO5	Identify the strategy for sustainable waste management and analyze the related case studies	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓				

Course Code	Course	L	T	P	C
PEC 04	Creativity, innovation and new product development	3	0	0	3

Course Objectives:

1.To impart the knowledge of various aspects of Creativity, Innovation and New Product Development

UNIT I Introduction **9hours**

The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - creativity and problem solving – brain storming - different techniques.

UNIT II Project Selection and Evaluation **9hours**

Collection of ideas and purpose of project - Selection criteria - screening ideas for new products (evaluation techniques).

UNIT III New Product Development **9hours**

Research and new product development - Patents - Patent search - Patent laws - International code for patents - Intellectual property rights (IPR).

UNIT IV New Product Planning **9hours**

Design of proto type - testing - quality standards - marketing research introducing new products.

UNIT V Model Preparation & Evaluation **9hours**

Creative design - Model Preparation - Testing - Cost evaluation – Patent application.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. Managing Technological Innovation: Integrated Technology by John Besant 2015.

T2. Osho: "Creativity – Unleashing the Forces Within"St Martin's Griffin, New York, March, 2007.

T3. Product Release Planning by Guenther Ruhe, Taylor & Francis, 2010.

REFERENCES

R1. Project Management 8th Edition 2021 by Erik W. Larson & Clifford F. Gray, Rohit Joshi, McGraw Hill

R2. New Product Development Quality a Clear and Concise Reference Kindle Edition.2019.

WEBLINKS

W1 https://nptel.ac.in/courses/112107217

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the use of creativity and innovation for problem solving.	**K2**
CO2	Summarize the projects using selection criteria and evaluation techniques.	**K2**
CO3	Interpret the knowledge on Patents, Quality, Creativity and Innovation, in future research projects and new product development.	**K2**
CO4	Organize the working models during new product development with respect to the quality standards.	**K3**
CO5	Develop and list the quality standards and market research in new product development.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PEC 05	NEUROBIOLOGY AND COGNITIVE SCIENCES	3	0	0	3

Course Objectives:

1. To know the general organization of brain and physiological and cognitive processes.
2. To apply the molecular, cellular, and cognitive bases of learning and memory

UNIT I NEUROANATOMY 9 hours

What are central and peripheral nervous systems; Structure and function of neurons; types of neurons; Synapses; Glial cells; myelination; Blood Brain barrier; Neuronal differentiation; Characterization of neuronal cells; Meninges and Cerebrospinal fluid; Spinal Cord.

UNIT II NEUROPHYSIOLOGY 9 hours

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; chemical and electrical synaptic transmission; information representation and coding by neurons.

UNIT III NEUROPHARMACOLOGY 9 hours

Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function

UNIT IV APPLIED NEUROBIOLOGY 9 hours

Basic mechanisms of sensations like touch, pain, smell and taste; neurological mechanisms of vision and audition; skeletal muscle contraction.

UNIT V BEHAVIOUR SCIENCE 9 hours

Basic mechanisms associated with motivation; control of feeding, sleep, hearing and memory; Disorders associated with the nervous system.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University Press, USA, 1994

REFERENCES

R1. Mathews G.G. Neurobiology, 2nd edition, Blackwell Science, UK, 2000.

R2 Mason P., Medical Neurobiology, Oxford University Press, 2011

WEBLINKS

W1 https://archive.nptel.ac.in/courses/109/104/109104171/

COURSE OUTCOMES

Upon completion of the course, the students will be able to,		
CO 1	Outline the structure and function of molecules and tissues involved in neurobiological systems	**K2**
CO 2	Summarize the role of ion channels, receptors and cell signalling in maintaining the function of nervous system	**K2**
CO 3	Choose the cellular and molecular basis for excitability, conductivity, synaptic function and plasticity of the nervous system	**K3**
CO 4	Select the basic mechanism associated with sensory perception and homeostasis	**K3**
CO 5	Identify the mechanisms involved in cognition, learning, memory, autonomic control, emotional regulation, appetite, and sleep	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO 1	**PO 2**	**PO 3**	**PO4**	**PO 5**	**PO 6**	**PO7**	**PO 8**	**PO9**	**PO10**	**PO11**	**PO1 2**	**PSO 1**	**PSO 2**
CO1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
CO2	1	1	1	1	-	-	-	-	-	-	-	-	2	1
CO3	1	1	1	1	-	-	-	-	-	-	-	-	2	1
CO4	1	1	1	1	-	-	-	-	-	-	-	-	2	1
CO5	1	1	1	1	-	-	-	-	-	-	-	-	2	1

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration / Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
PEC 06	AQUACULTURE	3	0	0	3

Course Objectives:

To give outline about the basics of aquaculture and various culture systems, pond management, study of monoculture, polyculture and integrated culture systems, water and soil quality in relation to fish production and to become familiar with practical aspects of aquaculture like feeds and feeding; stocking, transport, harvest and post-harvest technology; marketing and economics; disease prevention, diagnosis and treatment.

UNIT I Introduction to Aquaculture 9 hours

Aquaculture: Definition-Site selection, design and construction of aquaculture pond. Criteria for selecting the candidate species for aquaculture. Types and methods: Extensive, Semi-intensive and Intensive culture. Composite fish culture and Integrated fish farming. Types of culture systems: Pen culture, Cage culture, Raft culture and Pond culture

UNIT II Hatchery Production and Genetic Improvement of Aquatic Organisms 9 hours

Design and construction of a fish hatchery. Types of hatcheries and management practices. Live feed culture: culture of microalgae, rotifers, copepods and Artemia. Selection of brooder, nutrition, gonadal changes, hormonal regulation. Genetic improvement: Inbreeding and cross breeding. Genetic manipulation: Sex-reversal and sex control, role of steroids in sex reversal, Chromosomal manipulation: Polyploidy, Androgenesis and Gynogenesis. Production of transgenic fishes, micro injection technique.

UNIT III Grow-Out Production of Aquatic Organisms and Pond Management 9 hours

Culture of economically important aquatic species: Seaweed, Shrimp, Seabass, Crab, Lobster, Mussels and Oysters. Culture practices of freshwater species: Prawns, Carps, Catfish, Murrels, and Ornamental fishes. Water quality management: Dissolved Oxygen, CO2, Ammonia, pH, salinity, temperature and turbidity. Pond management: Nursery and grow-out pond maintenance, pond fertilization. Biofloc technology.

UNIT IV Post-Harvest Technology 9 hours

Types of harvest, sorting, cleaning, packing, transportation of live organisms and preservation. Fish processing: Types of processing and canning, Quality assurance: Standards of sanitation and hygiene. Implementation of HACCP concept and food safety in fish industry.

UNIT V Fish Diseases and Control Measures 9 hours

Disease diagnosis: Principles of disease diagnosis in finfish and shell fish. Microbial diseases: Bacterial disease, fungal disease, and viral disease. Disease treatment methods: prophylactic and therapeutic. Parasitic diseases: Diseases caused by Protozoa and Metazoa, and their symptoms, cure and control. Non–infectious diseases: Nutritional and environmental diseases, symptoms, cure and control. Treatment of Aquaculture effluents.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Advances in Marine and Brackishwater Aquaculture, Santhanam Perumal, Thirunavukkarasu A.R., Perumal Pachiappan. Editors. Springer India, 2015.

T2 Aquaculture, N.Arumugam. Saras Publication, 2014.

T3 FAO, The state of world fisheries and aquaculture. FAO, Rome, 2018.

T4 Pillay T.V.R. &Kutty M.N. Aquaculture: Principles and Practices, Wiley India Pvt Ltd; 2nd Edition 2011

REFERENCES

R1. Tools of Titans: The Tactics, Routines, and Habits of Billionaires, Icons, and World-Class Performers Hardcover 2016, by Timothy Ferriss, Arnold Schwarzenegger. Publisher:

R2. Houghton Mifflin Harcourt, ISBN-10: 1328683788; ISBN-13: 978-1328683786. Disrupted: My Misadventure in the Start-Up Bubble Hardcover 2016, Dan Lyons. Publisher

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the fundamentals of Aquaculture design and construction	**K2**
CO2	Demonstrate the knowledge of hatcheries and management practices	**K2**
CO3	Explain the various methods of Production of Aquatic Organisms and Pond Management	**K2**
CO4	Develop the knowledge of various types of Post-harvest Technology	**K3**
CO5	Identify the methods for diagnosis of various fish diseases and treatment.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PEC 07	BIOSIMILARS TECHNOLOGY	3	0	0	3

Course Objectives:

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

UNIT I Introduction to Biopharma **9 hours**

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

UNIT II Types of biosimilar drugs **9 hours**

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

UNIT III Characterization methods **9 hours**

Aggregation- precipitation, floccule strength, precipitate ageing & kinetics, adsorption of proteins & peptides on surfaces, effect of temperature on protein structure, hydration & thermal stability of proteins, analytical and spectrophotometric characterization of proteins, protein sequencing and structure determination

UNIT IV Biosimilars **9 hours**

Immunogenicity & allergenicity of biosimilars; factors affecting immunogenicity - structural, post-translational modifications, formulations, impurities, manufacturing and formulation methods for biosimilars

UNIT V Bioequivalence and Case studies **9 hours**

Types of bioequivalence (average, population, individual), experimental designs & statistical considerations for bioequivalence studies, introduction to "ORANGE BOOK" & "PURPLE BOOK". Indian companies working in this space & their product pipeline (Biocon,Intas, Dr Reddy's, Reliance, Bharat Biotech, Lupin, Cipla, Shanta, etc); products - Erythropoietin, growth hormone, granulocyte stimulating factors, interferons, streptokinase, monoclonal antibodies.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow, Biosimilar Drug Development, Drugs and Pharmaceutical Sciences, Vol 216, CRC Press, 2017.

T2. Cheng Liu and K. John Morrow Jr., Biosimilars of Monoclonal Antibodies: A Practical Guide to Manufacturing, Preclinical and Clinical Development, Wiley, Dec 2016.

WEBLINKS

W1 https://www.drugs.com/medical-answers/many-biosimilars-approved-unitedstates-3463281

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Summarize about the biosimilars and its importance in the biopharmaceutical industry	**K2**
CO2	Utilize the knowledge on different biosimilars for the current and future biotechnology related products	**K3**
CO3	Develop the suitable methods for characterization of biosimilars	**K3**
CO4	Demonstrate about the bioequivalence studies and its formulation	**K2**
CO5	Compare the products associated with the industries for drug development	**K2**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓				

Course Code	Course	L	T	P	C
PEC 08	MOLECULAR PATHOGENESIS OF INFECTIOUS DISEASES	3	0	0	3

Course Objectives:

1. This course will introduce the students to understand about the microbial toxins and modern molecular pathogenesis.
2. To know about the host pathogen interaction and identifying virulence factors
3. To control pathogens by modern approaches.

UNIT I OVERVIEW 5 hours

Historical perspective - discovery of microscope, Louis Pasteur's contributions, Robert Koch's postulates, early discoveries of microbial toxins, toxic assays, vaccines, antibiotics and birth of molecular genetics and modern molecular pathogenesis studies, Various pathogen types and modes of entry.

UNIT II HOST-DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES 8 hours

Attributes & components of microbial pathogenesis, Host defence: skin, mucosa, cilia, secretions, physical movements, limitation of free iron, antimicrobial compounds, mechanism of killing by humoral and cellular defence mechanisms, complements, inflammation process, general disease symptoms, Pathogenic adaptations to overcome the above defences

UNIT III MOLECULAR PATHOGENESIS (WITH SPECIFIC EXAMPLES) 16 hours

Virulence, virulence factors, virulence-associated factors and virulence lifestyle factors, molecular genetics and gene regulation in virulence of pathogens, Vibrio Cholerae: Cholera toxin, co-regulated pili, filamentous phage, survival *E.coli* pathogens: Enterotoxigenic *E.coli* (ETEC), labile & stable toxins, Entero- pathogenic *E.coli* (EPEC), type III secretion, cytoskeletal changes, intimate attachment; Enterohaemerrohogic*E.coli* (EHEC), mechanism of bloody diarrhoea and Haemolytic Uremic Syndrome, Enteroaggregative *E.coli* (EAEC). Shigella: Entry, macrophage apoptosis, induction of macropinocytosis, uptake by epithelial cells, intracellular spread, inflammatory response, tissue damage Plasmodium: Life cycle, erythrocyte stages, transport mechanism and processes to support the rapidly growing schizont, parasitiparous vacuoles, and knob protein transport, Antimalarials based on transport processes. Influenza virus: Intracellular stages, Neuraminidase & Haemagglutinin in entry, M1 & M2 proteins in assembly and disassembly, action of amantidine.

UNIT IV EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS 8 hours

Virulence assays: adherence, invasion, cytopathic, cytotoxic effects. Criteria & tests in identifying virulence factors, attenuated mutants, molecular characterization of virulence factors, signal transduction & host responses

UNIT V MODERN APPROACHES TO CONTROL PATHOGENS 8 hours

Classical approaches based on serotyping. Modern diagnosis based on highly conserved virulence factors, immuno& DNA-based techniques. New therapeutic strategies based on recent findings on molecular pathogenesis of a variety of pathogens, Vaccines - DNA, subunit and cocktail vaccines.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Iglewski B.H and Clark V.L "Molecular basis of Bacterial Pathogenesis ", Academic Press, 1990

T2. Eduardo A. Groisman, Principles of Bacterial Pathogenesis, Academic Press, 2001.

REFERENCES

R1. Peter Williams, Julian Ketley& George Salmond, "Methods in Microbiology: Bacterial Pathogenesis, Vol. 27, Academic Press, 1998.

