PANDIT DEENDAYAL ENERGY UNIVERSITY

B.Tech Biotechnology

Department of Biotechnology

School of Energy Technology

Curriculum 2023-2027

PDEU

PANDIT DEENDAYAL ENERGY UNIVERSITY

Formerly Pandit Deendayal Petroleum University (PDPU)

UGC RECOGNIZED

B. TECH
BIOTECHNOLOGY

Vision & Mission Statement

Department of Biotechnology

School of Energy Technology

Pandit Deendayal Energy University, Gandhinagar

VISION

To provide excellent education in industry-driven modules that stimulate young Biotechnologist to create knowledge wealth in order to produce employability while adhering to professional ethics and focusing on a sustainable environment and societal advantages.

MISSION

- To provide state-of-the-art facilities to Biotechnology students with a focus on skill development, creativity, innovation, and strengthening leadership characteristics.
- To develop creative minds via mentoring, excellent education, and research in order to construct a value-based, sustainable society.
- To provide an inspiring atmosphere for young faculty and staff by offering a safe work environment, openness, professional ethics, and accountability, allowing them to lead the department in the appropriate spirit.
- To collaborate with academic and industry partners at the national and international levels to address societal challenges of greater importance.
- To instil a culture of continuous learning among faculty by encouraging them to participate in professional development programmes and to address social, economic, and environmental issues.

Department of Biotechnology
School of Energy Technology
Pandit Deendayal Energy University, Gandhinagar

PROGRAM EDUCATION OBJECTIVES (PEOs)

- Acquire the fundamental principles of science and Biotechnology with modern experimental and computational skills.
- Ability to handle problems of practical relevance of society while complying with economical, environmental, ethical, and safety factors.
- Demonstrate professional excellence, ethics, soft skills and leadership qualities with life-long learning's.
- Graduates will be active members ready to serve the society locally and internationally.

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PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified need with appropriate considerations for public health and safety, and the cultural, societal and environmental considerations.
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.
5. **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.
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 professional engineering practices.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical practices and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
10. **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.
11. **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 the team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning of broadest context of technological change.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

1. To analyse and tackle the complex and diverse engineering problems by appropriate experimentation, simulation, data analysis and interpretation, and, provide probable solutions by applying principles of Biotechnology in combination to the fundamental knowledge of basic sciences and mathematics.
2. Competence to incorporate socio-economic considerations in engineering practices, including the concept of sustainable development, into Biotechnology practice.
3. An ability to work together collaboratively in multidisciplinary teams to tackle multifaceted problems and pursue a bright career in Biotechnology and allied areas by demonstrating professional success at different platforms within industry, governmental bodies or academia.

Course Curriculum Framework

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
I	BSC	23MA101T	Mathematics - I for Biotechnology	3	1	0	4	4
	ESC	20CH101T	Engineering Chemistry	3	0	0	3	3
	ESC	20CH101P	Engineering Chemistry - Lab.	0	0	2	2	1
	ESC	20ME102T	Elements of Mechanical Engineering	3	0	0	3	3
	ESC	20ME102P	Elements of Mechanical Engineering - Lab.	0	0	2	2	1
	BSC	20IC101T	Basic Electronics	2	0	0	2	2
	BSC	20IC101P	Basic Electronics - Lab.	0	0	2	2	1
	ESC	20ME101P	Engineering Graphics - Lab.	0	0	4	4	2
	ESC	20CP101T	Programming with C	1	0	0	1	1
	ESC	20CP101P	Programming with C - Lab.	0	0	2	2	1
	HSC	20HS102T	Environmental Studies	3	0	0	3	3
	HSC	16SP101	NCC - I	0	0	2	2	1
		16SP102	NSS - I					
		16SP103	Sports - I					
	Category Code	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs.**	**Credits**
II	BSC	23MA102T	Mathematics - II for Biotechnology	3	1	0	4	4
	PC	23BIO102T	Principles of Biotechnology	3	0	0	3	3
	PC	23BIO103T	Human Anatomy & Physiology - I	4	0	0	4	4
	PC	23BIO103P	Human Anatomy & Physiology - I - Lab.	0	0	2	2	1
	ESC	22PH101T	Engineering Physics	3	0	0	3	3
	ESC	22PH101P	Engineering Physics - Lab.	0	0	2	2	1
	ESC	16ME103P	Workshop Practice	0	0	2	2	1
	ESC	20CP102P	Fundamentals of Python Programming	0	0	2	2	1
	HSC	20HS101P	Communication Skills - I	0	0	2	2	1
	HSC	16HS109T	Professional Ethics & Human Values	1	0	0	1	1
	HSC	16SP101	NCC - II	0	0	2	2	1
		16SP102	NSS - II					
		16SP103	Sports - II					
	HSC	20TP110	Civic Services & Social Internship	0	0	0	0	1

	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
III	PC	23BIO201T	Principles of Biochemistry	3	0	0	3	3
	PC Lab	23BIO201P	Biochemistry - Lab.	0	0	2	2	1
	PC	23BIO202T	Human Anatomy and Physiology - II	3	0	0	3	3
	PC Lab	23BIO202P	Human Anatomy and Physiology - II - Lab.	0	0	2	2	1
	PC	23BIO203T	General Microbiology	3	0	0	3	3
	PC Lab	23BIO203P	General Microbiology - Lab.	0	0	2	2	1
	PC	23BIO204T	Biophysics & Structural Biology	3	1	0	4	4
	OE	23BIO205T	Open Elective I	3	0	0	3	3
	PC	23BIO206T	Technical Seminars	0	0	2	2	0
	HSC	20HS201P	Communication Skills - II	0	0	2	2	1
Semester	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs.**	**Credits**
IV	PC	23BIO207T	Molecular Biology and Genetics	3	0	0	3	3
	PC Lab	23BIO207P	Molecular Biology and Genetics - Lab.	0	0	2	2	1
	PC	23BIO208T	Bioprocess Engineering	3	0	0	3	3
	PC Lab	23BIO208P	Bioprocess Engineering - Lab.	0	0	2	2	1
	PC	23BIO209T	Analytical Bioinformatics	3	0	0	3	3
	PC Lab	23BIO209P	Analytical Bioinformatics - Lab.	0	0	2	2	1
	PC	23BIO310T	Analytical Methods in Bioengineering	3	0	0	3	3
	PC	23BIO311T	Pharmacology of Drug Action	3	0	0	3	3
	OE	23BIO312T	Biomedical Informatics	3	0	0	3	3
	IND	20IF301T	Industry 4.0	2	0	0	2	2
	IND	20IF301P	Industry 4.0 - Lab.	0	0	2	2	1
	Project	20TP210	Industrial Orientation (3 weeks-summer break)	0	0	0	0	1
Semester	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs.**	**Credits**
V	PC	23BIO301T	Genomics & Proteomics	4	0	0	4	4
	PC	23BIO302T	Immunology and Immunotechnology	3	0	0	3	3
	PC Lab	23BIO302P	Immunology and Immunotechnology - Lab.	0	0	2	2	1

	PC	23BIO303T	Animal and Plant Biotechnology	3	0	0	3	3
	PC Lab	23BIO303P	Animal and Plant Biotechnology - Lab.	0	0	2	2	1
	CE	23BIO304T	Medical Diagnostics	3	0	0	3	3
	CE	23BIO305T	Green Biotechnology and Pollution Abatement					
	CE	23BIO306T	Computer Aided Drug Design					
	OE	23BIO307T	Molecular Diagnostics	3	0	0	3	3
	HSC	20HS301P	Communication Skills - III	0	0	2	2	1
Semester	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs.**	**Credits**
VI	PC	23BIO308T	Genetic Engineering techniques	3	0	0	3	3
	PC Lab	23BIO308P	Genetic Engineering - Lab.	0	0	2	2	1
	PC	23BIO309T	Tissue Engineering and Regenerative Medicine	4	0	0	4	4
	PC Lab	23BIO310P	Biomaterials and Tissue Engineering - Lab.	0	0	2	2	1
	CE	23BIO311T	Biomaterial and Implants	3	0	0	3	3
	CE	23BIO312T	Novel Separation Processes - Dyes and Pigments					
	CE	23BIO313T	Cheminformatics and Medicinal Chemistry					
	CE	23BIO314T	Pharmacokinetics and Pharmaco Dynamics	3	0	0	3	3
	CE	23BIO315T	Food Biotechnology					
	CE	23BIO316T	Next Generation Sequence Analysis					
	OE	23BIO317T	Biosimilars Technology	3	0	0	3	3
	Project	20TP310	Industrial Training / IEP (6 weeks-summer break)	0	0	0	0	2
	Category Code	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs.**	**Credits**
VII	PC	23BIO401T	Bioethics, IPR and Biosafety	3	0	0	3	3
	PC	23BIO402T	Nanotechnology	3	0	0	3	3
	PC Lab	23BIO402P	Nanotechnology - Lab.	0	0	2	2	1
	PC	23BIO403T	Downstream Processing	3	0	0	3	3
	PC Lab	23BIO403P	Down Stream Processing - Lab.	0	0	2	2	1

	CE	23BIO404T	Pharmaceutical Biotechnology	3	0	0	3	3
	CE	23BIO405T	Synthetic and Systems Biology					
	CE	23BIO406T	Metabolic Engineering					
	CE	23BIO407T	Biomass Conversion and Utilisation	3	0	0	3	3
	CE	23BIO408T	Stem Cell Technology					
	CE	23BIO409T	Molecular Data Analysis and Simulations					
	Project	20TP410	Mini Project	0	0	6	6	3
	Category Code	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs.**	**Credits**
VIII	Project	20TP422	Major Project Internship with Industry	0	0	26	26	13

Sr No	Code	Component
1	HSC	Humanities & Social Science Including Management Courses
2	BSC	Basic Science Courses
3	ESC	Engineering Science Courses including Workshop, drawing, Basic of Electrical, Basic of Mechanical, Computer etc…
4	IND	Industry 4.0 Course
5	PC	Professional Core Courses
6	CE	Professional Elective Courses related to chosen specialization
7	OE	Open Elective Subjects from Other technical / emerging subjects
8	Project	Project work, Seminar or Internship in Industry or elsewhere
9	NC	Non-Credit course

Semester –I

Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
BSC	23MA101T	Mathematics - I for Biotechnology	3	1	0	4	4
ESC	20CH101T	Engineering Chemistry	3	0	0	3	3
ESC	20CH101P	Engineering Chemistry - Lab.	0	0	2	2	1
ESC	20ME102T	Elements of Mechanical Engineering	3	0	0	3	3
ESC	20ME102P	Elements of Mechanical Engineering - Lab.	0	0	2	2	1
BSC	20IC101T	Basic Electronics	2	0	0	2	2
BSC	20IC101P	Basic Electronics - Lab.	0	0	2	2	1
ESC	20ME101P	Engineering Graphics - Lab.	0	0	4	4	2
ESC	20CP101T	Programming with C	1	0	0	1	1
ESC	20CP101P	Programming with C - Lab.	0	0	2	2	1
HSC	20HS102T	Environmental Studies	3	0	0	3	3
HSC	16SP101	NCC - I	0	0	2	2	1
	16SP102	NSS - I					
	16SP103	Sports - I					
			15	1	14	30	23

Pandit Deendayal Energy University **School of Energy Technology**

23MA101T					Mathematics I for Biotechnology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To make students acquainted with the basics of sets, relation and functions.
2. To introduce the concept of matrix, determinants and their use to solve systems of equations.
3. To learn fundamental of differential and integral calculus.
4. To understand the use of calculus in real world applications.

UNIT 1 SET, RELATION, AND FUNCTIONS **10 Hrs.**

Sets and their representation. Union, intersection, and complement. Mapping or function. One-one, onto mappings. Inverse and composite mappings.

UNIT 2 MATRICES AND DETERMINANTS **10 Hrs.**

Algebra of matrices. Determinant of a square matrix. Properties of determinants. Some simple type of matrices. Inverse of a matrix.

UNIT 3 DIFFERENTIAL CALCULUS - SINGLE VARIABLE **10 Hrs.**

Limit, continuity, Differentiability, Increasing and Decreasing Functions, Maxima and Minima.

UNIT 4 INTEGRAL CALCULUS - SINGLE VARIABLE **10 Hrs.**

Integrals of elementary functions. Substitution and partial fractions. Definite Integral as a limit of sum. Properties of definite integrals. Application to areas and lengths

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the basic concepts of single variable calculus and matrices.
CO2 – Demonstrate basic matrix operations and determinants.
CO3 – Apply the concepts of calculus to find maxima, minima and area under the curve.
CO4 – Analyse the use of single variable calculus and matrices in engineering problems.
CO5 – Evaluate the determinant of different types of matrices, differentiation and integration of functions.
CO6 – Develop basic understanding of matrices and calculus in solving various engineering problems.

TEXT/REFERENCE BOOKS

1. NCERT, Mathematics Textbook for class XI and XII, 2009.
2. G. B. Thomas, J. Hass, C. Heil, M. D. Weir, Thomas' Calculus, Pearson Education; 14th edition, 2018.
3. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and sons (Asia), Pvt. Ltd., 7th edition, Singapore, 2002.
4. Nita H. Shah, Foram A. Thakkar, Matrix and Determinant Fundamentals and Applications, CRC Press, 2021.

Pandit Deendayal Energy University **School of Energy Technology**

20CH101T					Engineering Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To develop the fundamental understanding about atomic structure and interatomic bonding.
- To provide the knowledge about structural features, synthesis, properties of various categories of materials.
- To develop the skills for phase, microstructural and elemental characterization of materials.
- To provide the knowledge about the role of chemistry in modern engineering applications.

UNIT 1 Atomic structure and interatomic bonding **12hrs**

Electrons in atoms, Bohr atomic model, wave mechanical model, introduction to quantum chemistry, wave functions and probability densities, quantum numbers, orbital shapes - *s,p,d,f*- LCAO-MO of H2, covalent, ionic and metallic bonding, bonding forces and energies, lattice energy and Madelung constant, metallic crystal structure, ceramic crystal structure and influencing factors.

UNIT 2: Chemistry of materials **10hrs**

Introduction and classification of materials; structural features, synthesis, properties of metallic (e.g., noble metal), polymeric (e.g., thermoplastic, and thermosetting), glass-ceramic (e.g., silicates, metal oxides) carbonaceous materials (e.g., fullerene, carbon nanotube, graphene); Introduction to nanomaterials, surface area to volume ratio and aspect ratio of nanomaterials, quantum confinement, top- down and bottom-up chemical/physical approaches for synthesis of nanomaterials.

UNIT 3: Chemistry of Fuels and energy devices **10hrs**

Fuels – Classification of fuels; Determination of calorific values of solid fuels by bomb calorimeter – Manufacture of synthetic petrol by Fischer-Tropsch method – Knocking in IC engines – Octane and cetane rating of fuels; Petrol and Diesel Engine, chemistry for alternative source and storage of energy (supercapacitor, fuel cell, battery); role of chemistry on in photo-voltaic devices (solar cell).

UNIT 4: Instrumental methods of chemical analysis **12hrs**

Characterization of materials using X-ray diffraction (XRD), thermal Analysis (TGA-DTA-DSC), basics and application of Microwave spectroscopy, FTIR, UV-visible spectroscopy; NMR spectroscopy; Chromatographic techniques (GC, HPLC).

Max. 44 h

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamental concept about atomic structure and interatomic bonding.

CO2 - Acquire knowledge about metallic and ceramic crystal structure.

CO3 - Acquire knowledge about structural features, properties of different classes of materials including nanomaterials. CO4 - Explain the methodologies for the synthesis of different categories of materials.

CO5 - Develop the skill for phase, microstructural and elemental characterization of materials.

CO6 - Develop the knowledge on the role of chemistry in various modern engineering applications.

TEXT/REFERENCE BOOKS

1. An Introduction to Materials Science & Engineering, W.D. Callister, John Wiley & Sons (2007).
2. Fundamental of Ceramics, MW Barsoum, IOP publishing (2003).
3. Text book of Nanoscience and Nanotechnology, T. Pradeep, Mc. Graw Hill Education (2003).
4. Textbook of Nanoscience and Nanotechnology, Murty, Shankar, B Raj, Rath, Murday, Springer (2013).
5. Materials Science and Engineering, V. Raghavan, Prentice-Hall of India Private Limited (2003).
6. Principles of Instrumental Analysis, Douglas A. Skoog, Donald M.West, 6th Edition, Cengage (2014)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Part A/Question: 3 Questions from each unit, each carrying 3 marks	36 Marks
Part B/Question: 2 Questions from each unit, each carrying 8 marks	64 Marks

Pandit Deendayal Energy University **School of Energy Technology**

20CH101P					Engineering Chemistry Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To enhance and develop scientific and analytical skills
2. To relate concepts learned in chemistry and engineering to the real-world situations.
3. To acquire skills to perform laboratory experiments.
4. To demonstrate safe and proper use of standard chemistry glassware and equipment.

Experiment Sessions would be simulation-based covering but not limited to following topics:

1. External Indicator: To determine the strength of given solution of ferrous ammonium sulphate by titrating against standard N/40 K2Cr2O7 using potassium ferricyanide as an external indicator
2. Iodometry: To determine the strength of given copper sulphate solution by titrating against N/20 sodium thiosulphate (hypo) solution
3. Iodimetry: To determine the strength of given ascorbic acid by titrating against standard N/10 iodine solution
4. Complexometric Titration: To determine the total, permanent and temporary hardness of given water by complexometric titration using standard 0.01M EDTA solution
5. pH metric titration: To determine the strength of given HCl solution using a standard NaOH solution by performing a pH- metric titration
6. Conductometric Titration: To determine the strength of given HCl solution using a standard NaOH solution by performing a conductometric titration
7. Potentiometric Titration: To determine the strength of given HCl solution potentiometrically
8. Chemical Kinetics: To study the kinetics of decomposition of sodium thiosulphate by a mineral acid
9. Chloride in Water Determination of Chloride in the given water sample by Mohr Method
10. Polymerization To prepare a polymer (Nylon 6,10), identify the functional groups by FT-IR
11. Spectrophotometry -To determine the λmax and concentration of given unknown potassium permanganate using UV-Visible spectroscopy technique

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the concepts learned in chemistry and engineering to the real-world situations.
CO2 - Enhanced ability to identify, analyze and interpret the results from the experiments
CO3- Carry out quantitative analysis by instrumental method using Conductometer.
CO4- Analyze compounds by titrimetric, gravimetric, and instrumental methods
CO5- Determine the concentration of unknown solutions by Spectrophotometric method.
CO6- Investigate the reaction rate and predict the order and rate constant

TEXT/REFERENCE BOOKS

1. College Practical Chemistry, VK Ahluwalia, S Dhingra, A Gulati, Universities Press
2. Foundations of Experimental Chemistry, JB Baruah, P Gogoi, Pharma Med Press.
3. A Text Book of Chemistry Practicals Vol I & II, SS Sawhney, M S Jassal, SP Mittal, APH Publishing Corp.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Part A: Lab Work-Continuous Assessment	50 Marks
PARTB: Lab Exam and Viva	50 Marks

Pandit Deendayal Energy University **School of Energy Technology**

20ME102T					Elements of Mechanical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To introduce and define the basics concept of mechanical engineering.
2. To familiarize the working principles of IC engines and industrial robotics systems.
3. To enable the students to understand the details about the energy systems and its components.
4. To demonstrate the various machine elements, materials and its function.
5. To help the students acquire knowledge about the various manufacturing process.

UNIT 1 Introduction to Thermodynamics **10 Hrs.**

Introduction to Thermodynamics: Definition and applications, systems and control volumes, thermodynamic properties, thermodynamic systems, state and equilibrium processes and cycles, temperature and Zeroth law of thermodynamics, forms of Energy, energy transfer by work and heat, law of conservation of energy, energy conversion efficiencies. Properties of Pure substances: Definition, examples and phases, phase change of pure substances, property diagrams and property tables. Solution of Numerical Problems through EES Software.

UNIT 2 Law of degradation of Energy and Internal Combustion Engines **10 Hrs.**

Law of degradation of Energy and Internal Combustion Engines: Limitations of First Law, Thermal Energy reservoirs, heat engines, Refrigerators and Heat pumps, Kelvin Plank and Clausius statement and their equivalence. Introduction, classification and brief description of I.C. engines mechanism, 4-Stroke and 2-Stroke cycles and engines. Otto, Diesel and dual cycles; MEP and air standard efficiencies.

UNIT 3 Engineering materials and Introduction to Manufacturing Processes **10 Hrs.**

Engineering materials and Introduction to Manufacturing Processes: Stresses, strains and material properties. Conventional manufacturing process: Lathe Machines, CNC machines, drilling machines, universal Milling machines. Non-conventional manufacturing processes: Additive Manufacturing, 3D printing.

UNIT 4 Introduction to industrial robotics and Introduction to Industry 4.0 **10 Hrs.**

Introduction to industrial robotics and Introduction to Industry 4.0. Introduction, Industrial and Non-industrial robots, Anatomy and configuration of Industrial Robots, Robot Components, Robot Applications.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Define the fundamentals and terminologies used in Thermodynamics.
CO2: Explain the energy conservation principles applicable for ideal gas and pure substance applications CO3: Analyze the performance of thermodynamic cycles.
CO3: Analyze the performance of the thermodynamic cycles.
CO4: Evaluate the performance of power cycles
CO5: Identify the principles of different machining techniques and material properties.
CO6: Understand the anatomy, applications of robots and introduction to industry 4.0.

TEXT/REFERENCE BOOKS

1. Yunus A. Cengel& Bole, Thermodynamics- Engineering Approach by Tata Mcgraw Hill.
2. Sharma PC. A Textbook of Production Enginerring. S. Chand Publishing.
3. P. K. Nag, Engineering Thermodynamics, Tata Mcgraw Hill, New Delhi.
4. Industrial Robotics, Mikell Groover, McGraw-Hill Education (India) Pvt Limited

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Unit 1 and 2: Two question from each unit (Total 4 question with subparts)	40 Marks
Unit 3 and 4: Two question from each unit (Total 4 question with subparts)	60 Marks

Pandit Deendayal Energy University **School of Energy Technology**

20ME102P					Element of Mechanical Engineering Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Continuous Evaluation			End Semester LE/Viva		Total Marks
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To Perform experiments and collect experimental data on thermal and mechanical systems to validate theoretical principles.
2. To analyze, differentiate and evaluate Law of conservation of energy on thermal systems.
3. To evaluate performance of heat engine and heat pumps.
4. To calculate and compare the components, application of the conventional manufacturing machines, non- conventional manufacturing machines and industrial robotic systems.
5. To demonstrate the working principle of heat engine and additive manufacturing process.

List of Experiments

1. To understand and perform fluid property evaluation using property tables and engineering equation solver software.
2. To perform experimental study and verify 1st law of thermodynamics by energy balance of heat exchanger.
3. To evaluate thermodynamic systems using Engineering Equation Solver.
4. To determine Performance of Heat pump and evaluate its coefficient of performance.
5. To understand and demonstrate components and working cycle of Internal Combustion engine.
6. To understand and demonstrate construction and working of conventional manufacturing machine.
7. To understand and demonstrate construction and working of non-conventional manufacturing machine.
8. To study additive manufacturing process applied for 3D printing.
9. To develop a working model of a simple robotic system.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand and evaluate conservation law of thermodynamics through experimentation.

CO2 – Understand and analyze thermal systems data using engineering equation solver.

CO3 – Measure the coefficient of performance of heat pump.

CO4 – Examine the internal combustion engine components and its working.

CO5 – Demonstrate the various components of convention and non-conventional manufacturing machines and elaborate their applications.

CO6 – Classify the components in industrial robots and develop a simple robotic system.

TEXT/REFERENCE BOOKS

1. Solar energy by Prof. Sukhatme.
2. Heat transfer by Yungus A. Cengel.
3. Industrial Robotics, Mikell Groover, McGraw-Hill Education (India) Pvt Limited

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 2h**
PART A – Laboratory Exam: would be conducted in the Lab, and students would be provided one or more questions on: designing/ experimentation/ programming-coding/ implementation/ investigation/ solution- development.	50 Marks
PART B – Viva	50 Marks

Pandit Deendayal Energy University **School of Energy Technology**

20IC101T					Basic Electronics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To introduce and define the basics concept of mechanical engineering.
2. To familiarize the working principles of IC engines and industrial robotics systems.
3. To enable the students to understand the details about the energy systems and its components.
4. To demonstrate the various machine elements, materials and its function.
5. To help the students acquire knowledge about the various manufacturing process.

UNIT 1: DIODES AND RECTIFIERS **08 Hrs.**

Review of p-n junction diode, 1-phase half wave, full wave and bridge rectifier using diode. Calculation of average & rms value, PIV, efficiency, transformer utilization factor and ripple for different diode rectifier circuit. Use of Capacitor Filter for ripple reduction, voltage multipliers, Zener diode in load and line regulation.

UNIT 2: BJT, FET AND MOSFET **07 Hrs.**

Working of a BJT, transistor biasing, different transient circuit configuration (CB, CE and CC), static characteristic for BJT, transistor as switch, amplifier, concept of feedback amplifier and oscillator. Classification of FET, static characteristics of FET, FET biasing and load line, MOSFET, static characteristic of MOSFET and biasing

UNIT 3: OPAMP **04Hrs.**

Introduction, Block Diagram and Characteristics of Ideal Op-Amp, Parameters of an Op-Amp, Inverting and Non- Inverting Amplifier, Virtual Ground, Adder, Subtractor, Comparator, Integrator and Differentiator.