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Outline the discovery of microbial toxins and pathogens entry to the body	**K2**
CO2	Organization of host defences against pathogens and pathogenic strategies	**K3**
CO3	Examine molecular pathogenesis with suitable examples	**K4**
CO4	Simplify host pathogen interactions and its characterization	**K4**
CO5	List out modern approaches to control pathogens	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

Course Code	Course	L	T	P	C
PEC 09	LIFESTYLE DISEASES	3	0	0	3

Course Objectives:

- Identify and describe lifestyle diseases including: drug and alcohol addiction, type 2 diabetes, and cardiovascular disease
- Differentiate between controllable risk factors and uncontrollable risk factors for lifestyle diseases
- Describe proactive behaviours to lessen the risks of developing a lifestyle disease

UNIT I Introduction 9 hours

Lifestyle diseases – Definition; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

UNIT II CANCER 9 hours

Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma esophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

UNIT III CARDIOVASCULAR DISEASES 9 hours

Coronary atherosclerosis – coronary artery disease; Causes -Fat and lipids, Alcohol abuse –Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation.

UNIT IV DIABETES AND OBESITY 9 hours

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Pediatrics and adolescent obesity – Weight control and BMI

UNIT V Cardiovascular Diseases 9 hours

Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking –Diagnosis - Pulmonary function testing.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. R. Kumar & Meenal Kumar, “Guide to Prevention of Lifestyle Diseases”, Deep Publications, 2003

T2. Gary Eggar et al, “Lifestyle Medicine”, 3rd Edition, Academic Press, 2017.

REFERENCES

R1. James M.R, “Lifestyle Medicine”, 2nd Edition, CRC Press, 2013.

R2. Akira Miyazaki et al, “New Frontiers in Lifestyle-Related Disease”, Springer, 2008

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the fundamentals of Lifestyle diseases	**K2**
CO2	Demonstrate the knowledge of various types of cancer diseases	**K2**
CO3	Explain the various causes of cardiovascular diseases	**K2**
CO4	Develop the knowledge of root cause for Diabetes and obesity	**K3**
CO5	Identify various types of respiratory diseases and its treatment	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PEC 10	GENE EXPRESSION AND TRANSGENICS	3	0	0	3

Course Objectives

- The course will provide the technical details and use of different gene expression systems for overexpression of recombinant proteins and protein 116 complexes for different applications.
- The course will also provide details about purification of proteins expressed in different expression systems.
- The course will teach about generation of transgenic animals for research.

UNIT I INTRODUCTION TO GENE EXPRESSION 9 hours

Overview of recombinant protein expression vectors and promoters: Vectors with tags His, GST, MBP, GFP. Cleavable tag and non-cleavable tags. Vectors for tag free protein expressions.

UNIT II OVEREXPRESSION OF A GENE 9 hours

Pseudomonas fluorescens, yeasts like S. cerevisiae and Pichia pastoris, insect cell lines like Sf21, Sf9 and BTI-TN-5B1-4, Mammalian cell line like Chinese Hamster ovary (CHO) and Human embryonic kidney (HEK), Plant single cell.

UNIT III TRANSFORMATION AND PURIFICATION 9 hours

Chloroplast transformation and protein expression in chloroplasts. Cell free protein Expression-Cell free extracts from E. coli, rabbit, wheat germ, insects. Purification of tagged and tag-free proteins. GMP and GLP requirements.

UNIT IV TRANSGENIC ANIMALS 9 hours

Use of transgenic animals. History, safety and ethics of transgenic animals. Methods for creation of transgenic animals-DNA microinjection, Embryonic stem cell-mediated gene transfer, Retrovirus-mediated gene transfer.

UNIT V APPLICATIONS OF TRANSGENICS 9 hours

Use transgenic animals in medical research, in toxicology, in mammalian developmental genetics, in molecular biology in the pharmaceutical industry, in biotechnology, in aquaculture and in xenografting. Humanised animal models**.**

TOTAL : 45 hours

Text Books

T1 Gene Expression Systems, Using Nature for the Art of Expression. Edited by Joseph M. Fernandez and James P. Hoeffler.

T2 Regulation of Gene Expression, By Perdew, Gary H., Vanden Heuvel, Jack P., Peters, Jeffrey M. Springer.

T3 Ethical Use of Transgenic Animals (English, Paperback, Shah Krunal V). Lambert

T4 Prokaryotic Gene Expression. Edited by Simon Baumberg. Oxford Press

T5 Transgenic Animal Technology,3rd Edition, A Laboratory Handbook By Carl Pinkert. Elsevier.

T6 Transgenic Animals as Model Systems for Human Diseases. Edited E. F. Wagner F. Theuring. Springer.

Reference Books

R1 James M.R, “Lifestyle Medicine”, 2nd Edition, CRC Press, 2013

R2 Akira Miyazaki et al, “New Frontiers in Lifestyle-Related Disease”, Springer, 2008

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Understand the various vectors and promotors involved in Gene expression	**K2**
CO2	Construction of over expressed gene in various species.	**K3**
CO3	Develop the transformation and purification methodologies for various expressed proteins.	**K3**
CO4	Model the genetically engineered transgenic animals and the techniques involved in gene transfer	**K3**
CO5	Apply the transgenics in various field of Biotechnology	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓		✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓					

Course code	Course	L	T	P	C
PEC 11	BIOBUSINESS	3	0	0	3

Course Objectives:

1.Illustrate the basics of Biobusiness in various emerging biological field
2. Build critical thinking capability and design methodologies for entrepreneur
3. Create the ability for planning, commencing, executing and managing business

UNIT I Introduction to Biobusiness 9 hours

Introduction to Biobusiness, Fundamentals of Biotech for bio-Business, Contemporary Vs antique Biobusiness, Wealth Creation in Biobusiness.

UNIT II Health Science and Life Sciences in Business 9 hours

Healthcare, Biomedical sciences, Industrial Life Sciences and Biotechnology, Where Things Stand: A Quick Survey of Regional and Global Strengths and Capabilities

UNIT III Agriculture and Environment in Business 9 hours

Agriculture based business, Food Industry; Business related to Environment Management, Bioremediation, Bioleaching and waste management

UNIT IV World Class Corporation & Regulatory Rules 9 hours

Creating World Class Corporations, Biotech Clusters, Process of Business commencement, Ethics in business, Reason for business failures, causes and preventive measures, Opportunities for business, Human Resource, Financing incentives and subsidies and bounties for business units by government and NGOs.

UNIT V Protecting the Intellectual Property & Entrepreneurship 9 hours

Intellectual Property, Technology Licensing and Branding, Patenting, Copyright, Geographical Indicator, Trade Secretes, Factors affecting entrepreneurship growth, Future of Entrepreneurship, Entrepreneurship Development Programme (EDP's) Technology Business Incubator, Open Discussion Recent updates, Group Project Presentation: Case studies of different industries and their strategic planning.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Science Business: The Promise, the Reality, and the Future of Biotech 1st Edition by Gary P. Pisano. ISBN-13: 978-1591398400; ISBN-10: 1591398401, 2006

T2. From Alchemy To IPO: The Business of Biotechnology by Cynthia Robbins-roth ISBN-10: 073820482X; ISBN 13: 978-0738204826, 2001

T3. Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science 4th Edition by Yali Friedman ISBN-13: 978-1934899298; ISBN-10: 193489929, Logos Press, 2014.

T4. All in: 101 Real Life Business Lessons for Emerging Entrepreneurs Hardcover 2017, BillGreen. Publisher: Koehler Books, ISBN-10: 1633934667; ISBN-13: 978-1633934665.

T5. Bioorganic Phase in Natural food: An overview.GnanavelVelu, VeluchamyPalanichamy, Anand Prem Rajan (2018). Phytochemical and pharmacological importance of secondary metabolites in modern medicines. Springer, 135-156. ISBN 978-3-319-74210-6.

REFERENCES

R1 Tools of Titans: The Tactics, Routines, and Habits of Billionaires, Icons, and World-Class Performers Hardcover 2016, by Timothy Ferriss, Arnold Schwarzenegger. Publisher:

R2 Houghton Mifflin Harcourt, ISBN-10: 1328683788; ISBN-13: 978-1328683786. Disrupted: My Misadventure in the Start-Up Bubble Hardcover 2016, Dan Lyons. Publisher:

R3 Hachette Books, ISBN-10: 0316306088; ISBN-13: 978-0316306089. Idea to Execution: How to Optimize, Automate, and Outsource Everything in Your Business Paperback 2016, Ari Meisel, Nick Sonnenberg. Publisher: Lioncrest Publishing, ISBN-10: 1619615053; ISBN-13: 978-1619615052.

R4 Unshakeable: Your Financial Freedom Playbook Hardcover 2017, Tony Robbins. Publisher: Simon & Schuster, ISBN-10: 1501164589; ISBN-13: 978-1501164583.

R5 Grit: The Power of Passion and Perseverance Hardcover 2016, Angela Duckworth. Publisher: Scribner; ISBN-10: 1501111108; ISBN-13: 978-1501111105.

R6 The Third Wave: An Entrepreneur's Vision of the Future Hardcover 2016, Steve Case

COURSE OUTCOMES

Upon successful completion of the course, students will be able to		
CO1	Outline the fundamentals of bio-business in biotechnology	**K2**
CO2	Demonstrate the knowledge of health science and life science in bio-business	**K2**
CO3	Explain the various aspects of bio-business related to environment and agriculture	**K2**
CO4	Develop the knowledge of creating world class corporations and identifying the regulatory affairs	**K3**
CO5	Identify various types of Intellectual Property rights for Entrepreneurship Development Programme.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
PEC 12	TISSUE ENGINEERING	3	0	0	3

Course Objectives:

- This course helps the learners to understand thoroughly the key concepts of tissue organization, remodelling and strategies for restoration of tissue function.

UNIT I INTRODUCTION TO TISSUE ENGINEERING AND BIOMATERIALS 8 hours

Cells as therapeutic Agents with examples, Cell numbers and growth rates. Biomaterials in tissue engineering - biodegradable polymers and polymer scaffold processing.

UNIT II BASIC BIOLOGY 12 hours

Fibrous extracellular matrix, Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Direct Cell-Cell contact - Cell junctions in tissues, malfunctions in direct cell- cell contact signaling. Response to mechanical stimuli, Cell-Polymer interaction.

UNIT III METHODS TO DEVELOP SCAFFOLDS FOR TISSUE ENGINEERING 8 hours

Hydrogel, porous scaffold, and Textile-based techniques used for medical application, Rapid prototyping/3D printing, Wound healing.

UNIT IV 3D PRINTING 8 hours

Introduction, 3D printing techniques for regenerative medicine, Scaffold based approach

UNIT V ORGAN REGENERATION 9 hours

Organ regeneration: Cartilage, Skin, Liver, Blood Vessel, Kidney, Urinary bladder, Tendons, Ligaments, Cornea.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Tissue Engineering, Bernhard O. Palsson, Sangeeta N. Bhatia, Pearson Prentice Hall Bioengineering, 2004.

T2. Principles of Tissue Engineering (Tissue Engineering Intelligence Unit), 2013 by Robert Lanza, Robert Langer, Joseph P. Vacanti, Academic Press; 4th edition.

REFERENCES

R1. Nanotechnology and Tissue engineering - The Scaffold, Cato T. Laurencin, Lakshmi S. Nair, CRC, 2008

WEBLINKS

W1 https://www.biologydiscussion.com/biotechnology/tissue-engineering/tissue-engineering-4-aspects-with-diagram/10577

W2 https://nptel.ac.in/courses/102106036

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the basics of tissue engineering and use of biomaterials	**K2**
CO2	Demonstrate the basics of cells in tissue engineering	**K2**
CO3	Make use of various methods to develop scaffolds for biomedical applications	**K3**
CO4	Apply the knowledge of 3D printing techniques for regenerative medicine	**K3**
CO5	Identify the regeneration techniques of various organs of the body	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PEC 13	Cancer Biology and Informatics	3	0	0	3

Course Objectives:

1.To understand the cellular and molecular mechanisms that are dysregulated in cancerous cells.
2. To understand genomic technologies and develop critical thinking skills in cancer research.
3. To learn both the traditional chemotherapy and novel targeted therapeutic approaches.

UNIT I Overview of the hallmarks of cancer 9hours

Hanahan and Weinberg defined six biological hallmarks of cancer, Mutagens, carcinogens – Causes for onset of genetic abnormalities, Evidence of mutation related cancers, Cellular processes that go awry in the transformation of normal cells to cancerous cells, Viruses (as causative agents).

UNIT II Evading Apoptosis and Telomere dysregulation 9hours

Apoptotic pathways and alterations in cancer, Bcl-2 Protein Family; IAPs; Endogenous inhibitors of IAPs, Telomeres, Hayflick limit, Telomerase Activation and Immortality, Alternative Lengthening of Telomere (ALT) pathway in Cancer.

UNIT III Angiogenesis and Metastasis 9hours

Angiogenesis – Angiogenesis, mechanism and role in tumour; Metastasis – Over view of metastasis – Seed and soil theory and beyond; epithelial to mesenchymal transition, signalling pathways in metastasis

UNIT IV Emerging Cancer Hallmarks 9hours

Emerging Hallmarks – Overview - Genomic Instability, Inflammation; Evading Immune system; Aberrant cellular energetics, Epigenetics, The Warburg effect, Introduction to Genomic Instability -Chromosomal instability (CIN), Microsatellite Instability (MSI), DNA repair dysregulation and genomic instability in Cancer.

UNIT V Cancer stem cells 9hours

The stem cell theory of Cancer/ Somatic Evolution of the cancer stem cell model, Evidence of cancer stem cells (CSCs), Origin of cancer stem cells, markers of cancer stem cells, Metabolic landscape of cancer stem cells/signalling pathways.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. The Biology of Cancer – Robert Weinberg. Edition – 2 nd ISBN:9780815342205 - 2013

REFERENCES

R1. Textbook readings; primary literature; in-class discussion. The Molecular Biology of Cancer: A Bridge from Bench to Bedside. Stella Pelengaris, Mike Khan -2 nd Edition - 2013

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain and relate the cellular and molecular mechanisms that are dysregulated in cancerous cells.	**K2**
CO2	Illustrate the genomic technologies and develop critical thinking skills in cancer research.	**K2**
CO3	Explain the traditional chemotherapy and novel targeted therapeutic approaches.	**K2**
CO4	Identify Emerging Cancer Hallmarks and its applications.	**K3**
CO5	Apply and categorize the cancer stem cell model, and Evidence of cancer stem cells (CSCs),	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PEC 14	FOOD BIOTECHNOLOGY	3	0	0	3

Course Objectives:

To familiarize the students with dimensions of food biotechnology.
2. To offer basics of Biotechnological Principles applied to Food Production
3. To offer Biotechnology approach to involved in processing of food

UNIT I World Food Resources **9 hours**

Food resources (plant, animal, microbes); Overview of current production systems; constraints and necessity of novel strategies, Improvement of plant nutritional and functional quality (starch, protein, fatty acid modification, biofortification); functional foods; genomic analysis of food nutrients in plant produce

UNIT II Animal food biotechnology **9 hours**

Improved milk, egg and meat quality using biotechnological interventions; application of transgenic fish technology in sea food production, Concept of SCP, mushrooms, food yeasts, algal protein.

UNIT III Food fermentations & food additives **9 hours**

Key concepts in fermentation; Overview of diverse fermented foods; Production process of selected fermented foods (Soyasauce, Sauerkraut, Beer, Wine, Yogurt, Cheese, Sausages); Starter cultures in food industry.

UNIT IV Molecular diagnostics in food quality control **9 hours**

Allergens, pathogenic microbes, adulterants (natural and man-made), mis-labelled produce, GM ingredients in food products. Food industry wastes: Characteristics of food wastes; treatment methods; recovery of value-added products

UNIT V Consumers and GM foods **9 hours**

Consumers and GM foods: Global perspective of consumers on GM foods; Major concerns of transgenic foods (labelling, bioavailability, safety aspects); regulatory agencies involved in GM foods.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. Science Business: The Promise, the Reality, and the Future of Biotech 1st Edition by Gary P. Pisano. ISBN-13: 978-1591398400; ISBN-10: 1591398401

T2 From Alchemy To IPO: The Business of Biotechnology by Cynthia Robbins-roth ISBN-10: 073820482X; ISBN-13: 978-0738204826

T3 Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science 4th Edition by Yali Friedman ISBN-13: 978-1934899298; ISBN-10: 193489929

T4 All in: 101 Real Life Business Lessons for Emerging Entrepreneurs Hardcover 2017, BillGreen. Publisher: Koehler Books, ISBN-10: 1633934667; ISBN-13: 978-1633934665

T5 Bioorganic Phase in Natural food: An overview.GnanavelVelu, VeluchamyPalanichamy, Anand Prem Rajan (2018). Phytochemical and pharmacological importance of secondary metabolites in modern medicines. Springer, 135-156. ISBN 978-3-319-74210-6

REFERENCES

R1. Tools of Titans: The Tactics, Routines, and Habits of Billionaires, Icons, and World-Class Performers Hardcover 2016, by Timothy Ferriss, Arnold Schwarzenegger. Publisher:

R2. Houghton Mifflin Harcourt, ISBN-10: 1328683788; ISBN-13: 978-1328683786. Disrupted: My Misadventure in the Start-Up Bubble Hardcover 2016, Dan Lyons. Publisher

R3 Hachette Books, ISBN-10: 0316306088; ISBN-13: 978-0316306089. Idea to Execution: How to Optimize, Automate, and Outsource Everything in Your Business Paperback 2016, Ari Meisel, Nick Sonnenberg. Publisher: Lioncrest Publishing, ISBN-10: 1619615053; ISBN-13: 978-1619615052.

R4 Unshakeable: Your Financial Freedom Playbook Hardcover 2017, Tony Robbins. Publisher: Simon & Schuster, ISBN-10: 1501164589; ISBN-13: 978-1501164583.

R5 Grit: The Power of Passion and Perseverance Hardcover 2016, Angela Duckworth. Publisher: Scribner; ISBN-10: 1501111108; ISBN-13: 978-1501111105

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Outline the fundamentals of Food resources and its analysis	**K2**
CO2	Demonstrate the knowledge of biotechnological interventions in animal food	**K2**
CO3	Explain the various aspects of fermentation and its food products	**K2**
CO4	Develop the knowledge of treatment methods for quality of food control	**K3**
CO5	Identify various techniques involved in consumers and regulatory agencies involved in GM foods.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course code	Course	L	T	P	C
PEC 15	DEVELOPMENTAL BIOLOGY AND REGENERATIVE MEDICINE	3	0	0	3

Course Objectives:

1.To provide a glimpse of scope and historical background of developmental biology to the students.
2. Knowledge regarding basic concepts of differentiation and growth, differential gene expression as well as cytoplasmic determinants to the students.
3.To develop detailed understanding of essential events of developmental biology through proper explanation of gametogenesis, fertilization, blastula formation, gastrulation as well as embryological induction as part of early embryonic development

UNIT I Introduction 9hours

Overview of Developmental Biology. Mathematical Modelling of Development growth (The mathematics of organismal growth / The mathematics of patterning). Approaches to Developmental Biology. Model organism, Formation and Structure of the Gametes, Types of sperm, Recognition of Egg and Sperm, Gamete Fusion and the Prevention of Polyspermy (Acrosomal process) in Sea urchin and Humans.

UNIT II Drosophila & Amphibians 9hours

Early Drosophila Development. The Origins of Anterior-Posterior Polarity. The Generation of Dorsal-Ventral Polarity, Early Amphibian (frog) Development (germ layers), Axis Formation in Amphibians. Cytoplasmic determinants in amphibians. Compare and contrast zebra fish and amphibian axis specification and gastrulation

UNIT III Vertebrates - Birds and mammals & Sex determination and Homeotic Genes 9hours

Early Development, and Axis Specification in Birds (chick) and Mammal (Mouse). Role of Cerberus in chick head formation. Tetrapod limb development (role of FGF). Neurulation (Neural Tube Formation), Chromosomal Sex Determination in Mammals, Primary and secondary sex characteristics Chromosomal Sex Determination in Drosophila, Environmental Sex Determination

UNIT IV Metamorphosis, Regeneration, and Aging 9hours

Metamorphosis: The Hormonal Reactivation of Development (Insect metamorphosis). Regeneration (Salamander Limbs/ Mammalian Liver/ Bone regeneration). Stem Cells: stem cell, Regenerative Therapy –Introduction, Large scale manufacturing of cells, tissues and organs.

UNIT V Applied Regenerative Medicine 9hours

Applied Regenerative Medicine: Applications of Regenerative Medicine in the nervous system, eye, heart, lung, liver, kidney, pancreas and kidney.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Gilbert Developmental Biology, 10th Edition. (2013)

T2. Slack JMW Essential Developmental Biology. 3rd Edition, Blackwell publishing. (2012)

T3. Hossein Baharvand, Nasser Aghdami Regenerative Medicine and Cell Therapy (2013)

T4. Stem Cell Biology and Regenerative Medicine. Humana Press.

T5. David L Stocum Regenerative Biology and Medicine, 2nd Edition, Academic Press. (2012)

REFERENCES

R1. Bruce M Carlson Human Embryology & Developmental Biology, 4th Edition 2011

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Relate the developmental biology and mathematical modelling.	**K1**
CO2	Explain the development of Drosophila and Amphibians	**K2**
CO3	Discuss the early development, and Axis specification in birds and Mammals	**K2**
CO4	Demonstrate the Metamorphosis stage and about stem cells	**K3**
CO5	Illustrate about the applications of regenerative medicine in various organs	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
PEC 16	BIOLOGICAL SPECTROSCOPY	3	0	0	3

Course Objectives:

1 To deliver the knowledge of spectroscopic techniques and its functions
2.To provide the technical information of spectroscopy for biological applications

UNIT I OPTICAL ROTATORY DISPERSION 9hours

Polarized light – optical rotation – circular dichroism – circular dichroism of nucleic acids and proteins

UNIT II TYPES OF NUCLEAR MAGNETIC RESONANCE 9hours

Chemical shifts – spin – spin coupling – relaxation mechanisms – nuclear overhauser effect – ESR multidimensional NMR spectroscopy – determination of macromolecular structure by NMR – magnetic resonance imaging.

UNIT III TYPES OF MASS SPECTROMETRY 9hours

Ion sources sample introduction – mass analyzers and ion detectors – bimolecular mass spectrometry – peptide and protein analysis – carbohydrates and small molecules – specific applications.

UNIT IV X-RAY DIFFRACTION 9hours

Scattering by x- rays – diffraction by a crystal – measuring diffraction pattern – Bragg reflection – unit cell – phase problem – anomalous diffraction – determination of crystal structure – electron and neutron diffraction.

UNIT V SPECIAL TOPICS AND APPLICATIONS 9hours

Electron microscopy – transmission and scanning electron microscopy – scanning tunnelling and atomic force microscopy – combinatorial chemistry and high throughput screening methods**.**

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Banwell, Colin N. and E.M. McCash. “Fundamentals of Molecular Spectroscopy” IVth Edition, Tata McGraw-Hill, 2017.

T2. Aruldas, G. “Molecular Structure and Spectroscopy”. IInd Edition, Prentice Hall of India, 2007.

T3. Pavia, D.L., G.M. Lampman and G.S. Kriz. “Introduction to Spectroscopy:” IIIrd Edition, Thomson, Brooks/ Cole, 2001.

T4. Williams, Dudley H. and Ian Fleming.” Spectroscopic Methods in Organic Chemistry”. Vith Edition, Tata McGraw-Hill, 2007.

REFERENCES

R1. Mass Spectrometry for Biotechnology 1st Edition, Kindle Edition 2022.

R2. Hammes, Gordon G. “Spectroscopy for the Biological Sciences”. John Wiley, 2005.

R 3. Mass Spectrometry: A Textbook Hardcover – Jurgen H Gross 14 February 2011

R4. Atkins P.W., “Physical Chemistry “,10th Edition, Oxford University Press India, 2014.

WEBLINKS

W1. https://nptel.ac.in/courses/104108078

W2. https://nptel.ac.in/courses/112106227

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain and list spectroscopic techniques and its functions.	**K2**
CO2	Classify the technical information of spectroscopy and its biological applications.	**K2**
CO3	Illustrate macromolecular structure by NMR – magnetic resonance imaging.	**K2**
CO4	Select and Explain mass analyzers and ion detectors.	**K3**
CO5	Identify and distinguish Electron microscopy – transmission and scanning electron microscopy.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
PEC 17	STRUCTURAL BIOLOGY	3	0	0	3

Course Objectives:

The course aims to

1. Familiarize about the structural aspects of protein and DNA
2. Understand about biophysical techniques for structure determination
3. Learn about X-Ray Crystallography, NMR and cryoelectron microscopy

UNIT I Structure of Macromolecules – DNA **9 hours**

Scope of structural biology – implications, drug discovery, Principles of nucleic acid structure - Watson and Crick's base-pairings and their implications. Non Watson and Crick pairing schemes - base stacking interactions - DNA polymorphism - structure of A-DNA, B-DNA and Z- DNA - helical transitions. Non-uniform helical DNA Structure. Unusual DNA structures - hairpins, bulges, cruciform, triplexes, tetraplexes

UNIT II Protein Structure and Function **9 hours**

Fundamentals of protein structure, Structural Hierarchy, Motifs and domains: domain structures, Types of proteins, Complex proteins, methods to secondary structural elements and prediction, study of prototype protein under each category - alpha, beta, alpha-beta structures, engineering and design of protein structures.

UNIT III X-RAY Crystallography **9 hours**

Elementary crystallography: Introduction: symmetry in crystals, crystal systems, resolution, growing crystals, sample preparation, X-ray sources, X-ray diffraction - Bragg's law - its application to geometrical Crystallography, strengths and limitations of crystallography.

UNIT IV Model Building and Refinement **9 hours**

In silico secondary and tertiary structure prediction: Homology modeling, threading and ab initio method, model refinement strategies, x-ray crystal structure determination, phase refinement and validation, deposition of structure in database

UNIT V NMR and Cryo-Electron Microscopy **9 hours**

Principle of Nuclear Magnetic Resonance, working of NMR spectroscopy, advantages, Nuclear spin, 1D- NMR spectra, 2D- NMR spectroscopy, Applications of NMR spectroscopy, Introduction to the principles of cryo-electron microscopy.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. K.P. Murphy. Protein structure, stability and folding (2001) Humana press. ISBN 0- 89603682-0

T2 Arthur M .Lesk Introduction to protein architecture (2010) Oxford University Press. ISBN 0198504748

T3 A.McPherson, Introduction to Macromolecular Crystallography. 2nd edition (2016)., John Wiley Co.