UNIT 4: DIGITAL ELECTRONICS **07Hrs.**

Number system, Binary arithmetic, logic gates and combinational logic, Boolean algebra, DeMOrgan's Theorems, Logic minimization and Karnaugh maps, full adder, multiplier, multiplexing, Flip Flops, Introductory Sequential Logic, Counters, Registers

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Demonstrate application of different diode in circuits CO2 Evaluate Zener diode as voltage regulator

CO2: Evaluate Zener diode as voltage regulator

CO3: Apply BJT, FET and MOSFET in different circuits CO4 Understand static characteristics OPAMP

CO4: Understand Static characteristics of OPAMP

CO5: Illustrate basic concepts and theorem of digital systems CO6 Build digital circuits using logic gates and flip flops

TEXT/REFERENCE BOOKS

1. Boylestad and Nashlesky, “Electronic Devices and Circuit Theory”, PHI
2. N.N. Bhargava, S.C. Gupta, and D.C. Kulshreshtha, “Basic Electronics and Linear Circuits,” McGraw Hill Education
3. R. A. Gaikwad, “Operational Amplifier and Linear Integrated Circuits”, PHI
4. Morris Mano, “Digital Design”, PHI
5. J. Millman, C. Halkais and C. Parikh, “Integrated electronics”, Tata McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	82 to 60 Marks

Pandit Deendayal Energy University **School of Energy Technology**

20IC101P					Basic Electronics Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To understand the characteristics of PN junction diodes and their applications
2. To Observe properties of BJT, FET and MOSFET
3. To illustrate the OPAMP application in different real-life circuits
4. To introduce basic concepts of digital electronics

Experiment Sessions would be simulation-based covering but not limited to following topics:

1. To study the simulation tool and its features for analog circuit simulation
2. To study the VI characteristic of silicon and germanium diodes.
3. To study reverse characteristics of Zener diode.
4. To study half wave, full wave and bridge rectifiers
5. To study BJT as switch
6. To study common emitter amplifier
7. To study different biasing circuits of BJT
8. To study transfer and drain characteristic of FET and MOSFET
9. To study the simulation of digital circuits
10. To study and verify logic gates
11. To implement X-OR and X-NOR gates using basic gates
12. To study and design adder and subtracter circuits
13. To study and design flip flops
14. To study OPAMP and its properties
15. To study ADC and DAC
16. Design of mini project in a group of 4-5 students

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Study the fundamentals of electronic components
CO2: Understand the working principle of semiconductor devices
CO3: Apply the analog and digital concept in building real time circuits
CO4: Analyze the behavior of semiconductor devices, OPAMP, ADC and DAC
CO5: Evaluate different circuit for different device parameters
CO6: Build analog and digital sub-system

TEXT/REFERENCE BOOKS

1. Boylestad and Nashlesky, “Electronic Devices and Circuit Theory”, PHI
2. N.N. Bhargava, S.C. Gupta, and D.C. Kulshreshtha, “Basic Electronics and Linear Circuits,” McGraw Hill Education
3. R. A. Gaikwad, “Operational Amplifier and Linear Integrated Circuits”, PHI
4. Morris Mano, “Digital Design”, PHI
5. J. Millman, C. Halkais and C. Parikh, “Integrated electronics”, Tata McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
PART A- Laboratory Exam: would be conducted in the Lab, and students would be provided one or more questions on: designing/ experimentation/ programming-coding/ implementation/ investigation /solution-development.	50 Marks
PARTB: Viva	50 Marks

Pandit Deendayal Energy University **School of Energy Technology**

20CP101T					Programming with C					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	50	25	--	--	100

COURSE OBJECTIVES

1. Develop a greater understanding of the issues involved in programming language, design and implementation
2. To inculcate functional and logical problem-solving skills through programming.
3. To understand the basic concepts of C programming
4. To understand design and implementation issues involved with variable allocation and binding, control flow, types, subroutines, parameter passing
5. To develop understanding of Compilation process.

UNIT 1 BASICS OF C PROGRAMMING **4 Hrs.**

Writing C Programs to implement: Input, Output constructs, different data types, types of Operators, Precedence and associativity of Operators, Control Structure and Loop Structure.

UNIT 2 ARRAY AND STRINGS **4 Hrs.**

Writing C Programs to implement: 1-dimensional, 2-dimensional, and 3-dimensional arrays, different types of user defined functions,
String operations in form of Character arrays, In-built String functions

UNIT 3 POINTERS **4 Hrs.**

Writing C Programs to implement: Basic pointer arithmetic, arrays and String using Pointer, call the functions using Call-by reference property

UNIT 4 FILE HANDLING **2 Hrs.**

Writing C Programs to implement: open the file in write mode and write the data into it, open the file in read mode and read from the file, Open the file in append mode and append the contents in the file, handle the File operations using seek function.

Total Theory (14 Hrs.) + Practical (24 Hrs.) = Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand functional and logical problem-solving skills through programming
CO2 - Write, compile and debug programs in C language
CO3 – Use basic and derived data types in C and Operators in C.
CO4 - Design programs involving decision structures, loops, and functions in C.
CO5 - Implement Programs to perform pointer arithmetic and array handling with Pointers.
CO6 - Perform File-handling operations in C.

TEXT/REFERENCE BOOKS

1. E.Balaguruswamy, Programming in ANSI C, McGraw-Hill
2. Jeri R. Hanly and Elli B.Koffman, Problem Solving and Program Design in C.
3. Brain W.Kernighan & Dennis Ritchie, C Programming Language, PHI

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Part A: 10 Questions of 2 marks each-No choice	20 Marks
Part B: 2 Questions from each unit with internal choice, each carrying	80 Marks

Pandit Deendayal Energy University **School of Energy Technology**

20CP101P					Programming with C – Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To understand the basic concepts of C programming
2. To understand design and implementation issues involved with variable allocation and binding, control flow, types, subroutines, parameter passing
3. To develop understanding of Compilation process.

List of Experiments

1. Add, subtract, multiply, divide two numbers.
2. Convert hours into minutes, minute to hours.
3. Conversion related programs dollars into Rs. Where 1 $ = 48 Rs. , grams to KG, Kilobytes to Megabytes.
4. Convert Celsius into Fahrenheit. F = (9/5 * C) + 32 and Fahrenheit into Celsius. C = 5/9 * (F – 32)
5. Calculate simple and compound interest where I = PRN/100.
6. Calculate area & perimeter of a square, rectangle, circle, triangle.
7. Program to sort N numbers. (Ascending and Descending)
8. Program to calculate string length, reverse the string.
9. Program to check the string and number is palindrome or not.
10. Program to generate sine, cosine, tan series.
11. Program to generate Fibonacci series.
12. Program to calculate factorial using recursion.
13. Program to create a database using array of structures.
14. Programs related to pointers.
15. Programs related to file.
16. Design based Problems (DP)/Open Ended Problem:
    1) Develop a game/Puzzle in C language.
    2) Use interrupts to develop programs related to basic operations

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand functional and logical problem-solving skills through programming.
CO2 - Write, compile and debug programs in C language.
CO3 – Use basic and derived data types in C and Operators in C.
CO4 - Design programs involving decision structures, loops, and functions in C.
CO5 - Implement Programs to perform pointer arithmetic and array handling with Pointers.
CO6 - Perform File-handling operations in C.

TEXT/REFERENCE BOOKS

1. E. Balaguruswamy, Programming in ANSI C, McGraw-Hill
2. 2. Jeri R. Hanly and Elli B. Koffman, Problem Solving and Program Design in C.
3. 3. Brain W. Kernighan & Dennis Ritchie, C Programming Language, PHI

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Part A: Lab Work – Continuous	50 Marks
Part B: Lab Exam and Viva	50 Marks

Pandit Deendayal Energy University **School of Energy Technology**

20ME101P					Engineering Graphics Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	4	2	4	-	-	-	50	50	100

COURSE OBJECTIVES

1. To learn fundamental of engineering drawing and standards used in drawing
2. To enable the students with various concepts of projections and standards related to technical drawings.
3. To demonstrate and communicate ideas using orthographic (2D) & isometric projection (3D) methods
4. To help students to use CAD software to solve engineering problems

UNIT 1 INTRODUCTION TO ENGINEERING GRAPHICS **10 Hrs.**

Importance and applications, drawing instruments & accessories, lettering, types of lines, dimensioning methods, basic geometric drawing. Computer Aided Engineering Drawing: Introduction to CAD, use of softwares in drawing, CAD software user interface, commands, menus and toolbars.

UNIT 2 ORTHOGRAPHIC PROJECTION **14 Hrs.**

Introduction to projection, types of projection, 1^ angle and 3'^ angle projection, 2D sketch, sketch entities and tools — origin, points, lines, arcs, polygons, fillets and chamfer, trim, extend and offset, projections from pictorial view, orientation of views, sections, and sectional views.

UNIT 3 ISOMETRIC PROJECTION **14 Hrs.**

Construction of isometric views from orthographic projections, approach to modelling, moving from 2D to 3D, creating 3D models using CAD features, assembly of components and exploded views. Projection of Solids - Classification of solids, projections of solids like cylinder, cone, pyramid, and prism with its inclination to reference plane, concept of development of lateral surfaces, intersection of solids.

UNIT 4 DRAFTING **14 Hrs.**

Drafting standards, drawing views, alignment of drawing views, dimensions and tolerances, symbols, comments and annotations, computer aided drafting, drawing sheet and title block. Tolerance - Introduction to limits, fits and tolerances, standardized representation of threads, fasteners, welds, bearings and springs, dimensional and geometric tolerances, surface finish symbols.

Total 52 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of engineering graphics and remember the basic rules of dimensioning and labelling.

CO2 - Develop the ability to learn fundamental of CAD software and its use to solve engineering problems.

CO3 - Comprehend the concept of projection and use it to represent the views on reference planes.

CO4 - Apply the technical communication skill for 3-dimensional geometries in the form of 3D models using isometric projection.

CO5 - Analyze the orientation of geometrical bodies with respect to reference planes and evaluate the intricate details of solid using sectioning and development of lateral surfaces.

CO6 - Create drawing sheet by organizing drawing views and applying necessary dimensions and tolerances

TEXT/REFERENCE BOOKS

1. R Hanifan, “Perfecting Engineering and Technical Drawing”, Springer International Publishing Switzerland
2. Bethune, J. D., “Engineering Design and Graphics with SolidWorks 2019, 1st edition”, Macromedia Press
3. K Morling, “Geometric and Engineering Drawing”, Elseveir Insights
4. DM Kulkarni, “Engineering Graphics with AutoCAD”, Easter Economy Edition
5. Agrawal, B. & Agrawal C. M., "Engineering Drawing”, Tata McGraw Hill Publishers
6. P.J. Shah, "Engineering Graphics", S. Chand Publishing
7. David C Planchard, “Engineering Graphics with SOLIDWORKS 2019: A Step-by-Step Project Based Approach”, SDC Publications.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Continuous Evaluation	50 Marks
End Semester Examination and Viva-voce	50 Marks

Pandit Deendayal Energy University **School of Energy Technology**

20HS102T					ENVIRONMENTAL STUDIES					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To provide the basic understanding of various structural and functional aspects of environmental science and their role in life sustenance
2. To identify and analyze different environmental pollution problems, as well as the risks associated with them

UNIT 1 BIRD'S EYE VIEW to ENVIRONMENT **10 Hrs.**

Environmental Studies Its importance and Multidisciplinary nature, Ecosystem and its various types, factors affecting the functioning of an ecosystem, Biodiversity its importance, threats and conservation, Natural Resources Forest, Water, Mineral, Energy, Food, Review of State of India's Environment.

UNIT 2 MULTI-SCALE ENVIRONMENTAL POLLUTION (GLOBAL, REGIONAL AND LOCAL) **12 Hrs.**

Concept of Clean Environment, Introduction to various environmental standards air, water, soil, noise, heat, Causes and Effects of Air Pollution, Water Pollution, Soil Pollution, Solid Waste (organic and Inorganic) Pollution, Hazardous Waste Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Radioactive Pollution, Pollution across Indian cities case studies, Introduction to man- made disasters like floods, heat waves, landslides, etc.

UNIT 3 ENVIRONMENTAL POLLUTION CONTROL STRATEGIES **10 Hrs.**

Case studies of Pollution control strategies, Review of the Cent policies and mechanisms for managing various natural resources and controlling the various types of pollutions (including Swacch Bharat Abhiyan), Global Initiatives for environmental management,

UNIT 4 SOCIAL ISSUES AND THE ENVIRONMENT **8 Hrs.**

Concept of sustainability and Sustainable Development, Environmental Sustainability Index, Environmental Ethics, Public awareness and people's participation, consumerism and waste production, Introduction to Carbon Footprint, Green Buildings & Water Footprint, Green buildings, and Green Business

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Outline the importance of Ecosystem, Biodiversity, and the conservation of natural resources

CO2 - Understand the consequences and impact of multi scale environmental pollution

CO3 - Implement the various Pollution controlling strategies across all the frontiers of environment effectively

CO4 - Illustrate an integrative approach to deal with environmental issues with a focus on sustainable development

CO5 - Review the various Global initiatives for environmental management

CO6 - Facilitate the critical thinking skills for environmental Protection

TEXT/REFERENCE BOOKS

1. Bharucha Erach, Textbook for Environmental Studies, UGC New Delhi
2. Principles of Environmental Science, Cunningham W.P. and Cunningham M.A. (2002), Tata McGraw-Hill

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Part A/Question	60 Marks
Part B/Question	40 Marks

Pandit Deendayal Energy University **School of Energy Technology**

16SP101/102/103					NCC/NSS/SPORTS					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens
2. To develop youth leadership in the students.
3. To induce social consciousness among students through various camps and 'Shibir' activities.
4. To develop skills and physical fitness among students through indoor & outdoor sports, field & track events.

National Cadet Corps (NCC):

Introduction to NCC, Aims and objectives, Structure and organization, NCC Song, Incentives, National Integration and Awareness, Drill, saluting, Personality Development & Leadership, Disaster Management, Social Awareness & Community Development, Health & Hygiene, Adventure camps, Environment Awareness and Conservation, Obstacle Training, Armed forces, Map reading, Field Craft & Battle Craft, Introduction to Infantry Weapons & Equipment, Weapon Training (During camps), Participation into Republic and Independence day ceremonial parades,

National Service Scheme (NSS):

Importance and role of youth leadership, Life competencies, Youth development programs and youth 'Shibir', Health, hygiene and sanitation, Youth health, lifestyle, first aid, youth and yoga

Sports:

Importance of sports/games in life, Physical fitness, Introduction to various games and sports, field and track events, Physical training, exercises, running, walking, jogging, Teaching of different sports/games, track & field events , demonstration, practice, skills and correction, Introduction to Yoga & Meditation.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the importance of Nation building and individual contribution to the same.
CO2 – Integrate physical fitness and mental wellbeing
CO3 – Discover grassroots challenges of community
CO4 – Creating societal impact
CO5 – Maintain discipline and team spirit
CO6 – Upholding the value of one for all and all for one

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

All registered students will be evaluated based on his/her attendance during the NCC/NSS/Sports sessions and participation to camps and other activities.