T4 Carl Branden and John Tooze and Carl Brandon Introduction to Protein Structure, (1999) John Garland, Publication Inc. ISBN 0815323050

T5 George H. Stout, Lyle H. Jensen, X-Ray Structure Determination: A Practical Guide, 2nd Edition. ISBN 0471607118. 2007

T6 G. E. Schulz. Principles of Protein Structure. Springer 2013

T7 Crystallography Made Crystal Clear: A Guide for Users of Macromolecular Models, 2006 by Gale Rhodes, Academic Press; 3 edition, ISBN-10: 0125870736, ISBN-13: 978- 0125870733

T8 The Nuclear Overhauser Effect in Structural and Conformational Analysis, by David Neuhaus Wiley-VCH; 2 edition, 2000, ISBN-10: 0471246751, ISBN-13: 978-0471246756

T9 Single-particle Cryo-electron Microscopy: The Path Toward Atomic Resolution/ Selected Papers Of Joachim Frank With Commentaries, World Scientific Publishing Co Pte Ltd, 2018

REFERENCES

R1. N. Gautham Bioinformatics (2006) Narosa publications. ISBN-13: 9781842653005

R2 VasanthaPattabhai and N. Gautham Biophysics (2002) Narosa Publishers ISBN 1- 4020-0218-1

R3 Rick NG, Wiley Blackwell. Drugs: From discovery to approval 3rd edition (2015)

R4 Ed Donald J Abraham Wiley-Inter science. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Drug Discovery and development.6th Edition (2003). ISBN 0471370282

WEBLINKS

W1 https://archive.nptel.ac.in/courses/102/107/102107086/

COURSE OUTCOMES

Upon completion of the course, the students will be able to,		
CO1	Explain about the basic building blocks of biological macromolecules	**K2**
CO2	Outline the structure, function, architecture and building blocks of protein	**K2**
CO3	Construct thethree dimensional molecular structure of a protein using X-Ray crystallography	**K3**
CO4	Apply the principles and mechanism behind protein model building and refinement	**K3**
CO5	Identify the molecular structure, phase changes, conformational and configurational alterations, solubility and diffusion potential of organic molecules	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
PEC 18	BIOTECHNOLOGY IN HEALTH CARE	3	0	0	3

Course Objectives:

The course is primarily designed for those who wish to develop their career in the biosciences with particular emphasis on medical and healthcare biotechnology (including bio-pharmaceutical and bio-industries).

UNIT I Immune System **5 hours**

Overview, Antibody-mediated response, Vaccines, Cell mediated immune response, Cancer immunotherapy.

UNIT II Oligonucleotides **6 hours**

Overview, Gene therapy, Antisense therapy, Ribozyme

UNIT III Cardiovascular Drugs **10 hours**

Myocardial infarction agents, Endogenous vasoactive peptides, Hematopoietic agents, Anticoagulants, antithrombotic and haemostatics.

UNIT IV Chemotherapeutic Agents **12 hours**

Synthetic antibacterial agents, antifungal, antiprotozoal, Antihelminthic agents Antiameobic agents, Antiviral agents.

UNIT V Drug Targeting **12 hours**

Basic concepts and novel advances, Brain-specific drug targeting strategies, Pulmonary drug delivery, Cell specific drug delivery.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. Pharmaceutical Chemistry by Christine M. Bladon. *John Wiley & Sons, Ltd.* (2002).

T2 Burger's Medicinal Chemistry and Drug Discovery (5th edition) by Manfred E. Wolff. A *Wiley &Sons, Inc.* (2000).

T3 Drug Targeting Organ-Specific Strategies by Grietje Molema and Dirk K. F. Meijer. Wiley-*VCH*. (2002).

T4 Kuby J, Immunology, WH Freeman & Co., 7th Edition 2012.

T5 Schacter B. Z. 2005. Biotechnology and Your Health: Pharmaceutical Applications. Chelsea House Publishers

REFERENCES

R1. Chetan DM and Dinesh KP, 2006. Health and Pharmaceutical Biotechnology. Firewall Media.

R2. Bustillo LGT and Pena IG, 2012. Biotechnology: Health, Food, Energy and Environment Applications (Biotechnology in Agriculture, Industry and Medicine). Nova Science Publication

R3 Dogramatzis, 2010. Health care Biotechnology. 1st Edition; CRC Press

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the basic concepts of Immune system and its function	**K2**
CO2	Compare different types of oligonucleotides and its therapy	**K2**
CO3	Illustrate the different types of cardiovascular drugs	**K2**
CO4	Explain the various types of Chemotherapeutic Agents	**K2**
CO5	Identify the methods of drug targeting and delivery	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course code	Course	L	T	P	C
PEC 19	MEDICAL MICROBIOLOGY	3	0	0	3

Course Objectives:

To enable the students

- To understand about the normal microbial flora and modern diagnostic techniques
- To know about various bacterial, viral and fungal disease and their causative agents
- To control pathogens by various antimicrobial agents

UNIT I Normal microflora of the human body and host pathogen interaction 10 hours

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract, Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS.

UNIT II Sample collection, transport and diagnosis 5 hours

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests,Complement fixation, PCR, DNA probes).

UNIT III Bacterial diseases 10 hours

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control; Respiratory Diseases: *Streptococcus pyogenes*,*Haemophilus influenzae, Mycobacterium tuberculosis* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori* Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani*, *Treponema pallidum, Clostridium difficie*

UNIT IV Viral Diseases 10 hours

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

UNIT V Antimicrobial agents: General characteristics and mode of action 10 hours

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism, Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication

T2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication

T3. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education

REFERENCES

R1 Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.

R2 Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

COURSE OUTCOMES

Upon successful completion of the course, students will be able to		
CO1	Explain the normal microflora of human body and their interactions with host	**K2**
CO2	Compare different methods of sample collection based on the culture	**K2**
CO3	Explain in detail about the causative agents of bacterial diseases	**K2**
CO4	Summarize different viral diseases, their symptoms, mode of transmission and prophylaxis	**K2**
CO5	Apply the knowledge of antimicrobial agents for treatment by understanding their mode of action	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
PEC 20	PRECISION MEDICINE & WELLNESS	3	0	0	3

Course Objectives:

The course will teach the students about use of modern omics techniques and systems biology in providing personalized medicine and preventive health care.

UNIT I INTRODUCTION **9 hours**

Use of genomics, transcriptomics, proteomics and metabolomics in understanding disease condition. Biomarker identification and validation of a disease state.

UNIT II GENOMES **9 hours**

Human Genome project. Cancer genome project. Different types of genetic and non- genetic variations, Genetic screening and diagnosis: prenatal carrier testing and newborn screening for Mendelian diseases

UNIT III PHARMACOGENOMICS **9 hours**

Pharmacogenomic testing for drug selection, dosing and predicting adverse effects of commonly prescribed drugs

UNIT IV CLINICAL DATA **9 hours**

Tumor profiling, Patient data and clinical decisions. Risk assessment through omics approach.

UNIT V ETHICS **9 hours**

Ethical, legal, and social implications of health privacy and policy laws for precision medicine. Ayurveda system of Prakriti and Agni.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. National Institute of General Medical Sciences. The New Genetics. Bethesda, MD: U.S. Department of Health and Human Services, 2010.

T2. Genomic and Precision Medicine, Geoffrey Ginsburg and Huntington Willard, 2016.

REFERENCE

R1. The Language of Life: DNA and the Revolution in Personalized Medicine, Francis S. Collins, 2010.

WEBLINK

W1. https://www.coursera.org/learn/precision-medicine?action=enroll#about

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Demonstrate on precision medicare and preventive care system using modern omics tools.	**K2**
CO2	Explain about the genome and its types	**K2**
CO3	Infer on the clinical database and assessment	**K2**
CO4	Outline the recent advances in disease risk prediction, molecular diagnosis and progression of diseases, and targeted therapies for individuals.	**K2**
CO5	Make use of ethical and policy laws for precision medicine	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓				

Course Code	Course	L	T	P	C
PEC 21	INDUSTRIAL ENZYMOLOGY	3	0	2	4

Course Objectives:

1. This course provides theory and knowledge relevant to enzymology, Techniques employed in enzyme purification and characterization is also emphasized in this course.
2. The applications of enzymes in food and pharmaceutical industries, and diagnostics would be deliberated.

UNIT I INTRODUCTION 9 hours

Enzymes: Structure, evolution and its basis, Enzyme action: Specificity, molecular aspects of enzyme action, and examples from different classes of enzyme, Regulation of enzymatic action: Activation of enzymes, covalent modification, allosteric interaction, multienzyme complexes

UNIT II INDUSTRIAL PRODUCTION OF ENZYMES 9 hours

Sources of enzymes, criteria for the selection of source for enzyme production, methods of large-scale production-solid substrate fermentation and submerged fermentation, factors affecting enzyme production, amylases, cellulases, pectinases, lactases, invertases, lipases, proteases.

UNIT III BIOCHEMICAL & PHARMACEUTICALS APPLICATIONS 9 hours

Role of soluble and immobilized enzymes in the synthesis and production of amino acids and chiral compounds; use of enzymes as detergents. Role of soluble and immobilized enzymes in production of antibiotics, steroids, and other important intermediates of biotechnological industry; role of soluble and immobilized enzymes in diagnosis and treatment of diseases; enzyme therapy.

UNIT IV APPLICATIONS IN FOOD INDUSTRY 9 hours

Soluble and immobilized enzymes - food production and processing, amylases, pectinases, proteases, lipases, glucoisomerases, naringinase

UNIT V ANALYTICAL APPLICATIONS 9 hours

Theory and applications of various enzyme electrodes e.g. enzyme sensors, enzyme membranes, biochips/bio-semiconductors, *In vitro* approaches to improve functional efficiency; Recombinant enzyme

Total Lecture hours: 45 hours

INDUSTRIAL ENZYMOLOGY PRACTICALS Total Practical hours: 15 hours

1. Extraction of Amylase from starch and Determination of Km and Vmax for the enzyme Amylase
2. Determination of MM Kinetics for Invertase
3. Enzyme Inhibition studies for Catalase Enzyme
4. Protein Precipitation by Solvents
5. Protein Precipitation by Salt

TEXT BOOKS

T1. Fundamentals of Enzymology: The cell and Molecular Biology of Catalytic Proteins by N.C. Price and L. Stevens, Oxford University, 2000..

T2. Enzymolgoy Lab Fax by P.C. Engel, Academic Press, 2003.

T3. Enzymes, Biomass, Food and Feed (Biotechnology 2E, Vol. 9) by Rehm, Reed, and A. Phuler, Wiley-VCH, Berlin, 2001.

T4 Industrial Enzymology: The Application of Enzymes in Industry by T. Godfrey and S. May, McMillan publishers, 2001.

T5 Enzyme Technology by M.F. Chaplin and C. Bucke, Cambridge University Press, NY, 1990.

T6 Enzymes in Food Processing by G.A. Tucker and L.F.J. Woods, 1995

T7 Principles of Enzyme Technology by M.Y. Khan & F. Khan, PHI Learning Pvt. Ltd., India, 2015

REFERENCES

R1. Godfrey T, Reichelt J. Industrial enzymology: the application of enzymes in industry, 1982

WEBLINKS

W1 https://wou.edu/chemistry/courses/online-chemistry-textbooks/ch450-and-ch451-biochemistry-defining-life-at-the-molecular-level/chapter-7-enzyme-kinetics/#CH450-6.10

W2 https://archive.nptel.ac.in/courses/102/103/102103097/

COURSE OUTCOMES

Upon completion of the course, the students will be able to,		
CO1	Classify different types of enzymes based on their mechanism of action	**K2**
CO2	Compare fermentors with design features for large-scale enzyme production	**K2**
CO3	Make use of immobilized enzymes for the production of biochemical and pharmaceutical compounds	**K3**
CO4	Identify the role of enzymes in food production, processing and maintenance of food quality	**K3**
CO5	Develop enzyme biosensors for application in healthcare industries	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
PEC 22	BIOSTATISTICS	3	0	2	4

Course Objectives:

- To learn the basic concepts of probability and to solve the standard distribution.
- To solve the measures of central tendency and to apply the hypothesis for problems under various test.

UNIT I BASIC PROBABILITY 12 hours

Introduction to Probability-Conditional probability – Baye's Theorem-Random Variables-Discrete random variables-Continuous Random Variables –Probability mass function-Probability density function.

UNIT II STANDARD DISTRBUTIONS 12 hours

Introduction to theoretical distribution-Discrete Distributions- Binomial, Poisson, Geometric Distributions-Continuous Distribution-Uniform, Normal, Exponential and Gamma Distribution-Properties.

UNIT III CORRELATION AND REGRESSION ANALYSIS 12 hours

Correlation: Types of Correlation-Methods of studying correlation- Scatter diagram method, Karl Pearson's Coefficient of correlation, Spearman's Rank Correlation Coefficient. Regression: Regression Lines and Regression equations - simple problems.

UNIT IV BASIC STATISTICS 12 hours

Introduction-Measures of Central tendency: Mean, Median and Mode- Measure of Dispersion- Range, Mean deviation-Standard Deviation and coefficient of variation

UNIT V SAMPLING 12 hours

Introduction to small sample – t-test-Single mean, difference of means and Paired t-test- F-test-Chi-squaretestforgoodnessoffitandindependenceofattributes.

Total Lecture hours: 60 hours

TEXT BOOKS

T1. N.P. Bali and Manish Goyal, A text book of engineering mathematics, laxmi publications, reprint, 2014 (Ninth Edition)

T2. S.P.Gupta, Statistical Methods. Sultan Chand & Sons, New Delhi

T3. S.C. Gupta and V.K. Kapoor, Fundamentals of Applied Statistics, Sultan Chand & Sons, 3rd Edition, 2001.

T4. S.Ross, A First Course in Probability, 6thEd., Pearson Education India, 2002.

REFERENCES

R1. Erwin Kreyszig, Advanced Engineering Mathematics, 9thEdition, John Wiley &Sons, 2006.

R2. P.G.Hoel,S.C.PortandC.J.Stone, Introduction to Probability Theory, Universal Book Stall, 2003(Reprint).

R3. W.Feller, An Introduction to Probability Theory and its Applications, Vol.1, 3rd Ed., Wiley, 1968.