Semester- II

Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
BSC	23MA102T	Mathematics - II for Biotechnology	3	1	0	4	4
PC	23BIO102T	Principles of Biotechnology	3	0	0	3	3
PC	23BIO103T	Human Anatomy & Physiology - I	4	0	0	4	4
PC	23BIO103P	Human Anatomy & Physiology - I - Lab.	0	0	2	2	1
ESC	22PH101T	Engineering Physics	3	0	0	3	3
ESC	22PH101P	Engineering Physics - Lab.	0	0	2	2	1
ESC	16ME103P	Workshop Practice	0	0	2	2	1
ESC	20CP102P	Fundamentals of Python Programming	0	0	2	2	1
HSC	20HS101P	Communication Skills - I	0	0	2	2	1
HSC	16HS109T	Professional Ethics & Human Values	1	0	0	1	1
HSC	16SP101	NCC - II	0	0	2	2	1
	16SP102	NSS - II					
	16SP103	Sports - II					
HSC	20TP110	Civic Services & Social Internship	0	0	0	0	1
			14	1	12	27	22

Pandit Deendayal Energy University **School of Energy Technology**

23MA102T					Mathematics II for Biotechnology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To make students acquainted with the basics of functions of several variables.
2. To be able to formulate and solve various engineering problems using the methods of solving ODEs.
3. To study the properties of Matrix algebra and apply them to solve system of algebraic equations.
4. To understand the use of multivariable calculus in real world applications.

UNIT 1 FUNCTIONS OF SEVERAL VARIABLES **10 Hrs.**

Functions of two variables, Limits and Continuity, Partial derivatives, Total derivatives, Maxima and minima, Lagrange multipliers method.

UNIT 2 MULTIPLE INTEGRALS **10 Hrs.**

Definition Evaluation of double integral (Cartesian – Polar form), Change of orders, Change of variables, Evaluation of triple integral, change of variables (Cartesian to spherical – and cylindrical), Applications, Area, Volume, Center of mass, Center of gravity by double and triple integral.

UNIT 3 ORDINARY DIFFERENTIAL EQUATIONS **10 Hrs.**

Differential equations of first order and first degree, Exact differential equations, Integrating factors, Higher order differential equations with constant coefficients, Rules for finding C.F. and P.I., Cauchy and Legendre's linear equations, Applications of higher order differential equations in solving engineering problems.

UNIT 4 MATRIX ALGEBRA AND ITS APPLICATIONS **10 Hrs.**

Rank of a matrix, consistency of system of equation, Characteristic equation of a square matrix, Eigen values and Eigenvectors of a real matrix, Properties of eigen values and eigen vectors, Cayley-Hamilton theorem (without proof). Diagonalization of a matrix.

Total 40Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the basic concepts of multivariable calculus, matrix algebra and differential equations.

CO2 – Demonstrate the use of multivariable calculus, differential equations, eigen value and eigen vector.

CO3 – Apply appropriate tool/method to extract the solutions of engineering problems.

CO4 – Analyze the obtained solution in context with theory.

CO5 – Evaluate surface area, volume, center of mass, and center of gravity using multiple integrals.

CO6 – Create a mathematical model of engineering interest.

TEXT/REFERENCE BOOKS

1. Erwin Kreyszig, Advanced Engineering mathematics, John Wiley, 10th edition, 2015.
2. G. B. Thomas, J. Hass, C. Heil, M. D. Weir, Thomas' Calculus, Pearson Education, 14th edition, 2018.
3. G. Strang, Linear Algebra and its applications, 4th edition, Cengage Learning, 2005.
4. S.L. Ross, Differential Equations, Wiley, 3rd edition, 2007.
5. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Alpha Science, 3rd edition, 2007.

Pandit Deendayal Petroleum University **School of Energy Technology**

23BIO103T					Human Anatomy and physiology -I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. Gain fundamental knowledge on Structure and functions of the various organs of the human body
2. Learn the homeostatic mechanisms and their imbalances in the human body
3. Understand the different Various vital physiological parameters of the human body and their clinical significance.
4. Understand the coordinated working pattern of different organs of each system

UNIT I: Cell and Tissues of Human Body 10 Hrs

Scope of Anatomy and Physiology, Structure of Cell: Components and its functions. Classification on Tissues of the human body, structure, location and functions of epithelial, muscular and nervous and connective tissues

UNIT II: Blood and Lymphatic system 10 Hrs

Haemopoietic system: Composition and functions of blood, Characteristics and functions of Blood cells, Mechanism of Blood Clotting, Importance of Blood grouping. Lymphatic organs and tissues, lymphatic vessels, lymph circulation and functions of lymphatic system

UNIT III: Respiratory system & Cardiovascular system 10 Hrs

Anatomy of respiratory organs and their functions, Regulation, and Mechanism of respiration. Respiratory volumes and capacities. Anatomy and Physiology of heart. Blood vessels and circulation. Cardiac cycle, Blood pressure and its regulation

UNIT IV: Nervous system and Sense organs 12 Hrs

Classification of nervous system. Classification of nervous system. Anatomy and physiology of cerebrum, cerebellum, mid brain. Function of hypothalamus, medulla oblongata and basal ganglia. Spinal cord-structure and reflexes. Names and functions of cranial nerves. Sense organs: Eye, Ear, Skin,Tongue and Nose

Max. 42 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Gain fundamental knowledge of human anatomy and physiology.
CO2: Understand the functions of Cell, tissues, muscles, vital organs and their control mechanism.
CO3: Classify and compare various blood cells, respiratory mechanisms, cardiac rhythm, nerves, organs and their applications.
CO4: Get acquainted with homeostatic mechanisms of human body.
CO5: Focus on consequence in organ dysfunction and its clinical significance.
CO6: Design and develop solutions to various clinical conditions.

TEXT/REFERENCE BOOKS

1. Ross and Wilson Anatomy and Physiology in Health and illness
2. Fundamentals of Medical Physiology by K. Sambulingam and P Sambulingam
3. Human Anatomy and Physiology by S. Chaudhary and A. Chaudhary
4. Human Physiology by C. C. Chatterjee
5. Goyal R.K., Natvar M.P. and Shah S.A., Practical Anatomy, Physiology and Biochemistry, Experimental Physiology

END SEMESTER EXAMINATION

Max. Marks: 100 **Exam Duration: 3 Hr.**

Semester 2

Pandit Deendayal Petroleum University **School of Energy Technology**

23BIO103P					Human Anatomy and physiology Lab -I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To learn the basics of Human Physiology.
2. To relate concepts learned in Human anatomy and physiology to the real-world situations.
3. To acquire skills to perform laboratory experiments.

List of Experiments

1. Study of compound microscope.
2. Microscopic study of Tissues
3. Identification of axial bones
4. Identification of appendicular bones
5. Identification of organs with charts, models and slides
6. Introduction to Equipment's.
7. Determination of heart rate
8. Determination of pulse rate
9. Determination of Body temperature.
10. Recording of blood pressure.
11. Determination of bleeding time
12. Determination of clotting time

COURSE OUTCOMES

On completion of the course, student will be able to

CO1:- To get basic knowledge of human anatomy and physiology.

CO2:- To be able to perform basic hematological experiments including vital assessments.

CO3:- Get acquainted with physiological processes, medical devices and other standard laboratory protocols

CO4: Develop the ability to identify and describe the structural and functional characteristics of human tissues, organs, and skeletal systems.

CO5: Demonstrate competence in analyzing and interpreting physiological data to assess normal and abnormal body functions.

CO6: Enhance critical thinking and problem-solving skills by applying knowledge of anatomy and physiology in practical and real-world contexts.

REFERENCE BOOKS

1.Anatomy and Physiology in Health and Illness by Kathleen J.W. Wilson, Churchill Livingstone, New York

2. Textbook of Human Histology by Inderbir Singh, Jaypee brother's medical publishers, New Delhi.

3. Textbook of Practical Physiology by C.L. Ghai, Jaypee brother's medical publishers, New Delhi.

4. Practical workbook of Human Physiology by K. Srinageswari and Rajeev Sharma, Jaypee brother's medical publishers, New Delhi.

END SEMESTER EXAMINATION

Max. Marks: 100

Pandit Deendayal Petroleum University **School of Energy Technology**

23BIO102T					Principles of biotechnology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. An explanation of biotechnology and its significant applications
2. A comprehensive overview of the basic science underlying the principles of biotechnology
3. Understanding of biotechnology, carefully blending science, consumer applications, regulatory information

UNIT 1 INTRODUCTION 10

History of Earth, Theories of origin of life, Millers experiment, Levels of organization, Nature of the earliest organisms, Whittaker's five-kingdom classification, Evolution of Prokaryotes and Eukaryotes.

UNIT 2 BASIC CONCEPTS ABOUT CELL 10

Origin and evolution of cells, cells as experimental models, Cell: basic unit of life-Molecular components of cell-Expression of genetic information: DNA and RNA - Cell growth, reproduction and differentiation.

UNIT 3 ORGANISMS TO ECOSYSTEMS 10

Mendel's experiments - Patterns of Genetic Inheritance-From Genotype to Phenotype-Evolutionary Mechanisms-Ecological Interactions

UNIT 4 COMMERCIAL APPLICATIONS OF BIOTECHNOLOGY 10

Moving Science from the Laboratory into Society-Risks and Regulations -Health Care Applications -Medical Biotechnology in Society - Biotechnology in the Food Industry-Ecology and Evolution in Agriculture-Biotechnology and Sustainable Agriculture-Environmental Sustainability and Biotechnology

TOTAL : 40 hours

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Gain fundamental knowledge of origin of life.
CO2: Understand the functions of cell and its components.
CO3: Differentiate the functions of DNA and RNA
CO4: Compare genotypic and phenotypic inheritance
CO5: Identify the risks and ethics in biotechnology.
CO6: Gain knowledge about biotechnology applications

TEXT BOOKS

1. Biology and Biotechnology: Science, Applications, and Issues, Helen Kreuzer and Adrianne Massey, ASM
Press, 2005
2. The Cell: A molecular approach by Geoffrey M.Cooper.ASM Press, 2007

END SEMESTER EXAMINATION

Max. Marks: 100 **Exam Duration: 3 Hr.**

Pandit Deendayal Energy University **School of Energy Technology**

22PH101T					Engineering Physics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand basic concepts of quantum mechanics and solve the Schrödinger equation for various cases.
2. To understand basics concepts of electric and magnetic properties of solids.
3. To develop the fundamental understanding of optoelectronic devices.
4. To understand the heat transfer mechanism in solids and fluids.

UNIT 1 Introduction to Quantum Mechanics **12 Hrs.**

Inadequacies in Classical Physics, Wave Nature of Matter, Heisenberg's Uncertainty Principle and its applications, zero-point energy, Basic Postulates and Formalism of QM: Energy, Momentum and Hamiltonian Operators. Time-independent Schrodinger Wave Equation for Stationary States. Properties and interpretation of Wave Function. Probability Density and Probability. Conditions for Physical Acceptability of Wave Functions, Application of time-independent Schrödinger equation for various potentials.

UNIT 2 Electronic theory of Solids **10 Hrs.**

Elements of crystallography; lattice vibrations of solids; Bloch Theorem and Origin of energy bands, band structure of conductors, type of semiconductors, Free Electron Theory of metals, Wiede-mann Franz Law, Kronig-Penny model, Hall effect. Magnetism and its origin, magnetization and susceptibility, dia-para-ferro-magnetism. Ferromagnetism, Nano magnets and magneto resistance, hard disk drive storage technology. Phenomenology of Superconductors, Meissner effect, BCS theory - high temperature superconductors.

UNIT 3 OPTICS, LASER AND OPTO-ELECTRONICS **08 Hrs.**

Optics: Introduction, division of amplitude, thin film interference, Applications of interference, Laser: The Einstein coefficients, Spontaneous and stimulated emission, Optical amplification and population inversion, meta stable state, optical resonator, the principle of pumping scheme, laser beam characteristics. Types of LASERS, Injection Laser Diode (ILD). Quantum Cascade Laser, Comparison between ILD and QCL. Applications of lasers.

UNIT 4 THERMAL PHYSICS **10 Hrs.**

Laws of thermodynamics-basic concepts, closed and open systems-first law. Heat transfer-thermal expansion of solids and liquids – Conduction in solids – thermal conductivity- Forbe's method, Lees' disc method, conduction through compound media, formation of ice on ponds, thermal insulation and its applications. Thermal Convection - properties of radiant heat, sea and land breeze. Thermal Radiation – emission and absorption radiation, emissive power, black body radiation – Kirchoff's, Stefan's laws, wien's law, Newton's law of cooling.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify and understand the experimental results which require conceptualization of quantum theory.

CO2 – Interpret the solution of Schrödinger equation to obtain physical information about the system.

CO3 - Identify basic concepts in semiconductors, superconductors and magnetism and apply it in engineering applications.

CO4 - To understand concepts of optical interference and LASER, analyze the lasing characteristics to apply in different laser diodes and other applications

CO5 - To understand concepts of thermal physics in terms of laws and modes of heat transfer.

CO6 - To apply knowledge of concepts of engineering physics to solve real world problems.

TEXT/REFERENCE BOOKS

1. N. Zettili, Quantum Mechanics: Concepts and applications, Willey Publications
2. Kittel, Charles. Introduction to Solid State Physics. John Wiley and Sons.
3. W.D. Callister and David Rethwisch, Materials Science & Engineering -An Introduction, 9th edn.,
4. Heat and Thermodynamics BrijLal, N. Subrahmanyam, S. Chand, Limited, 2001.
5. Optics by Ajay Ghatak, Tata macgraw hill publishing.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Part A: 3 Questions from each unit, each carrying 3 marks	36 Marks
Part B: 2 Questions from each unit, each carrying 8 marks	64 Marks

Pandit Deendayal Energy University **School of Energy Technology**

22PH101P					Engineering Physics Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	0	0	0	50	50	100

COURSE OBJECTIVES

1. To understand the working of various electrical, mechanical and optical instruments in the laboratory.
2. To gain practical knowledge in Physics through experiments.
3. To understand basics concepts of Physics and be able to apply in performing the experiments.

List of Experiments

1. Introduction to Oscilloscope.
2. Study of Interference using Newton's Ring experiment.
3. Determination of thermal conductivity of different solids.
4. Experiment with solar collector.
5. Experimental to determine linear thermal expansion coefficient of solid bodies.
6. Experiment on reflection of Ultrasonic waves.
7. Experiments with heat pump.
8. Determining Plank's constant and Inverse square law.
9. Experiments on diffraction with He-Ne Laser Kit.
10. Study of Hall Effect.
11. Determining semiconductor energy band gap using four probe method.
12. Experiment to study forced oscillations.
13. Study of charging and discharging of capacitive plates.
14. Study of Bio-Savart's Law
15. Experiments on Fiber Optics.
16. Study of Photoconductivity.
17. Determining e/m by Thomson's method.
18. Study of Polarization of light using LASER.
19. Millikan's oil drop experiment.
20. Study of Holography.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply and analyze the concepts of electricity and magnetism.
CO2 - Understand the interaction of light waves and its propagation in different media.
CO3 - Demonstrate and implement the phenomenon of resonance
CO4 - Investigate the electrical properties of a given semiconductor device
CO5 - Examine the charge transport mechanism in different conductors
CO6 - Design and analyze the light propagation for communication application using fibre optics

END SEMESTE EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3h**

Part A: Lab work – Continuous assessment 50 Marks
Part B: Lab exam and Viva 50 Marks

Pandit Deendayal Energy University **School of Energy Technology**

16ME103P					Workshop Practices		
Teaching Scheme					Examination Scheme		
L	**T**	**P**	**C**	**Hrs/Week**	**Continuous Evaluation**	**End Semester**	**Total Marks**
0	0	2	1	2	25	25	100

COURSE OBJECTIVES

1. To impart the machining skills in students
2. To develop a skill in precision, safety at work place, team working with right attitude
3. To prepare a job by using ability to design and model different prototypes.

Metrology

Semi-Precision tools: Rules and scales, try square. Inside/Outside Calipers, Depth gages etc. Precision Tools: Micrometers, Vernier calipers, Bevel Protractor, Dial indicator, Gage blocks, Surface plates etc.

Carpentry Shop

Timber, Seasoning and Preservation, Plywood and Ply boards, Carpentry Tools, Engineering applications. Different Joints

Bench work and Fitting

Introduction to the familiarization with tools and their uses, Hammers, Hacksaws, choice of blades & sawing techniques, Files with their classification; According to their longitudinal shape & cross section, classification based on cuts; teeth; length of the file, Care of files and hand tool safety rules Vices & their classification, Other hand tools; scribers, chisels, scrapers, center, punch, surface gauge, Universal cribbing block, Trammel, Screw drivers, Drills, Spanners, Pliers, Taps, Dies, Reamers, Screw drivers etc, Fitting Processes : Marking, Chipping, Sawing, Filing, Scrapping, Drilling, Internal Threading (or Trapping), External Threading (or Dieing), Reaming, welding, soldering, brazing

Tin Smithy Surface development

Shearing and bending of sheets, Making simple products by Tin Smithy practice.

List of Experiments

1. Introduction to Workshop and safety.
2. Experiment on measurement of linear, angular and curved dimensions of the object.
3. Fitting job: Detailed drawing of work piece, use of fitting tools and job preparation.
4. Hands on experience on welding, brazing and soldering.
5. Carpentry job: Detailed drawing of work piece, use of carpentry tools and job preparation.
6. Sheet metal job: Detailed drawing of work piece, use of sheet metal working tools and job preparation.
7. Plumbing job: Internal/External threading, piping network using Tees, Elbows, Reducer, Bends etc

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Define fundamentals and principles cutting and enhance the machining skills in students

CO2: Apply principles of machining and develop a skills in dignity of labour, precision, safety at work place, team working and development of right attitude
CO3: analyze the effect design and model different prototypes in carpentry
CO4: Examine the effect and create and develop ability to design and model different basic prototypes in trade of fitting
CO5: Determine the effect and create and develop ability to design and model different basic prototypes in trade of tin smithy
CO6: Evaluate the performance of different machining and cutting processes such as fitting, carpentry, plumbing etc.

Pandit Deendayal Energy University **School of Energy Technology**

20CP102P					Fundamentals of Python Programming					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

Unit I Introduction to Python

The basic elements of Python, branching programs, Strings and Input, Iteration Functions, Scoping and Abstraction: Functions and Scoping, Specifications, Recursion, Global variables, Modules, Files Testing and Debugging: Testing, Debugging

Unit II Structured Types, Mutability and Higher-order Functions

Tuples, Lists and Mutability, Functions as Objects, Strings, Tuples and Lists, Dictionaries Exceptions and assertions: Handling exceptions, Exceptions as a control flow mechanism, Assertions

Unit III Classes and Object-oriented Programming

Abstract Data Types and Classes, Inheritance, Encapsulation, and information hiding, Some Simple Algorithms and Data Structures: Search Algorithms, Sorting Algorithms, Hashtables

Unit IV

Plotting and more about Classes: Plotting using PyLab, plotting mortgages and extended Examples Dynamic Programming: Fibonacci sequence revisited, Dynamic programming and the 0/1 Knapsack algorithm, Dynamic programming and divide and conquer

TEXT/REFERENCE BOOKS

1. Introduction to C Programming, ReemaThareja, Oxford, 1st Edition
2. Let Us C, YashavantKanetkar, BPB Publication,9th Edition
3. Object Oriented Programming with C++, E. Balaguruswami, TMH, 3rd Edition
4. C: The Complete Reference, Herbert Schildt

END SEMESTER EXAMINATION PATTERN

Max. Marks: 100 **Exam Duration: 3h**

Pandit Deendayal Energy University **School of Energy Technology**

20HS101P					Communication Skills – I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. Understand of the fundamental elements of communication in English language.
2. Know and understand different practices of verbal and non-verbal communication with inputs to improve basic language skills.
3. Students are expected to be better equipped in the following areas:
4. Listening: Understanding basic content in lectures and common everyday situations
5. Speaking: Correct expression in the English language at a basic level
6. Reading: Understanding, retaining, and critically analysing technical/non-technical content
7. Writing: Using appropriate vocabulary, grammar, effective paragraph construction, writing in day-to-day scenarios, including digital platforms

UNIT 1 **21 Hrs.**

Structure of English Language Academic, Research and Technical Vocabulary Phonetics and Accent

UNIT 2 **03 Hrs.**

Listening Skills Note Taking and Note Making Collective Note-taking and Note-making on Digital Platforms

UNIT 3 **03 Hrs.**

Reading Comprehensions Speed Reading

UNIT 4 **01 Hrs.**

The art of introducing oneself public speaking and articulation

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Confidence to listen, speak, read, and write in English
CO2 – Being able to produce something new with the help of inputs
CO3 - Learning to critically analyze
CO4 - Preparing reports/critique with the help of collected data
CO5 - Having a multi-dimensional/disciplinary perspective and approach
CO6 - Better improved and sharpened skills to present, convince and persuade to be an effective and successful professional

TEXT/REFERENCE BOOKS

1. Harmer, Jeremy. The Practice of English Language Teaching. Harlow: Pearson Longman, 2007.
2. Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
3. Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.

4. Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3h**
Part A: Listening and Questionnaire – 15/ Grammar Worksheet – 20/ Short Story/Essay (750 – 1000 words) – 05/ Reading Comprehension – 10	50 Marks
Part B: Wordsworth – 10/ Narrating a Story along with Self Introduction/Speech – 15/ Reading Aloud – 05/ Vocabulary/Phonetics – 20	50 Marks

Pandit Deendayal Energy University **School of Energy Technology**

16HS109T					Professional Ethics & Human Values					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	50	25	-	-	100

COURSE OBJECTIVES

1. Identify the core values that shape the ethical behaviour of an Engineer
2. Awareness on professional ethics and human values
3. To know their role in technological development
4. To appreciate the rights of others
5. Improved communication and learn to work in group
6. Learn to understand and discuss on issues of social interest

UNIT 1 HUMAN VALUES **05 Hrs.**

Morals, Values and Ethics - Integrity - work Ethic - Service Learning - Civic Virtue - Respect for others - Living peacefully - Caring - Sharing - Honesty - Courage - Valuing time - Co-operation - Commitment - Empathy - Self-Confidence - Character – Spirituality

UNIT 2 ENGINEERING ETHICS **04 Hrs.**

Sense of 'Engineering Ethics' - Variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy - Models of Professional Roles & Professionalism - theories about right action - Self-interest - customs and religion - uses of ethical theories.

UNIT 3 ENGINEERING AS EXPERIMENTATION **04 Hrs.**

Engineers as responsible experimenters - Research ethics -Codes of ethics - Industrial Standard - Balanced outlook on law - the challenger case study.

UNIT 4 SAFETY, RISK AND GLOBLE ISSUES **05 Hrs.**

Safety and risk - assessment of safety and risk - Risk benefit analysis and reducing risk - Threat of Nuclear power - Collegiality and loyalty - respect for authority - Confidentiality - conflicts of interest - professional rights – employee's rights - Intellectual Property rights (IPR) - discrimination. Multinational corporations - Business ethics - Environmental ethics - Role in Technological Development - Weapons development - consulting engineers - engineers as expert witnesses and advisors-Ethics.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Find the core values that shape the ethical behavior of an Engineer
CO2: Students will get aware of the professional ethics and human values
CO3: Develop and understand their role in technological development
CO4: Simplify to the rights of others
CO5: Perceive improved communication with activities and learning to work in group
CO6: Discuss on issues of social interest and make opinions based on logical reasoning

TEXT/REFERENCE BOOKS

1. A Textbook on Professional Ethics and Human Value by Prof. R. S. Nagaarazan, New Age International Limited Publisher, Chennai. 2006
2. A Text book on Professional Ethics and Human Values by M. Govindarajan, S. Natarajan, V. S. Senthilkumar, PHI Learning Pvt. Ltd., 2013.
3. A Text book on Professional Ethics and Human Values by Dinesh Babu, Firewall Media, 2007

Pandit Deendayal Energy University **School of Energy Technology**

16SP101/ 02/ 03					NCC/NSS/SPORTS-II					
Teaching Scheme					Examination Scheme					
					Theory			Practical		
L	T	P	C	Hrs/Week	MS	ES	IA	LW	Participation & attendance	Total Marks
0	0	2	1	2	Continuous evaluation			50	50	100

COURSE OBJECTIVES

1. To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens
2. To develop youth leadership in the students.
3. To induce social consciousness among students through various camps and 'Shibir' activities.
4. To develop skills and physical fitness among students through indoor & outdoor sports, field & track events.