R4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

WEBLINKS

W1 https://nptel.ac.in/courses/102106051

W2 https://onlinecourses.nptel.ac.in/noc19_bt19/preview

W3 https://nptel.ac.in/courses/127106134

W4 https://nptel.ac.in/courses/110107114

Case Study:

1. Measures of Central Tendency& Measures of Dispersion
2. Correlation Analysis
3. Regression Analysis
4. Sampling- t-test
5. Sampling- Chi-square test

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Apply the fundamental concepts of probability.	**K3**
CO2	Identify with of standard distributions which can describe real life phenomenon.	**K3**
CO3	Analyse the concepts of correlation and Regression	**K4**
CO4	Evaluate the underlying assumptions of analysis tools for measures of central tendency and dispersion	**K5**
CO5	Determine the uses and limitations of testing of hypothesis used in engineering	**K5**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓	✓	

Course Code	Course	L	T	P	C
PEC 23	RATIONAL DRUG DISCOVERY	3	0	2	4

Course Objectives:

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

UNIT I Molecular Modelling in Drug Discovery 9 hours

Drug discovery process, Role of Bioinformatics in drug design, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand-based drug design, modelling of target-small molecule interactions, Molecular simulations. Protein Modelling.

UNIT II Quantum Mechanics and Molecular Mechanics 9 hours

Features of molecular mechanics force fields; Bond structure and bending angles – electrostatic, van der Waals and non – bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

UNIT III MolecularDynamics simulation methods 9 hours

Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time – dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

UNIT IV Molecular Docking and lead optimization 9 hours

Molecular Docking; Types of Molecular Docking, de novo ligand design; Applications of 3D Databases: Searching and virtual Screening; Strategy for target identification and Validation, lead identification, drug likeness, optimization and validation, Absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer-based tools for drug design

UNIT V Pharmacophore and QSAR 9 hours

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

Total Lecture hours: 45 hours

Rational Drug Discovery Practical 15 hours

1. Role of Bioinformatics in drug design
2. Structure Based Drug Design
3. ADME calculation
4. Application of 3D Database searching in Molecular Docking
5. Receptor theories and drug action

TEXT BOOKS

T1. Computational methods in drug design Fred E. Cohen, Walter Hamilton Moos Publisher: ESCOM Science, 1993.

T2. Molecular Modelling for Beginners - Alan Hinchliffe Publisher: John Wiley & Sons Inc, 2008. ISBN: 978-0470513149.

T3. Combinatorial Library Design and Evaluation: Principles, Software, Tools, Applications in Drug Discovery – Arup Ghose, VellarkadViswanadhan Publisher: CRC Press, 2001. ISBN: 0-8247-0487-8.

T4 Jensen JH. Molecular modeling basics. CRC Press; 2010

T5 3D QSAR in Drug Design: Recent Advances – Hugo Kubinyi, Gerd Folkers, Yvonne C. Martin Publisher: Springer Science & Business Media, 2006. ISBN: 0-306-46858-1

T6 Computational Chemistry and Molecular Modeling - K. I. Ramachandran, Gopakumar Deepa, Krishnan Namboori Publisher: Springer – Verlag Berlin Heidelberg, 2008. ISBN: 978-3540773023.

REFERENCES

R1. Pharmacology in Drug Discovery. T. P. Kenakin. Elsevier, 1 st Edition 2012

R2 Textbook of Drug Design. Krogsgaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002.

R3 . Drug Discovery Handbook S.C. Gad (Editor) Wiley-Interscience Hoboken USA, 2005

WEBLINKS

W1 https://archive.nptel.ac.in/courses/102/106/102106070/

COURSE OUTCOMES

Upon completion of the course, the students will be able to,		
CO1	Outline various strategies to design and develop new drug like molecules	**K2**
CO2	Compare force fields and the various interactions between the molecules and their impact in drug discovery	**K2**
CO3	Experiment with various molecular dynamic simulation methods for rational drug designing	**K3**
CO4	Build the structure of proteins and new ligands for studying the protein ligand interactions using docking techniques	**K3**
CO5	Apply the concept of pharmacophore and structure-based drug design methods to develop new drugs.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO 2**
CO1	3	3	2	3	3	-	-	-	-	-	-	-	3	3
CO2	3	3	1	1	1	-	-	-	-	-	-	-	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course code	Course	L	T	P	C
PEC 25	ANIMAL AND PLANT BIOTECHNOLOGY	3	0	2	4

Course Objectives:

1.To provide a glimpse of scope and historical background of developmental biology to the students.
2. Knowledge regarding basic concepts of differentiation and growth, differential gene expression as well as cytoplasmic determinants to the students.
3.To develop detailed understanding of essential events of developmental biology through proper explanation of gametogenesis, fertilization, blastula formation, gastrulation as well as embryological induction as part of early embryonic development

UNIT I **Animal Cell Culture Growth and Scaleup** **12 hours**

History of Animal Cell Culture, Characteristics of animal cell, metabolism, regulation and nutritional requirements, Culture Media and Growth Conditions, Development of Primary Culture and Cell Lines, Suspension Culture, Characterization and maintenance of cell lines, Cryopreservation, Common Cell Culture Contaminants, Marker Gene Characterization, Transfection and Transformation of Cells.

Need for scaling-up of cells for vaccine or antigen or pharmaceutical protein production, Hybridoma Technology, Cell culture reactors, Scale-Up in suspension and monolayer cultures, Factors affecting cell growth, Growth Monitoring, Mass Transfer.

UNIT II **Animal Biotechnology** **12 hours**

Concept of transgenic animals, Methods of transgene delivery, Microinjection of recombinant DNA into fertilized eggs/stem cells, Animal Pharming, Organ Culture, Regenerative Medicine, Human Embryonic Stem Cell research, Ethical Concerns and Biosafety.

UNIT III **Plant tissue culture and Crop Improvement** **12 hours**

History of plant tissue culture, plasticity and totipotency. Laboratory setup for a typical plant tissue culture facility. Sterilization methods used in plant tissue culture. Types of nutrient media and plant growth regulators in plant regeneration. Pathways for in vitro regeneration: organogenesis, somatic and gametic 93 embryogenesis; protoplast isolation, culture and regeneration; culture of other explants, somatic hybridization; Application of tissue culture for crop improvement. Methods for Plant Conservation, Cryopreservation, synseedproduction.Crop Improvement: The need of crop improvement. Conventional methods of crop improvement, selection, mutation, polyploidy and clonal selection. Green revolution in India.

UNIT IV **Principles and methods of genetic transformation** **12 hours**

Introduction to Agrobacterium biology and biotechnology. Mechanism of T-DNA transfer to plants and Agro infection. A. rhizogenes and its application. Transplastomics and its utility. Methods for direct gene transfer, Marker and reporter genes; Promoters used in plant vectors. Plant viral vectors. Molecular techniques for analysis of transgenics (copy number, transgene stability, silencing; segregation). Marker-free transgenics and environmental, social and legal issues associated with transgenic plants. Case studies for genetic engineering in plants for traits of agronomic value, biotic, abiotic stresses and herbicide tolerance.

UNIT V **Molecular Farming and Genome Editing** **12 hours**

Transgenic crops for production of antibodies, viral antigens and peptide hormones in plants, Edible vaccines and Nutraceuticals. Plant Biotechnology for biofuels. Genome Editing: The history of targeted mutations in plants. Use of ZFNs and TALENs as early tools for genome editing. Discovery of CRISPR-Cas system and its applications. Recent innovations in the technology and case studies where CRISPRCas has been used for plant improvement.

Practical's

1. Animal Cell Culture Biosafety and Ethical Concerns
2. Cell counting and plating
3. Cell Viability Assay
4. Isolation of protoplasts by Enzymatic method
5. Isolation of protoplasts by Mechanical method
6. Callus Induction

Total Lecture hours: **60 hours**

TEXT BOOKS

T1. Culture of Animal Cells by R.I. Freshney. 2010

T2. Animal Cell Biotechnology, Humana Press by Portner R. 2007

T3. Basic Cell Culture Second Edition, Oxford University Press by Davis, J.M. 2005

T4. Principles of Plant Genetics and Breeding by George Acquaah. Blackwell Publishing. 2007

T5. An introduction to Plant Tissue culture by MK Razdan. M.K. 2003. Oxford & IBH Publishing Co, New Delhi, 2003.

REFERENCES

R1 Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.

R2 Biochemistry & Molecular Biology of Plants. Bob Buchanan, Wilhelm Gruissem, Russell Jones. John Wiley & Sons, 2002.

WEBLINK:

W1. https://onlinecourses.swayam2.ac.in/cec23_bt01/preview

W2. https://archive.nptel.ac.in/courses/102/106/102106080/

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Infer systematically about the complexities and defining various types of cell cultures.	**K2**
CO2	Recognize the design and learn strain-engineering strategies to alter cellular behavior, metabolic flux, and product formation.	**K2**
CO3	Explain vast industrial applications of metabolic engineering in the field of medicine, energy and environment.	**K2**
CO4	Employ the traditional and new approaches and methods of genetic transformation	**K3**
CO5	Illustrate about the Transgenic crops, Molecular Farming and Genome editing	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Syllabus
Open Elective Courses

Course code	Course	L	T	P	C
OEC 01	BIOLOGY FOR ENGINEERS	3	0	0	3

Course Objectives:

To provide a basic understanding of biological mechanisms of living organisms from the perspective of engineers. In addition, the course is expected to encourage engineering students to think about solving biological problems with engineering tools

UNIT I Introduction to life **9 hours**

Characteristics of living organisms-Basic classification-cell theory-structure of prokaryotic and eukaryotic cell-Introduction to biomolecules: definition-general classification and important functions of carbohydrates-lipids-proteins-nucleic acids vitamins and enzymes-genes and chromosome.

UNIT II Biodiversity **9 hours**

Plant System: basic concepts of plant growth-nutrition-photosynthesis and nitrogen fixation-Animal System: elementary study of digestive-respiratory-circulatory-excretory systems and their functions, Microbial System: history-types of microbes-economic importance and control of microbes.

UNIT III Genetics and Immune system **9 hours**

Evolution: theories of Evolution-Mendel's cell division–mitosis and meiosis-evidence of e laws of inheritance-variation and speciation- nucleic acids as a genetic material-central dogma immunity, antigens-antibody-immune response.

UNIT IV Human Diseases **9 hours**

Definition- causes, symptoms, diagnosis, treatment and prevention of diabetes, cancer, hypertension, influenza, AIDS and Hepatitis.

UNIT V Biology and its Industrial application **9 hours**

Transgenic plants and animals-stem cell and tissue engineering-bioreactors-biopharming-recombinant vaccines-cloning-drug discovery-biological neural networks-bioremediation-biofertilizer-biocontrolbiofilters-biosensors-biopolymers-bioenergy-biomaterials-biochips-basic biomedical instrumentation.

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. A Text book of Biotechnology, R.C.Dubey, S. Chand Higher Academic Publications, 2013

T2. Diseases of the Human Body, Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company, 2011.

T3. Biomedical instrumentation, Technology and applications, R. Khandpur, McGraw Hill Professional, 2004

REFERENCES

R1. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011.

R2. Cell Biology and Genetics (Biology: The unity and diversity of life Volume I), Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008.

R3. Biotechnology Expanding horizon, B.D. Singh, Kalyani Publishers, 2012

WEBLINKS

W1 https://archive.nptel.ac.in/courses/121/106/121106008/

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain and relate the biological engineering principles, procedures needed to solve real-world problems.	**K2**
CO2	Explain the Microbial System: history-types of microbes-economic importance and control of microbes.	**K2**
CO3	Compare Evolution: theories and Mendel's cell division.	**K2**
CO4	Develop and explain stem cell and tissue engineering-bioreactors	**K3**
CO5	Apply the fundamentals of living things, their classification, cell structure and biochemical constituents.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO1 0**	**PO1 1**	**PO12**	**PSO1**	**PSO2**
CO1	-	1	3	3	3	2	3	2	3	3	3	3	-	3
CO2	-	1	3	3	3	2	3	2	2	2	2	3	-	3
CO3	-	1	3	3	3	2	3	2	2	2	2	3	-	3
CO4	-	1	3	3	3	-	3	1	2	1	3	3	-	3
CO5	-	1	3	3	3	3	3	2	3	2	2	3	-	3

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
OEC 02	FOOD AND NUTRITION TECHNOLOGY	3	0	0	3

Course Objectives:

1. Build knowledge and an overview on general aspects of nutrition and health.
2. Distinguish the nutritive value of various food items, BMI calculation differentiating super junk, and functional foods in the market.
3. Solve the real-world problems based on nutrition and health.

UNIT I NUTRIENTS IN FOOD 9 hours

Macro nutrients- carbohydrates, proteins and lipids. Micronutrients-Minerals: Calcium, Magnesium, Iron, Zinc, Copper and Selenium; Vitamins.

UNIT II NUTRITIONAL PHYSIOLOGY 9 hours

Digestion, absorption, and utilization of major and minor nutrients.

UNIT III ENERGY CALCULATION 9 hours

Energy balance and methods to calculate individual nutrient and energy needs. Planning a healthy diet.

UNIT IV FOOD RELATED NUTRITIONAL DISORDERS 9 hours

Causes of life style and stress related diseases. Cardio-vascular diseases, hypertension, obesity

UNIT V FOOD RELATED LAWS 9 hours

Inspection – Microbial Indicators of product quality – Indicators of food safety – Microbiological safety of foods - control strategies – Hazard Analysis Critical Point System (HACCP concept)- Microbiological criteria

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Nutrition- Concepts and Controversies. Frances Sienkiewicz Sizer and Ellie Whitney, 13e. Thompson Wadsworth, 2014

T2. B. Srilakshmi, Food science, New Age Publishers,2002

REFERENCES

R1. Whitney EN, Rolfes SR. Understanding nutrition. Cengage learning; 2015.