National Cadet Corps (NCC):

Introduction to NCC, Aims and objectives, Structure and organization, NCC Song, Incentives, National Integration and Awareness, Drill, saluting, Personality Development & Leadership, Disaster Management, Social Awareness & Community Development, Health & Hygiene, Adventure camps, Environment Awareness and Conservation, Obstacle Training, Armed forces, Map reading, Field Craft & Battle Craft, Introduction to Infantry Weapons & Equipment, Weapon Training (During camps), Participation into Republic and Independence day ceremonial parades,

National Service Scheme (NSS):

Importance and role of youth leadership, Life competencies, Youth development programmes and youth 'shibir', Health, hygiene and sanitation, Youth health, lifestyle, first aid, youth and yoga

Sports:

Importance of sports/games in life, Physical fitness, Introduction to various games and sports, field and track events, Physical training, exercises, running, walking, jogging, Teaching of different sports/games, track & field events, demonstration, practice, skills and correction, Introduction to Yoga & Meditation.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the importance of Nation building and individual contribution to the same.
CO2 – Integrate physical fitness and mental wellbeing
CO3 – Discover grassroots challenges of community
CO4 – Creating societal impact
CO5 – Maintain discipline and team spirit
CO6 – Upholding the value of one for all and all for one

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	Exam Duration
All registered students will be evaluated based on his/her attendance during the NCC/NSS/Sports sessions and participation to camps and other activities	

Pandit Deendayal Energy University **School of Energy Technology**

20TP110					Civic & Social Service Internship					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/ Viva	
0	0	0	1	0	-			-	100	100

COURSE OBJECTIVES

1. To develop a holistic view of social work and social welfare in the community, with special emphasis on the role of different agencies like Govt. departments and NGOs in human services.
2. To enlighten and sensitize students on various types of problems of the people and their diversified cultural background.
3. To understand the agency as an organization, its structure, functions, activities and sources of funding.
4. To understand and make a commitment to the basic humanistic values and principles of social work practice in a secular democratic society.
5. To develop an understanding of the application of the methods of social work practice in the field.
6. To develop an understanding of the opportunities in working with diverse populations.
7. To develop the self – awareness necessary to assess one's own value, attitude, feelings, strengths, limitations, interests, and performance.
8. To inspire young technocrats to become change makers

UNIT 1: Overview of Civic and Social Service Sector

UNIT 2: Understanding of NGO/Civic Body/Government Body Management and their functioning

UNIT 3: Study of Individual organizational and government projects and schemes where students are interning

UNIT 4: Field visits

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Become sensitized workforce of enlightened Engineers and Managers who are socially concerned and willing to positively contribute to the society

CO2 – Acquire desired work habits and attitudes with the sense of social responsibility and think innovatively to find solutions

CO3 – Understand the role of different NGO/civic/government bodies in the service of citizens

CO4 – Imbibe basic humanistic values and principles of social work practice in a secular democratic society

CO5 – To assess one's own value, attitude, feelings, strengths, limitations, interests, and performance through opportunities f working with diverse Maintain discipline and team spirit

CO6 – Obtain experiential learning via internship and be sensitive towards issues of modern-day citizenship and democracy

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration**
Part A: NGO evaluation	50 Marks
Part B: Internal Faculty	50 Marks

Semester – III

Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
PC	23BIO201T	Principles of Biochemistry	3	0	0	3	3
PC Lab	23BIO201P	Biochemistry - Lab.	0	0	2	2	1
PC	23BIO202T	Human Anatomy and Physiology - II	3	0	0	3	3
PC Lab	23BIO202P	Human Anatomy and Physiology - II - Lab.	0	0	2	2	1
PC	23BIO203T	General Microbiology	3	0	0	3	3
PC Lab	23BIO203P	General Microbiology - Lab.	0	0	2	2	1
PC	23BIO204T	Biophysics & Structural Biology	3	1	0	4	4
PC	23BIO206T	Technical Seminars	0	0	2	2	0
HSC	20HS201P	Communication Skills - II	0	0	2	2	1
			12	1	10	23	17

23BIO201T					Principles of Biochemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. Develop knowledge of the fundamental chemical principles that govern biological systems
2. Distinguish biomolecules and their metabolic pathways
3. Discover the comprehension of the regulation of biological/biochemical processes

UNIT I INTRODUCTION **10 Hr**

Introduction to biological system, Review on cellular, chemical, physical, genetic and evolutionary backgrounds to biochemistry; Properties of water- solubility, ionization property and water as a reactant, pH and buffers and their importance.

Unit –II AMINO ACIDS AND PROTEINS **10 Hr**

Amino acids and Proteins: Classification, structure and biological importance of amino acids, acid–base chemistry and stereochemistry of amino acids. Proteins: Primary, secondary, tertiary, quaternary & domain structure of proteins. Protein denaturation and renaturation. Enzyme and its classification.

Unit III CARBOHYDRATES **10 Hr**

Carbohydrates: Definitions, biological functions, Physical properties. Classification of carbohydrates. Metabolism of carbohydrates: Glycolysis, TCA cycle, oxidative phosphorylation, gluconeogenesis and pentose phosphate pathway and their regulation

UNIT-IV NUCLEIC ACIDS **10 Hr**

Nucleic acids: Composition, properties and function. Metabolism- synthesis of purines and pyrimidine. Lipids: Classification, structure, properties, function and metabolism of fatty acids. Classification, structure, properties and biological function of simple lipids – triacylglycerol and waxes. Compound lipids- phospholipids and glycolipids. Cholesterol- structure, properties and importance.

Max 40 Hr

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: Recall the fundamentals of biomolecules.

CO2: Explain the importance of biological buffer systems.

CO3: Classify amino acids and proteins and describe their functions.

CO4: Analyze the metabolic pathways of carbohydrates.

CO5: Evaluate the relationship between the structure and function of nucleic acids.

CO6: Create a model of lipid functions in biological systems.

REFERENCE BOOKS

1. David L. Nelson and Michael M. Cox. 2020. Lehninger Principles of Biochemistry: International Edition. 7th edition, W.H. Freeman. USA.
2. Biochemistry by Berg, Tymoczko and Stryer (5th Edition, 2007)W.H. Freeman Press, SanFrancisco, USA.

23BIO201P					Biochemistry Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/ Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To learn the basics of biochemistry.
2. To relate concepts learned in chemistry and engineering to real-world situations.
3. To acquire skills to perform hematological assays.
4. To demonstrate various enzymatic activities.

List of Experiments

1. Laboratory practices in biochemistry and reagent preparation (calculations)
2. Qualitative analysis of carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose andstarch)
3. Identification tests for Proteins (albumin and Casein)
4. Quantitative analysis of reducing sugars (DNSA method) and Proteins (Biuret method)
5. Qualitative analysis of urine for abnormal constituents
6. Determination of blood creatinine
7. Determination of blood sugar
8. Determination of serum total cholesterol
9. Preparation of buffer solution and measurement of pH
10. Study of enzymatic hydrolysis of starch
11. Determination of Salivary amylase activity
12. Study the effect of Temperature on Salivary amylase activity.

COURSE OUTCOMES

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

CO1: Apply Laboratory Fundamentals

CO2: Analyze Biomolecules

CO3: Interpret Diagnostic Values

CO4: Understand Buffer Systems

CO5: Investigate hematology parameters

CO6: Evaluate Enzyme Function

REFERENCE/TEXT BOOKS

1. Principles of Biochemistry by Lehninger.
2. Harper's Biochemistry by Robert K. Murry, Daryl K. Granner and Victor W. Rodwell.
3. Biochemistry by D. Satyanarayan and U.Chakrapani
4. Outlines of Biochemistry by Conn and Stum

23BIO202T					Human Anatomy and physiology -II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To gain the fundamental knowledge on Structure and functions of the various organs and systems of the human body.
2. To learn the skeletal architecture and significance of joint articulation.
3. To understand the vital functions of Digestive, Urinary, Endocrine and reproductive system.
4. To evaluate the physiological aspect of Endocrine hormones and significance of reproduction system.

UNIT I: DIGESTIVE AND URINARY SYSTEM	10 Hrs.
Anatomy and Physiology of the GIT with special reference to associated organs and accessory glands. Physiology of digestion and absorption of Nutrients. disorders of GIT. Anatomy and physiology of urinary system. Physiology of urine formation. Mechanism of micturition. Regulation of Renin - angiotensin system.	
UNIT II: SKELETAL SYSTEM AND JOINTS	12 Hrs.
Divisions of skeletal system, types of bone, salient features and functions of bones of axial and appendicular skeletal system, Organization of skeletal muscle, physiology of muscle contraction, neuromuscular junction. Structural and functional classification, types of joints movements and its articulation	
UNIT III: ENDOCRINE SYSTEM	10 Hrs.
Classification of hormones, structure and functions of pituitary gland, parathyroid gland, thyroid gland, adrenal gland, pancreas, thymus and their disorders	
UNIT IV: REPRODUCTIVE SYSTEM	10 Hrs.
Anatomy of male and female reproductive system, Functions of male and female reproductive system, sex hormones, physiology of menstruation, fertilization.	
TOTAL HOURS: 42 Hrs.	

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1	:	Understand the anatomy of Skeletal system, Joints, Digestive, Excretory, Endocrine and reproductive system
CO2	:	Demonstrate the involvement of vital organs, bones, hormones and their control mechanism.
CO3	:	Classify and compare various bones, hormones, digestive mechanism, reproductive pathways, organs and their applications.
CO4	:	Get acquainted with functions of Joints, GIT, Excretory Organs and hormones of human body.
CO5	:	Focus on consequence of various disease conditions pertaining to Joints, Digestive, Excretory, Endocrine and reproductive system.
CO6	:	Design and develop solutions to various clinical conditions.

TEXT/REFERENCE BOOKS

1. Ross and Wilson," **Anatomy and Physiology in Health and illness**", Elsevier.
2. K. Sambulingam and P Sambulingam," **Fundamentals of Medical Physiology**", Jaypee Brothers Medical Publishers.
3. S. Chaudhary and A. Chaudhary," **Human Anatomy and Physiology**", S Vikas and Company.
4. C. C. Chatterjee," **Human Physiology**", CBS Publisher.
5. Goyal R.K., Natvar M.P. and Shah S.A," **Practical Anatomy, Physiology and Biochemistry, Experimental Physiology**",B.S.Books.

6. Arthur C, Guyton and John.E," **Text book of Medical Physiology**", Elsevier.

23BIO202P					Human Anatomy and physiology Lab -II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To understand and relate the concepts learned in Human anatomy and physiology to the real-world situations.
2. To acquire skills to perform laboratory experiments.
3. To analyses and compare different hematology parameters
4. To analyses and compare different Serology parameters

LIST OF EXPERIMENTS	
1	Microscopic study of organs with slides
2	Identification of system with Specimens, charts & models
3	Estimation of hemoglobin content
4	Demonstration of serology parameters by auto analyzer
5	Determination of Blood Glucose level
6	Determination of Serum Cholesterol level
7	Determination of SGOT level
8	Determination of SGPT level
9	Determination of Blood urea level
10	Determination of Creatinine level
11	Demonstration of total blood count by hematology analyzer
12	Enumeration of white blood cell (WBC) count
13	Enumeration of total red blood corpuscles (RBC) count.
14	Demonstration on Mechanical ventilator

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1	:	Study the fundamentals concepts involved in performing laboratory experiments in physiology
CO2	:	Acquire skills to perform laboratory experiments in physiology.
CO3	:	Apply the standard laboratory protocols in clinical assessment
CO4	:	Analyse the applications of haematology and serology profiling using standard operating procedures
CO5	:	Evaluate the clinical standards of different physiological parameters during pathological condition
CO6	:	Design and develop standard laboratory protocols for assessment of clinical conditions

TEXT/REFERENCE BOOKS

1. Ross and Wilson," **Anatomy and Physiology in Health and illness**", Elsevier.
2. Inderbir Singh," **Textbook of Human Histology"**, Jaypee Brothers Medical Publishers.
3. C.L. Ghai," **Human Anatomy and Physiology**", Jaypee Brothers Medical Publishers.
4. K. Srinageswari and Rajeev Sharma," **Practical workbook of Human Physiology"**, Jaypee Brothers Medical Publishers.
5. Goyal R.K., Natvar M.P. and Shah S.A," **Practical Anatomy, Physiology and Biochemistry, Experimental Physiology**",B.S.Books.

23BIO203T					General Microbiology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. Apply fundamental microbiology principles, including classification, diversity analysis, microscopy, staining, and aseptic technique.
2. Demonstrate proficiency in core laboratory techniques for isolating, culturing, and identifying microorganisms.
3. Analyze microscopic structures, staining results, and molecular data to classify microorganisms and study their cellular architecture.
4. Explain the principles underlying sterilization, media preparation, and cell growth, and understand the membrane transport mechanisms.

UNIT 1 HISTORY AND CLASSIFICATION **12 Hr**

Concepts of species and hierarchical taxa. Bergey. 's system of classification. Classification of Bacteria, Fungi, and Viruses; Modern methods to study microbial diversity: NGS. MiSeq; Molecular Taxonomy- 16S rRNA gene sequencing, Phylogenetic grouping. Fatty Acid Methyl Ester (FAME) analysis, ITS; Methods to study microbial community: DGGE, SSCP, T-RFLP.

UNIT- 2 MICROSCOPY AND STAINING **10 Hr**

Microscope- Principles, working mechanism and application - Simple and compound microscope -Dark field - Phase contrast, Fluorescence, SEM and TEM. Structure and organization of bacterial cell, Gram-positive and Gram-negative bacterial cell wall. Types of Staining - Simple, Differential (Gram's, AFB), Special - Capsular staining(negative), Spore. LPCB, KOH mount

UNIT- 3 SUBCELLULAR STRUCTURES **10 Hr**

Microbial cell: Ultrastructure of bacteria, subcellular structures and cell envelope – slime, capsule, cell wall, pili,flagella, cell inclusions, biosynthesis of bacterial cell wall, cell membrane – Bio-membrane, liposomes – membrane transport – diffusion, active and passive transport and osmoregulation.

UNIT- 4 STERILIZATION & MEDIA AND TECHNIQUES **10 Hr**

Sterilization and Disinfection- principles -methods of sterilization- physical methods - Dry heat- Moistheat- Radiation. Filtration (Membrane and HEPA). Chemical sterilization- Chemical agents- mode of action- phenol coefficient test sterility testing. Culture and media preparation - solid and liquid. Types of media- Semi synthetic,Synthetic, Enriched, Enrichment, Selective and Differential media. Pure culture techniques – Tube dilution, Pour,Spread, Streak plate. Anaerobic culture technique Wright's Tube, Roll tube method, Anaerobic Jar.

Max 42 Hr

COURSE OUTCOMES

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

CO1: Apply fundamental principles of microbiology, including classification, diversity analysis, microscopy, staining, and aseptic technique.

CO2: Demonstrate proficiency in core laboratory techniques for isolating, culturing, and identifying microorganisms.