R2 McGuire M, Beerman KA. Nutritional sciences: From fundamentals to food. Cengage Learning; 2017

R3 Motarjemi Y, Lelieveld H, editors. Food safety management: a practical guide for the food industry. Academic Press; 2013

WEBLINKS

W1 https://archive.nptel.ac.in/courses/126/105/126105011/

COURSE OUTCOMES

Upon completion of the course, the students will be able to,		
CO1	Classify the macro and micronutrients present in food	**K2**
CO2	Summarize the mechanisms of absorption, utilization and digestion of food nutrients	**K2**
CO3	Develop healthy diet with proper nutrients and energy values in food	**K3**
CO4	Identify the food related nutritional disorders	**K3**
CO5	Make use of regulatory agencies in enforcing food laws to formulate the standard of food	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO 4**	**PO5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PS O1**	**PSO2**
CO1	-	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	1	1	1	-	-	-	-	-	-	-	-	-	1	-
CO3	1	1	1	2	1	-	-	-	-	-	-	-	2	1
CO4	-	1	1	1	1	-	-	-	-	-	-	-	1	1
CO5	1	1	1	1	1	-	1	-	-	-	-	-	2	1

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
OEC 03	BIOTERRORISM AND NATIONAL SECURITY	3	0	0	3

Course Objectives:

- Familiarization of issues involved and threats facing society due to bioterrorism and approaches to tackle it effectively.

UNIT I TERRORISM AND BIOTERRORISM 9 hours

Definition-Traditional Terrorists-New Terrorists-Nuclear, chemical, and radiological weapons-The psychology of Bioterrorism-Historical perspective.

UNIT II MICROBES AND IMMUNE SYSTEM 9 hours

Primary classes of Microbes-bacteria, virus, and other Agents-Immune system, Interaction between microbes and the immune system.

UNIT III BIOTERRORISM WEAPONS AND TECHNIQUES 9 hours

Characteristics of microbes and the reasons for their Use-Symptoms-Pathogenicity -Epidemiology-natural and targeted release-The biological, techniques of dispersal, and case studies of Anthrax, Plague-Botulism, Smallpox, and Tularemia and VHF.

UNIT IV PREVENTION AND CONTROL OF BIOTERRORISM 9 hours

Surveillance and detection- Detection equipment and sensors –Diagnosis-Treatment-Vaccinations-Supplies-Effectiveness-Liability-Public Resistance-Response-First Responders-Infectious, Control-Hospital-Prevention-Protection-Decontamination-Notification-Role of Law Enforcement-Economic impact.

UNIT V BIOTERRORISM MANAGEMENT ETHICAL ISSUES 9 hours

Personal, national, the need to inform the public without creating fear, cost-benefit Rations-Information Management-Government control and industry Support-Microbial forensics.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Bioterrorism: Guidelines for Medical and Public Health Management, Henderson, Donald, American Medical Association, 1st Edition, 2002.

T2. Biological Weapons: From the Invention of State-Sponsored Programs to Contemporary Bioterrorism – 2006 by Jeanne Guillemin, Columbia University Press; Edition Unstated.

REFERENCES

R1. The Demon in the Freezer: A True Story, Preston, Richard, Fawcett Books, 2003.

R2. Biotechnology research in an age of terrorism: confronting the dual use dilemma, National Academies of Science, 2003.

WEBLINKS

W1 https://meridian.allenpress.com/aplm/article/127/6/764/453835/Bioterrorism-Guidelines-for-Medical-and-Public

W2 https://www.fda.gov/drugs/emergency-preparedness-drugs/bioterrorism-and-drug-preparedness

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the concepts of traditional terrorism and psychology of bioterrorism	**K2**
CO2	Demonstrate the basics of microbial cells and immune systems	**K2**
CO3	Explain the concept of pathogenicity and epidemiology of microbes to develop bioweapons	**K2**
CO4	Identify the prevention and control measures to eradicate bioterrorism	**K3**
CO5	Identify the various ethical issues to manage bioterrorism among the public	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓				

Course Code	Course	L	T	P	C
OEC 04	BIOETHICS AND BIOSAFETY	3	0	0	3

Course Objectives:

1. To discuss various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.

UNIT I Bioethics **9 hours**

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against molecular technologies.

UNIT II Biosafety **9 hours**

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

UNIT III Patent Law **9 hours**

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT IV Patent of Biological Products **9 hours**

Detailed information on patenting biological products, Biodiversity, Budapest treaty, Appropriate case studies

UNIT V IPR **9 hours**

Distinction among various forms of IPR, Requirement of a patentable novelty, invention step and prior art and state of art, procedure

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.

T2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

T3. Patent Strategy for Researchers & Research Managers- Knight, Wiley Publications

T4. Biotechnology & Safety Assessment, Thomas, Ane/Rout Publishers. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.

REFERENCES

R1. Intellectual Property Protection & Sustainable Development, Phillipe Cullet, Ldexix Nexis Butterworths.

R2. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw Hill, New York (2005)

R 3. Kankanala C., Genetic Patent law &strategy. First edition. Manupatra, Information Solution Pvt.Ltd., 2007.

WEBLINKS

W1 https://nptel.ac.in/courses/112107217

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain the ethical and social responsibilities of life scientists with reference to the responsible conduct of research and other work	**K2**
CO2	Explain the international and national controls with regards to biosafety, biosecurity and bioethics applicable to facilities and associated scientists handling pathogens.	**K2**
CO3	Explain the types of patents and patenting system in India & learn international patenting procedures and Patent infringements	**K2**
CO4	Select the value of IPR in our lives and fosters a better understanding of the rights associated with IPR	**K3**
CO5	Analyzethedifferent types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO1 0**	**PO1 1**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	3	3	3	3	3	3	3	2	2	2	2	3
CO2	3	2	3	3	3	3	3	3	3	1	-	2	2	3
CO3	3	1	3	3	3	3	3	3	3	2	2	1	1	3
CO4	3	1	3	3	3	3	3	3	3	1	1	1	2	3
CO5	2	1	3	3	3	3	3	3	3	2	2	1	2	2

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

Course Code	Course	L	T	P	C
OEC 05	CLINICAL TRIALS	3	0	0	3

Course Objectives:

To highlight the epidemiologic methods, study design, protocol preparation

- To gain knowledge in the basic bio-statistical techniques involved in clinical research.
- To describe the principles involved in ethical, legal and regulatory issues in clinical trials.

UNIT I ROLE OF CLINICAL TRIALS IN NEW DRUG DEVELOPMENT 9hours

Drug Discovery, regulatory guidance and governance, pharmaceutical manufacturing, nonclinical research, clinical trials, post-marketing surveillance, ethical conduct during clinical trials.

UNIT II FUNDAMENTALS OF TRIAL DESIGN 9hours

Randomised clinical trials, uncontrolled trials. Protocol development, endpoints, patient selection, source and control of bias, randomization, blinding, sample size and power.

UNIT III ALTERNATE TRIAL DESIGNS 9hours

Crossover design, factorial design, equivalence trials, bioequivalence trials, non-inferiority trials, cluster randomized trials, multi-center trials.

UNIT IV BASICS OF STATISTICAL ANALYSIS 9hours

Types of data and normal distribution, significance tests and confidence intervals, comparison of means, comparison of proportions, analysis of survival data, subgroup analysis, regressionpb analysis, missing data.

UNIT V REPORTING OF TRIALS 9hours

Overview of reporting, trial profile, presenting baseline data, use of tables, figures, critical appraisal of report, meta-analysis.

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Fundamentals of Clinical Trials, Lawrence M. Friedman, Springer Science & Business Media, 2010

T2 Textbook of Clinical Trials, David Machin, Simon Day, Sylvan Green, John Wiley & Sons,2007

T3 Clinical Trials: A Practical Approach, Stuart J. Pocock, John Wiley & Sons, 17-Jul-2013

REFERENCES

R1. Clinical trials, A practical guide to design, analysis and reporting. Duolao Wang and AmeetBakhai. Remedica. 2006.

R2. Introduction to statistics in pharmaceutical clinical trials. T.A. Durham and J Rick Turner.Pharmaceutical Press 2019

R3 Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines, Tom Brody Academic Press, 2016.

WEBLINKS

W1 https://nptel.ac.in/courses/127106137

W2 https://podcasts.ox.ac.uk/keywords/clinical-trials

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Define the basic concepts of Drug Discovery, regulatory guidance.	**K1**
CO2	Classify the different types of clinical trial design	**K2**
CO3	Solve the bioequivalence and alternative trial design	**K3**
CO4	Summarize different methods of statistical analysis	**K2**
CO5	Apply the knowledge of clinical trails	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1														
CO2														
CO3														
CO4														
CO5														

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓				

Course Code	Course	L	T	P	C
OEC 06	STEM CELL TECHNOLOGY	3	0	0	3

Course Objectives:

The course objectives are imparting the basic knowledge of students about stem cell, culturing and its clinical applications

UNIT I STEM CELLS AND TYPES 9 hours

Stem cells: Definition, Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. –Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties –Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties

UNIT II STEM CELLS IN PLANTS AND ANIMALS 9 hours

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

UNIT III STEM CELLS DIFFERENTIATION 9 hours

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

UNIT IV REGENERATION AND EXPERIMENTAL METHODS 9 hours

Germ cells, hematopoietic organs, and kidney, cord blood transplantation, donor selection, HLA

UNIT V APPLICATION AND ETHICAL ISSUES 9 hours

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

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Stem cells by C.S Potten, Elsevier, 1997, ISBN: 978-0-12-563455-7

T2. Essentials of Stem Cell Biology by Robert Lanza, 2014

REFERENCES

R1. Quesenberry PJ, Stein GS, Forget BG, Weissman SM, editors. Stem cell biology and gene therapy. John Wiley & Sons; 1998.

R2 Turksen K, editor. Embryonic Stem Cell Protocols. Humana Press; 2016.

R3 Bongso A, Lee EH. Stem cells: from bench to bedside., 2005

R4 Gholamrezanezhad A. Stem cells in clinic and research. 2011.

WEBLINKS

W1 https://archive.nptel.ac.in/courses/102/106/102106081/

COURSE OUTCOMES

Upon completion of the course, the students will be able to,		
CO1	Explain the types and various sources of stem cell.	**K2**
CO2	Compare the factors regulating genome structure, homeostasis of gene, protein and metabolite expression in stem cells in higher organisms	**K2**
CO3	Identify the physical, chemical and molecular factors influencing the differentiation of stem cell.	**K3**
CO4	Utilize stem cells as therapeutic tools for the development of human organs	**K3**
CO5	Make use of stem cells for addressing human diseases and disorders including neurodegenerative, cancer, vascular and cardiac disease, wound healing, and bone injury.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PS O1**	**PSO2**
CO1	-	1	-	1	-	-	-	2	-	-	-	-	3	3
CO2	2	1	1	1	-	-	-	2	-	-	-	-	3	3
CO3	2	1	1	1	-	-	-	2	-	-	-	-	3	3
CO4	2	3	2	3	1	-	-	2	-	-	-	-	3	3
CO5	2	3	2	3	-	-	-	2	-	-	-	-	3	3

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

Course Code	Course	L	T	P	C
OEC 07	BIO ENTREPRENEURSHIP	3	0	0	3

Course Objectives:

1.This course provides a detailed overview of entrepreneurship as the foundation of business growth and value creation in the national economy

UNIT I Introduction to Biotechnology & Applications: 9hours

Biotechnology – definition, history, thrust areas of biotechnology; Elements of Bio-Process Engineering; Biotech Industries; Basic concepts of GLP, GMP and FDA; Scope and Importance of Biotechnology and allied fields

UNIT II Introduction to Bio-entrepreneurship 9hours

Definition of Bio entrepreneurship, traits of an entrepreneur; Copyright, Patents, trademark, plant breeders and farmers' rights, biodiversity related issues; Biopiracy, International and Indian business policies with the focus on Bio and Pharmaceutical products.

UNIT III Entrepreneur and Entrepreneurship 9hours

Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

UNIT IV Planning a Small-Scale Enterprises 9hours

Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site. Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership. Case study of any top three Biotechnology Companies (start-up, various stages in establishment, etc..

UNIT V Business Model 9hours

Identifying the value proposition; market and competitor analysis, IPR situation: Understanding the intellectual property rights (IPR) situation and developing a viable IPR strategy, Business Plan: Assembling a coherent and compelling business plan document

Total Lecture hours: 45 hours

TEXT BOOKS

T1. Dr. Vasant Desai, Management of Small-Scale Enterprises, Himalaya Publishing House, 2004.

T2. Patzelt, Holger, Brenner, Thomas (Eds.). Handbook of Bio entrepreneurship. Springer, 2008.

T3. A Handbook for Entrepreneurs Development, Sabur Khan 2013.

T4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013.

REFERENCES

R1. Lee, James W., 2013. Advanced Biofuels and Bioproducts. Springer New York,

R2. C. T. Hou, Jei-Fu Shaw, 2008. Biocatalysts and Bioenergy Wile

WEBLINKS

W1 https://nptel.ac.in/courses/110107094.

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Explain and illustrate the scope, importance of biotechnology and allied fields.	**K2**
CO2	Classify the role of entrepreneurship in economic development of industry.	**K2**
CO3	Compare Market survey and assessment.	**K2**
CO4	Identify and differentiate Business Plan; learn Forms of business organization/ownership.	**K3**
CO5	Categorize the Case study of any top three Biotechnology Companies (start up, various stages in establishment. Etc.,)	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO1 0**	**PO1 1**	**PO12**	**PSO1**	**PSO2**
CO1	-	1	3	3	3	2	3	2	3	3	3	3	-	3
CO2	-	1	3	3	3	2	3	2	2	2	2	3	-	3
CO3	-	1	3	3	3	2	3	2	2	2	2	3	-	3
CO4	-	1	3	3	3	-	3	1	2	1	3	3	-	3
CO5	-	1	3	3	3	3	3	2	3	2	2	3	-	3

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

Syllabus
Humanities and Social Science Courses

Course Code	Course	L	T	P	C
HSC 01	ENGLISH	2	0	0	2

Course Objectives:

1. To acquire ability to speak effectively in real life situations.
2. To write letters and reports effectively in formal and business situations.
3. To develop listening skills for academic and professional purposes.
4. To gain effective speaking and listening skills in communication.
5. To develop the soft skills and interpersonal skills to excel in their career.
6. To enhance the performance of students at Placement Interviews, Group Discussions and other recruitment procedures.

UNIT I VOCABULARY BUILDING 8 hours

General Vocabulary –Nouns--Compound nouns, Synonyms, Antonyms, Prefixes and Suffixes, Homonyms, Homographs and Homophones, Changing words from one form to another, Acronyms and Abbreviations. -Instructions.

UNIT II BASIC WRITING 8 hours

Sentences structures –Kinds of sentences, Types of sentences, Clauses and Phrases, Punctuations, Blending and Clipping, Framing questions- Yes/No types and "Wh" questions, Summarizing, Precise writing, Paragraph Writing.

UNIT III IDENTIFYING COMMON ERRORS IN ENGLISH 8 hours

Articles, Prepositions, Subject-verb Agreement, Pronouns - Relative pronouns, Demonstrative pronouns, Misplaced Modifiers, Redundancies, Clichés, Infinitives& Gerund, Checklist.

UNIT IV NATURE AND STYLE OF SENSIBLE WRITING 8 hours

Situational Dialogues, Process description, Definitions, Numerical Expressions, Recommendation, Information Transfer- Flow chart Bar chart and Pie chart, Writing introduction and conclusion

UNIT V WRITING PRACTICES 8 hours

Active voice and Passive voice, making negative sentences, Tenses, Letter Writing- Formal & Informal Letters, Report Writing- Letter Report, Accident Report, Investigation Report and Survey, Essay writing, Reading Comprehension Passages

Total Lecture hours: 40 hours

TEXT BOOKS

T1. Department of English, Anna University, Mindscapes, 'English for Technologists and Engineers', Orient Longman Pvt. Ltd, Chennai: 2012.

T2. Department of Humanities and Social Sciences, Anna University, 'English for Engineers and Technologists' Combined Edition (Volumes 1 and 2), Chennai: Orient Longman Pvt. Ltd., 2006

T3. Department of English, Anna University, Mindscapes, 'English for Technologists and Engineers', Orient Longman Pvt. Ltd, Chennai: 2012.

REFERENCES

R1. Practical English Usage. Michael Swan. OUP. 1995.

R2. Remedial English Grammar. F.T. Wood. Macmillan.2007

R3. On Writing Well. William Zinsser. Harper Resource Book. 2001

WEBLINKS

W1 https://ehlion.com/magazine/technical-english/

W2 https://www.kkcl.org.uk/pdf/KKCL_Technical_English_for_Engineers_Brochure.pdf

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Improve the language proficiency of a technical under-graduate in English with emphasis on Learn, Speak, Read and writing skills	**K2**
CO2	Develop listening skills for academic and professional purposes.	**K3**
CO3	Acquire the ability to speak effectively in English in real life situations	**K3**
CO4	Provide learning environment to practice listening, speaking, reading and writing skills	**K3**
CO5	Variety of self-instructional modes of language learning and develop learner autonomy.	**K4**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓	✓	

Course code	Course	L	T	P	C
HSC 02	ENGLISH LABORATORY	0	0	2	1

Course Objectives:

- To enable the student to explore the knowledge in communication skills.
- To gain knowledge in the process of Placement Interviews, Group Discussions and other recruitment procedures

LIST OF EXPERIMENTS

1. Introduction to English sounds
2. Consonants and vowels
3. Syllable and Stress
4. Intonation
5. Communication Skills
6. Summarizing
7. Report Writing
8. Information Transfer
9. Presentation Skills
10. Group Discussion
11. Letter Writing
12. Cover letter and Resume

Total hours: **40 hours**

TEXT BOOKS:

1. Department of English, Anna University, Mindscapes, 'English for Technologists and Engineers', Orient Longman Pvt. Ltd, Chennai: 2012.

2. M.AshrafRizvi, "Effective Technical Communication", Tata McGraw-Hill Publishing Company Limited, New Delhi.2009.

REFERENCE BOOKS:

1. Practical English Usage. Michael Swan. OUP. 1995.
2. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
3. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

REFERENCES

R1. Department of English, Anna University, Mindscapes, 'English for Technologists and Engineers', Orient Longman Pvt. Ltd, Chennai: 2012.

R2. M.Ashraf Rizvi, "Effective Technical Communication", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2009.

R3. Practical English Usage. Michael Swan. OUP. 1995.

R4. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.

R5. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

WEBLINKS:

W1. https://onlinemasters.ohio.edu/blog/engineering-communication/

W2. https://online.rice.edu/courses/communication-skills-for-engineers-specialization

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Distinguish various listening & written contexts for understanding the implied meanings and responding to them accordingly.	**K5**
CO2	Use appropriate pronunciation and rhythm of spoken language in oral communication.	**K4**
CO3	Draft and interpret the written communication in official contexts like narrative, descriptive, creative, critical and analytical reports.	**K5**
CO4	Infer implied meanings of different genres of texts and critically analyze and evaluate them for ideas, as well as for method of oral presentation.	**K4**
CO5	Make use of suitable communicative strategies to express their point of views convincingly in any type of discussions, negotiation and conversations.	**K2**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Observation**	**Record**
		✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Viva**	**Demonstration/ Presentation**	**Open book test**
		✓	✓	✓	

Course code	Course	L	T	P	C
HSC 03	PERSONALITY DEVELOPMENT I	2	0	0	2

Course Objectives:

1. To nurture and develop winning personalities and eventually leading them to become dynamicand socially responsible leaders

UNIT I SOFT SKILLS I **6 hours**

Introduction to Personality Development – Meaning–Features of personality – Dimensions of Personality Determinants of Personality–Features and Traits– Components of self-concept–Barriers–Self analysis

UNIT II SOFT SKILLS II **6 hours**

Importance of Soft Skills – First impression–Work Place requirements–Discipline –Cleanliness Hygiene –general Appearance—Building Confidence—Concept of Thinking and Usage –Value of Time–Focus & Commitment

UNIT III SOFT SKILLS IN ACTION **6 hours**

Grooming – Attire – Understanding others– Stability & Maturity Development – Strength s – Weakness – Opportunities– threats – Merits of SWOT Analysis – Components – how to convert weakness into strengths – Goal setting

UNIT IV SELF AWARENESS AND SELF ESTEEM **6 hours**

Definitions – Components of Self-awareness – Developing Self-awareness – Self-esteem – meaning –Steps to improve self-esteem.

UNIT V SELF MOTIVATION **6 hours**

Motivation – Meaning –Techniques of self-motivation–Motivation & goal setting – Motivation and emotion – Motivation at work.

Total Lecture hours: **30 hours**

TEXT BOOKS

T1. Personality Development and Soft Skills Barun K Mitra, Oxford Publication

T2. Seven habits of Highly Effective people – Stephen R. covey

REFERENCES

R1. Emotion, motivation and Self-regulation – Nathan C. Hall, McGill University, Canada Thomas Goetz, University of Konstanz, Germany http://www.emeraldgrouppublishing.com.

R2. Psychology of Self-esteem – Nathaniel Branden, Nash (1st edition), Jossey – Bass (32nd anniversary edition)

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Discuss the features, dimensions and determinants of personality	K2
CO2	Make a good first impression in professional and other situations	K3
CO3	Demonstrate confidence, punctuality and commitment as an engineer	K5
CO4	Set goals for development using SWOT analysis	K3
CO5	Develop self-awareness and improve self esteem	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case studies**
			✓	✓	✓
Projects	**Viva**	**Quiz**	**MCQ**	**Demonstration/ Presentation**	**Open book test**
		✓	✓	✓	

Course code	Course	L	T	P	C
HSC 04	PERSONALITY DEVELOPMENT II	2	0	0	2

Course Objectives:

1. To nurture and develop winning personalities and eventually leading them to become dynamicand socially responsible leaders

UNIT I SOFT SKILLS III **6 hours**

Basic Etiquette – Email etiquette – Business etiquette – Telephone etiquette – Meeting etiquette – Adjustment of Role & Leadership – Team Management & Development

UNIT II QUANTITATIVE APTITUDE I **6 hours**

Percentage – Profit Loss –Discount – Ratio Proportion – Time & Work – Time, Speed & Distance. Problems relating to ages– Permutation & Combination–Probability

UNIT III QUANTITATIVE APTITUDE I **6 hours**

Mensuration – Clocks and Calendars – Boats – Simple Interest – Compound Interest – Fractions and Decimals – Square roots – Functions.

UNIT IV ANALYTICAL PROBLEMS **6 hours**

Introduction – Linear Sequencing – Seating Arrangements – Distribution/Double Line Up – Selection – Ordering and Sequencing – Binary Logic – Venn Diagrams –Directions.

UNIT V LOGICAL PROBLEMS **6 hours**

Introduction to Logical problems – Cause and Effect – Course of Action – Statement and Assumption – Letter and Symbol series – Analogies.

Total Lecture hours: **30 hours**

TEXT BOOKS

T1. K. R. Dhanalakshmi and N S Raghunathan, Personality Enrichment, Margham Publications, 2012

T2. R. S. Agarwal, Quantitative Aptitude for Competitive Examinations, S. Chand Publishers, 2017

REFERENCES

R1. D. P. Sabharwal, Personality Development Handbook, Fingerprint publishing, 2021

R2. A.K Gupta, Logical and Analytical Reasoning (English), Ramesh Publishing House, 2022

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Discuss the basic, email, business, telephone and meeting etiquettes.	**K2**
CO2	Solve problems on ratio proportion related to profit and loss, discounts, time and work, Time, speed and distance	**K3**
CO3	Work with fractions, decimals and square roots.	**K3**
CO4	Analyze the cause, effect and course of action in logical problems.	**K4**
CO5	Solve problems on the letter and symbol series.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case studies**
			✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book t**
✓		✓	✓	✓	

Course code	Course	L	T	P	C
HSC 05	PERSONALITY DEVELOPMENT III	2	0	0	2

Course Objectives:

1. To enhance the communication, interpersonal, group skills.

UNIT I VERBAL APPTITUDE I **6 hours**

Phonetics / Neutral Accent / Pronunciation – Speech Mechanism / Mouth & Face Exercise – Vowels & Consonants – Sounds – Syllable and Syllable Stress/ Word Stress – Sentence Stress & Intonation Articulation Exercise – Rate of Speech / Flow of Speech / Idiomatic Phrases.

UNIT II VERBAL APTITUDE II **6 hours**

Singular/plural – present tense / past tense – genders Prepositions – conjunctions – Choice of words –simple sentences – compound sentences – summarizing phrases Synonyms – Antonyms – Analogies –Similar Words.

UNIT III SOFT SKILLS **6 hours**

Attitude – Meaning–Features of attitude – Formation – Personality Factors –Types of attitudes – change in attitude – developing Positive attitude.

UNIT IV TIME MANAGEMENT **6 hours**

Definition – Meaning–Importance, Value of time as an important resource – comparison of Time and Money – Circle of influence and circle of control – Definition of URGENT and IMPORTANT – Time Wasters and how to reduce – Procrastination – meaning and impact – 4 Quadrants.

UNIT V TEAM BUILDING **6 hours**

Meaning – Aspects of team building – Process of team building – Types of Teams – Team Ethics and Understanding – Team trust and commitment.

Total Lecture hours: **30 hours**

TEXT BOOKS

T1. B N Ghosh, Managing Soft Skills and Personality, Mc graw Hill Publications

T2. Shejwalkar and Ghanekar, Principles and Practices of Management, Mc Graw Hill Latest.

T3. Roberta Roesch, Time management for Busy people, Tata McGraw–Hill Edition

REFERENCES

R1. D. P. Sabharwal, Personality Development Handbook, Fingerprint publishing, 2021

R2. Dr V M Selvaraj, Personality Development, Bhavani Publications

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Articulate by understanding the rate and flow of speech.	**K3**
CO2	Choose words and phrases appropriately for any verbal communication.	**K3**
CO3	Develop a positive attitude in handling diverse situations.	**K4**
CO4	Prioritize important and urgent tasks using the four quadrants method.	**K4**
CO5	Practice team ethics and understanding when working with teams.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case studies**
			✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book t**
✓		✓	✓	✓	

Course code	Course	L	T	P	C
HSC 06	PERSONALITY DEVELOPMENT IV	2	0	0	2

Course Objectives:

1. To enhance the soft skills and prepare them towards the skills needed for their career.

UNIT I SOFT SKILLS **6 hours**

Assertiveness – Meaning – Importance of assertiveness – Characteristics of Assertive communication –Merits – forms of assertion – Causes of misunderstanding

UNIT II COMMUNICATION SKILLS **6 hours**

Meaning – Elements of Communication – Functions of Communication – Principles of Communication Formal and Informal Communication – Barriers in Communication – Characteristics of good – communication – Feedback – Communication systems.

UNIT III PRESENTATION SKILLS **6 hours**

Meaning – Importance of Presentation – Concept of 5 W's and one H – understanding the audience –Types of presentations – How to make effective presentation.

UNIT IV PRESENTATION SKILLS II **6 hours**

Use of slide, PPT's and visuals – Rules for slide presentation – precautions – seminars and conferences – Steps to eliminate Stage fear.