CO3: Analyze microscopic structures, staining results, and biochemical data to classify microorganisms and study their cellular architecture.

CO4: Explain the principles underlying sterilization, media preparation, and the mechanisms of cell growth and transport

CO5: Utilize modern molecular tools (e.g., 16S rRNA sequencing, FAME) and community analysis techniques to study microbial diversity and interactions.
CO6: Apply critical thinking and scientific reasoning to design microbiological experiments, interpret results, and evaluate techniques

TEXT / REFERENCE BOOKS

2. Prescott, Harley, Klein. 2003. Microbiology. 5th Edition. McGraw Hill Publ.
3. Bernard R. Glick & Jack J. Pasternak. 2002. Molecular Biotechnology. Indian edition. Panima PublishingCorporation.
4. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.
5. Tortora, G.J., Funke, B.R. and Case, C.L. 2012. Microbiology - An Introduction. 11th Edition. PearsonEducation.

23BIO203P					General Microbiology Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. Perform Microbial Isolation and Cultivation
2. Analyze Microbial Morphology and Physiology
3. Explore Fungal Identification Techniques
4. Assess Microbiological Quality of Food and Water

List of Experiments

1. Techniques for isolation of microorganisms-Pour plate technique and Spread plate technique
2. Purification of microorganisms from a mixed culture by streak plate preparation
3. Preservation of microorganisms-Glycerol stock method and Agar slant method
4. Microscopy
   i. Microscopic examination of stained cell preparation-Preparation of bacterial smears, simple staining, negative staining, gram staining
   ii. Microscopic examination of live bacterial population-Hanging drop method
5. Biochemical Activities of Microorganisms: IMViC, catalase, oxidase
6. The Fungi Cultivation and identification of unknown fungi by lactophenol cotton blue staining
7. Microbiology of food-Methylene Blue Reductase Test and Microbiological Analysis of Food products
8. Microbiology of water Standard Qualitative analysis of water: Presumptive test, Confirmed test, Completed Test

COURSE OUTCOMES

On completion of the course, students will be able to

CO1:- Prepare basic solutions required for complex analysis.
CO2:- Employ tools in biochemistry to assess biomolecules.
CO3:- Discuss the various steps of analysis.
CO4:- Interpret the results obtained from assay methods.
CO5:- Develop different strategies for the analysis of novel molecules.
CO6:- Criticize the results and validate methods.

REFERENCE/TEXT BOOKS:

1. Melvyn Kay, Practical Handbook of Microbiology (2nd edition), CRC Press, 2008.

23BIO204T					Biophysics and Structural Biology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	-	-	100

COURSE OBJECTIVES

1. Learn the strategy and tactics of biophysical concepts of macromolecules and the conformational analysis
2. Understand the kinetics to study the ligand interaction with macromolecules.
3. Gain the fundamental on forces those determine the protein and nucleic acid structure and ligand interaction with macromolecules.
4. Create interest in life science and impart knowledge on health and disease
5. Learn the concepts of size and shape of the macro molecule using different techniques using various tools like X-ray crystallography and other techniques is explained.

UNIT 1 INTRODUCTION **10Hrs.**

Levels of structures in biological macromolecules, basic strategies in biophysics, Principles and concepts used in biophysical analysis of life processes, biomolecules and their interactions, size and shape of macromolecules.

UNIT 2 CONFORMATIONAL ANALYSIS OF PROTEINS: **10Hrs.**

Basic problems, polypeptide chains geometrics, potential energy calculations, observed values for rotation angles, hydrogen bonding, hydrophobic interactions and water structures, ionic interactions and disulphide bonds, Prediction of proteins structure.

UNIT 3 CONFORMATIONAL ANALYSIS OF NUCLEIC ACIDS **10Hrs.**

General characteristics of nucleic acid structure, geometrics, glycosidic bond, rotational isomers and those puckering, backbone rotational angles and steric hindrances, forces stabilizing ordered forms, base pairing, base stacking, tertiary structure of nucleic acids.

UNIT 4 TECHNIQUES FOR THE STUDY OF BIOLOGICAL STRUCTURE AND FUNCTION **12Hrs**

Size and shape of macromolecules, methods of direct visualisation, macromolecules as hydrodynamic particles, macromolecular diffusion, ultracentrifugation, viscometer, X-ray crystallography: X–ray diffraction, determination of molecular structures, electron microscopy, neutron scattering, light scattering.

Max 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Classify and Compare the different macromolecules
CO2: Gain the fundamental knowledge on conformational analysis of biomolecules
CO3: Understand the principles of biological structure and their functions
CO4: Get acquainted with the techniques for the studying macromolecules
CO5: Focus professionally on analytical techniques and methods
CO6: Develop solution of different potential energy calculations and prediction of protein structure.

TEXT/REFERENCE BOOKS

1. Cantor, R. and Schimmel, P. R., "Biophysical Chemistry", Vol. I, II, W. H. Freeman & Co., 2018.
2. Gu, J. and Bourne, P. E., "Structural Bioinformatics", 2nd Edition, Wiley, 2019.
3. Quantum Chemistry, I.N. Levine, (2020), Pearson Educ., Inc., New Delhi.

20HS201P					Communication Skills – II (Semester – III/IV) (Second Year)					
Teaching Scheme					Examination Scheme					
					Theory			Practical		Total Marks
L	T	P	C	Hrs/Week	MS	ES	IA	LW	LE/Viva	
0	0	2	1	2 hours per week	--	--	--	50	50	100

Course Objectives:

1. To understand communication and its process and effect on giving and receiving information.
2. To learn and apply communication skills in different public and interpersonal contexts.
3. To develop analytical, research, and organizational skills through communication skills for a fulfilling career.

Syllabus:

Unit I **7 hrs**

- Technical Writing
  - ✓ Report Writing
  - ✓ Creating Lab Journals and Manuals
- Portfolio of Critical Writing and Creative Writing
  - ✓ Essay, Story-writing, etc.

Unit II **7 hrs**

- Summarizing
- Writing Reviews (Books/Articles/Movies/websites)
- Reading Skills (Advanced)

Unit III **7 hrs**

- Digital Literacy
  - ✓ Emails
  - ✓ Creating e-content
  - ✓ Editing and proofreading online
  - ✓ Using grammar and spell check software
  - ✓ Using plagiarism checkers

Unit IV **9 hrs**

- Group Discussion
- Resume Writing
- Interview Skills

Max.: 30hrs

Course Outcomes:

On completion of the course, student will be able to

CO1 : **Analyse** and apply current technology for effective communication leading to better dissemination of knowledge and expertise.

CO2 : **Demonstrate** relevant knowledge of communication skills in different settings to cater to different purposes and audiences.

CO3 : **Develop** a sound understanding of communication theory, practice and application to optimize career opportunities.

CO4 : **Evaluate** professional relationships and apply dynamic communication skills to build and maintain professional rapport.

CO5 : **Demonstrate** effective communication skills to prepare and present messages, reports and documents in intent and to integrate different sources of information and knowledge.

CO6 : **Critically** reflect on communication skills for the adoption of appropriate strategy required in achieving the desired outcomes.

Text/Reference Books:

- Harmer, Jeremy. The Practice of English Language Teaching. Harlow: Pearson Longman, 2007.
- Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
- Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.
- Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.
- Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.

Assessment Tools:

Component	Marks	Assignments
Lab Work	50	• Essay/Journal Writing – 10 • Report Writing – 10 • Creating e-content – 10 • Email Writing – 10 • Review Writing – 10
Lab Exam/Viva	50	• Mock Interview – 8 • Group Discussion – 07 • Summarizing – 10 • Written Test – 10 • Cover Letter/Curriculum Vitae – 15

23BIO206T					Technical Seminars					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	0	2	-	-	-	-	-	-

COURSE OBJECTIVES

1. Expose students to cutting-edge technologies in biotechnology by engaging with industry experts and subject matter specialists.
2. Bridge the gap between academia and industry by discussing commercialization strategies, research gaps, and industrial expectations.
3. Enhance student networking opportunities with industry professionals, fostering collaborations and potential career guidance.
4. Develop critical thinking and presentation skills by encouraging student-led discussions, research reviews, and participation in technical debates.

Suggested Topics for Expert Talks and Panel Discussions:

1. Biopharmaceuticals and Drug Development
    - Emerging Trends in Biologics and Biosimilars
    - Vaccine Development: Challenges and Innovations
    - Monoclonal Antibodies and Their Therapeutic Applications
2. Targeted Drug Delivery Systems & Nanotechnology in Medicine
    - Role of Liposomes, Micelles, and Nano-carriers in Drug Delivery
    - Advances in CRISPR-based Drug Targeting
    - Nanomedicine for Cancer Therapy
3. Antimicrobial Resistance (AMR) and Future Therapeutics
    - Antibiotic Resistance Mechanisms and Global Challenges
    - Phage Therapy and Alternative Antimicrobial Strategies
    - Role of AI and In-Silico Approaches in Antimicrobial Drug Discovery
4. Gene Therapy and Genomic Engineering
    - CRISPR-Cas9 and its Biomedical Applications
    - Gene Editing for Rare Genetic Disorders
    - Ethical Considerations in Gene Therapy
5. Cancer Biology and Precision Medicine
    - Onco-Genomics and Personalized Cancer Therapy
    - Targeting Tumor Microenvironment in Cancer Treatment
    - Biomarkers in Early Cancer Diagnosis
6. In-Silico Drug Discovery and Bioinformatics Applications
    - Role of Computational Biology in Drug Development
    - AI and Machine Learning in Biopharmaceutical Research
    - Molecular Docking and Simulation Techniques for Drug Screening
7. Industrial Biotechnology and Commercialization Strategies
    - Scaling Up Biotechnology Processes: Challenges and Solutions
    - Biotech Startups and Entrepreneurship: Road to Commercialization
    - Regulatory Frameworks and Patent Strategies in Biotechnology
8. Emerging Fields in Biotechnology
    - Synthetic Biology and Its Industrial Applications
    - 3D Bioprinting for Tissue Engineering
    - Neurobiotechnology and Brain-Computer Interfaces

COURSE OUTCOMES

On completion of the seminars, students will be able to

CO1: Analyze the latest advancements in biopharmaceuticals, nanotechnology, gene therapy, and related biotechnological innovations.

CO2: Identify industry requirements and research gaps in biotechnology-related fields such as antimicrobial resistance, personalized medicine, and synthetic biology.

CO3: Demonstrate an understanding of the commercialization process, regulatory challenges, and intellectual property rights in biotechnology.

CO4: Engage effectively in scientific discussions and networking with industry professionals, enhancing career prospects.

CO5: Develop and deliver professional presentations on biotechnology-related topics, improving communication and technical articulation skills.

CO6: Propose innovative solutions and research ideas based on insights gained from industry experts and subject matter specialists.

Semester IV

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
IV	PC	23BIO207T	Molecular Biology and Genetics	3	0	0	3	3
	PC Lab	23BIO207P	Molecular Biology and Genetics - Lab.	0	0	2	2	1
	PC	23BIO208T	Bioprocess Engineering	3	0	0	3	3
	PC Lab	23BIO208P	Bioprocess Engineering - Lab.	0	0	2	2	1
	PC	23BIO209T	Analytical Bioinformatics	3	0	0	3	3
	PC Lab	23BIO209P	Analytical Bioinformatics - Lab.	0	0	2	2	1
	PC	23BIO310T	Analytical Methods in Bioengineering	3	0	0	3	3
	PC	23BIO311T	Pharmacology of Drug Action	3	0	0	3	3
	OE	23BIO312T	Biomedical Informatics	3	0	0	3	3
	IND	20IF301T	Industry 4.0	2	0	0	2	2
	IND	20IF301P	Industry 4.0 - Lab.	0	0	2	2	1
	Project	20TP210	Industrial Orientation (3 weeks-summer break)	0	0	0	0	1
				20	**0**	**8**	**28**	**25**

23BIO207T					MOLECULAR BIOLOGY AND GENETICS					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. The course aims to give an understanding on the fundamentals of molecular biology
2. To understand the fundamentals of DNA repair mechanisms
3. Explore the principles of genetics and inheritance patterns
4. Understand the molecular basis of genetic modifications

UNIT I INTRODUCTION 12Hrs

History of molecular biology; Central dogma of life; Structure of DNA and RNA; Gene structure and function; DNA replication; transcription; Genetic code and translation; Structure of prokaryotic and eukaryotic nuclear and organelle genomes; Gene regulation in prokaryotes: Lac operon concept, trp concept.

Unit II POST TRANSLATIONAL MODIFICATION 12Hrs

Post translational modification, DNA repair and Recombination, DNA repair mechanisms and their types, Holliday Junction, Process of recombination. Programmed cell death, cell junctions and adhesion.

Unit III GENETICS 8Hrs

Genetics: Mendelian genetics and heredity, Mendel's experiments, principles of segregation, Principle of independent assortment, polygenic inheritance, Multiple alleles, Linkage and Crossing Over, Eugenics

Unit-IV MUTATION AND MICROBIAL GENETICS 10Hrs

Mutation and Microbial Genetics: Molecular basis of mutation and their different types, Microbial genetics: conjugation, transformation, transduction, Plasmids and transposable elements, Chromosomal variation; Genetic disorders; Population genetics; Epigenetics; Selection and inheritance; Adaptive and neutral evolution; Genetic drift; Species and speciation

Max. 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the foundations of Mendelian genetics and chromosomal theory and apply these,with appropriate terminology, to contemporary concepts in genetics.