UNIT V CHANGE MANAGEMENT **6 hours**

Definition – Necessity – Resistance towards Change – 10 Principles of Change Management – Leader's approach – Effective Change management.

Total Lecture hours: **30 hours**

TEXT BOOKS

T1. LaClair, J. and Rao, R. Helping Employees Embrace Change, McKinsey Quarterly, 2002, Number 4.

T2. Spencer Johnson, Who Moved My Cheese, Vermilion, First edition

T3. Adair, John, Effective Communication, London: Pan Macmillan Ltd., 2003.

REFERENCES

R1. Bovee, Courtland L, John V. Thill & Barbara E. Schatzman. Business Communication Today, Tenth Edition. New Jersey: Prentice Hall, 2010.

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Be assertive in their communication.	**K3**
CO2	Differentiate the principles of formal and informal communication.	**K4**
CO3	Make an effective presentation by understanding the audience.	**K3**
CO4	Practice the rules of presentation using slides, PPT's and visuals.	**K3**
CO5	Discuss the principles of change management.	**K2**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case studies**
			✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book t**
✓		✓	✓	✓	

Syllabus

Mandatory Courses

Course code	Course	L	T	P	C
MC 01	UNIVERSAL HUMAN VALUES 2: UNDERSTAMBDING HARMONY	2	0	0	0

Course Objectives:

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

UNIT I **Course Introduction - Need, Basic Guidelines, Content and Process for Value Education** **6 hours**

Understanding the need, basic guidelines, content and process for Value Education, Self-Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

UNIT II **Understanding Harmony in the Human Being - Harmony in Myself** **6 hours**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health

UNIT III Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship **6 hours**

Understanding harmony in the Family- the basic unit of human interaction , Understanding values in human-human relationship; meaning of *Nyaya* and program for its fulfillment to ensure *Ubhay-tripti*; Trust (*Vishwas*) and Respect (*Samman*) as the foundational values of relationship, Understanding the meaning of *Vishwas*; Difference between intention and competence, Understanding the meaning of *Samman*, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): *Samadhan*, *Samridhi*, *Abhay*, *Sah-astitva* as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society (*AkhandSamaj*), Universal Order (*SarvabhaumVyawastha*)- from family to worldfamily!

UNIT IV Understanding Harmony in the Nature and Existence - Whole existence as Co-existence **6 hours**

Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature, Understanding Existence as Co-existence (*Sah-astitva*) of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence.

UNIT V **Implications of the above Holistic Understanding of Harmony on Professional Ethics** **6 hours**

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identifythescopeandcharacteristicsofpeople-friendlyandeco-friendly production systems, technologies and management models, Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers, b) At the level of society: as mutually enriching institutions and organizations.

Total Lecture hours: **30 hours**

TEXT BOOKS

T1. R R Gaur, R Sangal, G P Bagaria, Human Values and Professional Ethics Excel Books, New Delhi, 2010

REFERENCES

R1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins,USA

R2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs,Britain.

R3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991

R4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society	**K2**
CO2	Distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co-existence of Self and Body.	**K3**
CO3	Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human-human relationships and explore their role in ensuring a harmonious society	**K2**
CO4	Understand the harmony in nature and existence, and work out their mutually fulfilling participation in the nature.	**K3**
CO5	Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT1	CAT2	Model Exam	End Semester Exams	Assignments	Case Studies
			✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/Presentation**	**Open book test**
			✓	✓	

Course code	Course	L	T	P	C
MC 02	CONSTITUTION OF INDIA	2	0	0	0

Course Objectives:

1. The purpose of the course is to acquaint the students with basic principles of the Constitution of India and its working.
2. To help students be familiar with the historical and significant aspects of the constitution of India.
3. To make students aware of their fundamental duties and rights.
4. To know about central and state government functionalities in India.

UNIT I NATURE, OBJECT AND SCOPE OF THE CONSTITUTION 6 hours

Nature, object and scope of Constitutional Law and Constitutionalism – Historical Perspective of the Constitution of India – Salient Features and Characteristics of Constitution of India.

UNIT II FUNDAMENTAL RIGHTS 6 hours

Nature and scope of Fundamental Rights – Scheme of Fundamental Rights – Right to Equality – Right to Freedom of Speech and Expression – Right to Life – Right against Exploitation – Right to Religious Freedom – Minority Rights.

UNIT III DIRECTIVE PRINCIPLES OF STATE POLICY AND FUNDAMENTAL DUTIES 6 hours

Directive Principles of State Policy – Importance and Implementation – Scheme of Fundamental Duties and its Legal Status.

UNIT IV FEDERAL STRUCTURE 6 hours

Federal Structure – Distribution of Legislative and Financial Powers between the Union and the States – Parliamentary Form of Government in India – Constituent Powers and Status of the President of India

UNIT V AMENDMENT AND EMERGENCY PROVISIONS 6 hours

Amendment of the Constitution – Procedure – Historical Perspective of the Constitutional Amendments in India – Emergency Provisions – National Emergency – President Rule – Financial Emergency – Local Self Government – Constitutional Scheme in India.

Total Lecture hours: 30 hours

TEXT BOOKS

T1. V.N. Shukla, Constitutional Law of India

T2. D.D. Basu, Commentary on the Constitution of India

T3. J.N. Pandey, Constitution of India

T4. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.

T5. R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.

T6. Maciver and Page, "Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.

T7. K.L.Sharma, (1997) "Social Stratification in India: Issues and Themes", Jawaharlal Nehru University, New Delhi.

REFERENCES

R1. V.D. Mahajan, Constitutional Law of India

R2. H.M. Seervai, Constitution of India

R3. Sharma, Brij Kishore, "Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.

R4. U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

R5. R.N. Sharma, "Indian Social Problems ", Media Promoters and Publishers Pvt. Ltd.

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Elaborate the constitution of India and its salient features.	**K2**
CO2	Know the fundamental rights and duties.	**K2**
CO3	Discuss the Parliamentary Form of Government in India.	**K2**
CO4	Recognize the Directive Principles of State Policy.	**K3**
CO5	Understand and abide the rules of the Indian constitution and to appreciate different culture among the people.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT1	CAT2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓		✓	✓	✓	

Course Code	Course	L	T	P	C
MC 03	BASIC LIFE SKILLS	2	0	0	0

Course Objectives:

1. To provide value education to improve the students' character, understanding of principled life, physical health, maintaining youthfulness, measures and methods in five aspects of life.

UNIT I PHYSICAL HEALTH 6 hours

Manavalakalai (SKY) Yoga: Introduction – Education as a means for youth empowerment– Greatness of Education – Yoga for youth Empowerment. Simplified Physical Exercises: Hand, Leg, Breathing, Eye exercises –Kapalabathi, Makarasana Part I, Makarasana Part II, Body Massage, Acu pressure, Relaxation exercises –Benefits. Yogasanas: Pranamasana–Hastha Uttanasana–Pada Hasthasana–Aswa Sanjalana Asana–ThuvipathaasvaSanjalana asana – Astanga Namaskara–Bhujangasana–Atha Muktha Savasana – Aswa Sanjalana Asana–Pada Hasthasana–Hastha Uttanasana–Pranamasana. Pranayama:Naddisuddi–Clearance Practice–Benefits.

UNIT II LIFE FORCE 6 hours

Reasons for Diseases – Natural reasons (Genetic / imprints, Planetary Position, Natural calamities and climatic changes) – Unnatural reasons (Food habits, Thoughts, Deeds). Philosophy of Kaya kalpa– Physical body –Sexual vital fluid–Lifeforce-Bio-Magnetism–Mind. Maintaining youthfulness. Postponing old age–Transformation of food into seven components–Importance of sexual vital fluid Measure and method in five aspects of life – Controlling undue Passion. Kayakalpa practice – Aswini Mudra –Ojas breath – Benefits of Kaya Kalpa

UNIT III MENTAL HEALTH 6 hours

Mental Frequencies –Beta, Alpha, Theta and Delta wave –Agna Meditation explanation–benefits. Shanthi Meditation explanation–Benefits –Thuriya Meditation explanation–Benefit. Benefits of Blessing–Self blessing (Autosuggestion)– Family blessing – Blessing the others – World blessing – Divine protection.

UNIT IV VALUES 6 hours

Human Values Self-control–Self-confidence–Honesty Contentment–Humility–Modesty Tolerance–Adjustment – Sacrifice – Forgiveness Purity (Body, Dress, Environment) – Physical purity – Mental purity –Spiritual purity Social Values: Non-violence– Service Patriotism – Equality Respect for parents and elders – care and protection–Respect for teacher Punctuality–Time Management

UNIT V MORALITY (VIRTUES) 6 hours

Importance of Introspection–I–Mine (Ego, Possessiveness). Six Evil Temperaments–Greed–Anger–Miserliness – Immoral sexual passion – Inferiority and superiority Complex – Vengeance. Maneuvering of Six Temperaments – Contentment – Tolerance – Charity – Chastity – Equality – Pardon (Forgiveness). Five essential Qualities acquired through Meditation: Perspicacity – Magnanimity – Receptivity – Adaptability – Creativity. Improved Memory Power–Success in the Examination.

Total Lecture hours: 30 hours

TEXT BOOKS:

1. Vethathiri Maharishi, 16th Edi.2013, Yoga for Modern Age, Vethathiri Publications, Erode.
2. Vethathiri Maharishi, 2014, Simplified Physical Exercises, Vethathiri Publications, Erode.
3. Vethathiri Maharishi, 3rd Edi.2014, Kayakalpam, Vethathiri Publications, Erode.
4. Rev.Dr.G.U. Pope, 2016, Thirukkural, Giri Trading Agency,

REFERENCE BOOKS

1. Vethathiri Maharishi, 1994, Mind, Vethathiri Publications, Erode.
2. Chandrasekaran.K, 1999, Sound Health through yoga, Sedapati, Tamilnadu, Premkalyan Publications.

3. Iyengar, B.K.S. 2008, Light on Yoga, Noida, UP India, Harber Collins Publishing India Ltd.,
4. K. R. Dhanalakshmi and N. S. Raghunathan, " Personality Enrichment, Margham Publications

WEBLINK

1. https://www.unicef.org/azerbaijan/media/1541/file/basic%20life%20skills.pdf

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Utilize skills developed through participation in Manavala kalai (SKY) Yoga to help maintain life long health and fitness.	**K2**
CO2	Demonstrate foundational standing, sitting, balance postures with proper alignment and maintain youthfulness through kaya kalpa practice.	**K3**
CO3	Explore relaxation techniques to observe thoughts and to manage emotions and stress, and reflect on those techniques which are most effective to them.	**K2**
CO4	Demonstrate an understanding of anatomy and physiology as it applies to the intentional integration of breath, postures, and movement within the practice of yoga to understand the human values.	**K3**
CO5	Achieve a greater sense of awareness, wisdom, introspection, and a deeper sense of relaxation through meditation to keep up morality in life.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	-	-	-	-	-	3	3	2	3	-	-	3	2	-
CO2	-	-	-	-	-	3	2	2	3	-	-	3	2	-
CO3	-	-	-	-	-	3	3	2	3	-	-	3	2	-
CO4	-	-	-	-	-	3	2	2	3	-	-	3	2	-
CO5	-	-	-	-	-	3	3	3	3	-	-	3	2	-

ASSESSMENT METHODS

CAT 1	CAT2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/Presentation**	**Open book test**
			✓	✓	

Course Code	Course	L	T	P	C
MC 04	GENDER INSTITUTION AND SOCIETY	2	0	0	0

Course Objectives:

- The course helps the student to understand concepts of social justice and gender justice. It provides the student with the knowledge of various institutions functioning worldwide which aim to eradicate discrimination against women. The course further aids students in understanding feminism and gender in relation to the society and to study the basic constitutional remedies available to women.

UNIT I **9 hours**

Social Justice and Gender Justice – Theories relating to Social Justice – Theories relating to Gender Justice – Interrelationship between Gender justice and Social Justice.

UNIT II **9 hours**

International Conventions for protection of Women – Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) – National Commission for women – Constitutional remedies available for women under Indian Constitution.

UNIT III **9 hours**

United Nations Entity for Gender Equality and the Empowerment of Women (UN Women) - Association for Women's Rights in Development (AWID) –Women kind worldwide – Centre for reproductive rights - Women's Environment and Development Organization (WEDO) - Global Fund for Women

UNIT IV **9 hours**

International Center for Research on Women (ICRW) - European Institute for Gender Equality (EIGE) – Promundo - International Alliance of Women (IAW) - International Women's Development Agency (IWDA).

UNIT V **9 hours**

World Health organisation – Sex and Gender – Feminism – Theories relating to Feminism – Gender and society

Total Lecture hours: **45 hours**

TEXT BOOKS

T1. Law relating to Women and children, Mamta Rao

T2. Gender, Politics and Institutions: Towards a Feminist Institutionalism, by Mona Lena krook and Fiano Mackay,2010

T3. Gender Justice and Feminist Jurisprudence, Dr.Sheetal Kanwal,2015

T4. Narain's Gender and society, P.Jain

REFERENCES

R1. Gender Justice and feminist Jurisprudence by Dr.Ishitha Chatterjee

R2. Gender and Institutions, Moira Gatens and Alison Mackkinon

WEBLINK:

W1. https://www.jstor.org/stable/3598436

COURSE OUTCOMES

Upon success completion of the course, students will be able to		
CO1	Understand the Concept of Social Justice and Gender Justice.	**K2**
CO2	Learning the International Conventions and constitutional remedies available for women.	**K2**
CO3	Identify the various gender Institutions and its functions for the development of women.	**K2**
CO4	Assessing the International agencies.	**K3**
CO5	Summarizing the study on feminism and relation of gender and society.	**K3**

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		