CO2 - Emphasize the molecular mechanism of DNA replication and repair in various organisms.CO3 - Explain the properties of genetic materials and storage and processing of geneticinformation.

CO4 - Analyse the processes of transcription and translation in both prokaryotes and eukaryotesat molecular level.

CO5 - Understand the redundant and universal qualities of the genetic code and how it is used to determine the amino acid sequence of a polypeptide.

CO6 - Compare the mechanisms of gene regulation in prokaryotes and eukaryotes.

TEXT / REFERENCE BOOKS

1. Lewin B., Genes XI, International Edition, Jocelyn Krebs, Stephen Kilpatrick and Elliott Goldstein, Jones & Bartlett Learning, 2017, ISBN 978-1-4496-5985-1
2. Strickberger M.W., Genetics, 3rd Edition, Prentice Hall of India, New Delhi, 2008.
3. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, W.W. Norton & Company, ISBN: 0815344643
4. Molecular Cell Biology by Harvey Lodish, Arnold Berk, Chris Kaiser, Monty Krieger, Matthew Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, W.H. Freeman publisher, ISBN: 142920314
5. Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J. (2017) An Introduction to Genetic Analysis, (11th ed.), W.H. Freeman & Company (New York), ISBN: 1464109486.
6. Pierce, B.A. (2012) Genetics - A Conceptual Approach, (6h ed.), W.H. Freeman & Co. (New York), ISBN: 13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.
7. Principles of Genetics, 7th Edition. D. Peter Snustad, Michael J. Simmons. Wiley

23BIO207P					Molecular Biology & Genetics Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

2015

COURSE OBJECTIVES

1. To provide students the knowledge about gene organization, genetic materials, molecular heritance, gene transfer, and their regulations.
2. To provide practical skills in molecular biology techniques
3. To develop critical thinking and analytical skill to interpret molecular biology data
4. To emphasize the importance of experimental design and data interpretation

LIST OF EXPERIMENTS

1. Making competent *E. coli* cells using chemical methods.
2. Transformation of *E. coli* and calculation of competence.
3. Extraction of plasmid DNA and calculation of concentration and purity.
4. Extraction of genomic DNA from animal and plant tissues and calculation of concentration and purity.
5. Estimation of size in bp of DNA using agarose gel electrophoresis.
6. Restriction mapping of pUC19 vector.
7. Extraction of proteins from plant or animal tissue and confirmation with qualitative tests
8. Separation and identification of proteins by SDS-PAGE using Coomassie Brilliant Blue stain
9. Extraction of RNA from animal and plant tissues.
10. Preparation of Drosophila polytene chromosome squashes

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Gain fundamental knowledge on electrophoresis techniques

CO2 – Get acquainted with calculation of concentration and purity

CO3 – Get acquainted with extraction protocol

CO4 - Analyze experimental data obtained from molecular biology experiments

CO-5 Evaluate, troubleshoot and validate the molecular biology experiments

CO-6- Design experiments incorporating fundamentals of molecular biology

TEXT/REFERENCE BOOKS:

1. Lewin B., Genes XI, International Edition, Jocelyn Krebs, Stephen Kilpatrick and Elliott Goldstein, Jones & Bartlett Learning, 2017, ISBN 978-1-4496-5985-1
2. Textbook on Molecular Genetics by D. N. Bharadwaj (2009); Kalyani Publisher
3. Ausubel, F.M. et al. (2012). Current protocols in molecular biology. New York: John Wiley & Sons.
4. Green, M. R., & Sambrook, J. (2012). Molecular cloning: A laboratory manual (4th ed., Vol. 1-3). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

23BIO209T					Analytical Bioinformatics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Learn the necessary basic protocols in computers and various biological databases.
2. Gain the fundamental on the tools used for biological sequential data analysis.
3. Create interest in Phylogenetic analysis and DNA mapping and sequencing.
4. Learn the concepts of analyzing genetic and protein information.
5. Understand the basic essential tools in bioinformatics and implementation.

UNIT 1 INTRODUCTION 10Hrs.

Scope of Bioinformatics – Elementary commands and Protocols, ftp, telnet, http. Databanks – nucleotide databanks – Genbank, NCBI, EMBL, DDBJ – protein databanks – sequence databanks – PIR, SWISSPROT, TrEMBL - structural databases – PDB, SCOP, CATH.

UNIT 2 SEQUENCE ALIGNMENT AND DYNAMIC PROGRAMMING: 10Hrs.

Introduction – Strings – Edit distance two strings – string similarity - local alignment - gaps – Parametric sequence alignments – suboptimal alignments – multiple alignment – common multiple alignment methods.

UNIT 3 SEQUENCE DATABASES, MAPPING AND ALIGNMENT 10Hrs.

Database search – Algorithms issues in database search – sequence database search – FASTA – BLAST – Amino acid substitution matrices PAM250 and BLOSUM62. Mapping and genome project – Physical and genetic maps - Map alignment – Sequence assembly.

UNIT 4 MOLECULAR PREDICTION 12Hrs.

Gene prediction methods and evaluation – Gene prediction in microbial genome and eukaryotes - Molecular predictions with DNA strings – Protein secondary structure prediction methods, Molecular Docking methods.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Classify and Compare the different biological databases

CO2: Gain the fundamental knowledge on sequence alignment and mapping

CO3: Understand the principles of BLAST and FASTA

CO4: Get acquainted with the algorithms used in sequence and structure databases

CO5: Focus professionally on software's and tools used for nucleotide and protein understanding

CO6: Develop solution for different prediction of protein structure and molecular docking methods.

TEXT/REFERENCE BOOKS

1. Dan Gusfield, "Algorithms on Strings Trees and Sequences", Cambridge University Press, Cambridge, 2020.
2. David Mount W., "Bioinformatics sequence and genome analysis", CBS Publishers, New Delhi, 2nd Edition, 2019.
3. Attwood T. K. and Parry-Smith D., "Introduction to Bioinformatics", Pearson Education, Delhi, 2021.
4. Arthur Lesk M, "Introduction to Bioinformatics", Oxford University Press, New Delhi, 2018.

23BIO208T					Bioprocess Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Learn the necessary basic protocols of cultivation, growth kinetics of microorganism, sterilization.
2. Gain the fundamental on the media formulation and scale up in bioprocess.
3. Create interest in learning bioreactor design and process control in bioprocess engineering system.
4. Understand the industrial applications of bioprocess engineering.

UNIT 1 INTRODUCTION 10Hrs.

Outline of an integrated bioprocess: Upstream and downstream, Unit operations involved in bioprocesses, Process flow sheets of metabolite production, Microbial kinetics of growth, Modes of bioreactor operation: Batch; Fed batch and Continuous operation, Production kinetics, Kinetics of substrate uptake and Yields in cell culture.

UNIT 2 MEDIA DESIGN AND STERILIZATION KINETICS 10Hrs.

Type of Sterilizations, Design of batch heat sterilization process, Design of continuous heat sterilization process, Filter sterilization of fermentation media, Medium formulation: Carbon sources, Nitrogen sources, Minerals, Chelators, Growth factors, Antifoams, Addition of precursors and Metabolic regulators to media, Introduction to media optimization.

UNIT 3 DESIGN OF BIOREACTORS 12Hrs.

Design and components of various bioreactors: Stirred tank (CSTR); Packed bed; Bubble-column; Fluidized bed; Trickle bed; Airlift loop; Photo bioreactors. Bioreactor control mechanism, Physical, Chemical and Biological environment of bioreactor, Role of physical, chemical & biological sensors, Online and offline analytical methods.

UNIT 4 APPLICATIONS OF BIOPROCESS ENGINEERING 8Hrs.

Food Industry (Baker Yeast Production), Environmental Industry (Biological Waste Water Treatment), Medical Applications of Bioprocess Engineering (Tissue Engineering, Gene Therapy).

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Classify the functions of a bioreactor and various types of bioreactors.
CO2: Gain the fundamental knowledge on sterilization kinetics.
CO3: Understand about the industrial fermentation process and process flow sheet.
CO4: List media requirements and examine the formulation and optimization for fermentation.
CO5: Focus professionally to select the right ancillaries or equipment's for the industrial units
CO6: Develop solution scale up and scale down of bioprocess system.

TEXT/REFERENCE BOOKS

1. Stanbury P., Whitaker A and Hall S. 2016. Principles of Fermentation Technology. 3rd Edition. Science & Technology Books.
2. Doran P.M. 2012. Bioprocess Engineering Principles. 2nd Edition. Academic Press.
3. Shuler M.L and Kargi F. 2012. Bioprocess Engineering: Basic Concepts. 2nd Edition. Prentice Hall Inc.
4. Bailey J.E and Ollis D.F. 2007. Biochemical Engineering Fundamentals. 2nd Edition. McGraw Hill.

23BIO209P					Analytical Bioinformatics Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	0	0	0	50	50	100

COURSE OBJECTIVES

1. To view and use the various biological databases available on the World Wide Web.
2. To retrieve the gene sequence in FASTA format
3. To identify the Genes present if any in the given genomic sequence
4. To predict primary, secondary and tertiary structure of the give protein sequences

Experiment Sessions would be simulation based covering but not limited to following topics:

1. Exploration of the resources available in NCBI and PUBMED
2. Retrieval of a Genbank Entry using an accession number
3. Retrieval and analysis of a gene sequence in FASTA format
4. Finding the official Symbol, alias name, chromosome number and ID for gene using NCBI
5. Retrieval and analysis of a protein sequence from protein database
6. Primary structure analysis of a protein
7. Secondary structure analysis of a protein
8. Tertiary protein structure analysis using RASMOL

9. Pair-wise and multiple sequence alignment using ClustalW
10. Pair-wise and multiple sequence alignment using BLAST

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Retrieve a nucleotide sequence of interest from Genbank and NCBI database

CO2: Analyse the NCBI web site and find the official gene symbol, its alias name, chromosome number and its ID

CO3: Analyse and retrieve the protein sequence of a protein from the Protein Data Bank (PDB) database

CO4: Explore the site map of NCBI and PUBMED and to study the resources available on NCBI and PUBMED

CO5: Perform pair wise and multiple sequence alignment using clustalw for given sequences

CO6: Develop solution for different prediction of protein structure and molecular docking methods.

TEXT/REFERENCE BOOKS

1) Bioinformatics: Experiments, Tools, Databases, and Algorithms (Oxford Higher Education) by Orpita Bosu.
2) Bioinformatics: Methods and Applications 1st Edition by Dev Bukhsh Singh (Editor), Rajesh Kumar Pathak.
3) Introduction to Bioinformatics Using Action Labs by Jean-Louis Lassez

23BIO208P					Bioprocess Engineering LAB					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. Experimentation with different ideal reactors for a homogeneous liquid phase reactions to determine kinetics
2. To find the kinetic parameter using Arrhenius theory by experimentation with different ideal reactors
3. Find the application of combination of ideal reactors and the change in performance with the ideal reactors

LIST OF EXPERIMENTS

1. Determine the growth patterns of *Escherichia coli*
2. Determination of specific thermal death rate constant (kd) for *Escherichia coli*
3. To analyse the effect of nutritional inhibitors on bacterial growth
4. Upstream of bioprocess for the production of Citric acid by *Aspergillus niger*
5. Bioprocess for the production of enzymes by *Aspergillus oryzae*
6. Preparation of immobilized enzymes & cells and evaluation of kinetic parameters
7. Ethanol fermentation using *Saccharomyces cerevisiae*
8. To study a non-catalytic homogeneous liquid phase reaction in an ambient CSTR
9. To study a non-catalytic homogeneous liquid phase reaction in an ambient straight tube PFR
10. To study a non-catalytic homogeneous liquid phase reaction in an ambient semi Batch

reactor

11. To study a non-catalytic homogeneous liquid phase reaction in an ambient three Cascaded CSTR
12. Evaluating kinetic parameters (k0 and E) for a saponification reaction in an Batch Reactor
13. Evaluating kinetic parameters (k0 and E) for a saponification reaction in an Coiled PFR
14. Evaluating kinetic parameters (k0 and E) for a saponification reaction in an CSTR
15. To study a non-catalytic homogeneous liquid phase reaction in an ambient combined flow reactor (CSTR+PFR)

COURSE OUTCOMES

CO1 – Relate to the basics of kinetics and application of the same in practical
CO2 – Interpret and evaluate the rate data and get the kinetics parameters for different reactors CO3 – Apply proper rate equations and compare the performance of different ideal reactors
CO4 – Examine the combinations of ideal reactors and analyze the theoretical findings
CO5 – Decide the reactor sequencing so as to optimize the volume or conversion for given combinations of reactors
CO6 – Develop an ability to work in group, learn report making, and improve soft skills in representing the findings

23BIO311T					**Pharmacology of Drug Action**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. To make students acquainted with different categories of drugs and fundamentals of drug action
2. To familiarize the mechanism of drug action of different categories drugs in disease condition
3. To understand the therapeutic uses and adverse effects of drugs across various disease condition
4. To develop the ability to critically evaluate the drug information and to make informed decisions about the therapy.

UNIT – 1 General Pharmacology and Drugs acting on cardio vascular system — 10 Hrs

Receptor theories and classification of receptors, regulation of receptors. Drugs used in congestive heart failure, Anti-anginal drugs, Fibrinolytics and anti-platelet drugs, Anti-hypertensive drugs, Anti-hyperlipidemic drugs.

UNIT – 2 Drugs acting on Peripheral nervous system and Autocoids — 10 Hrs

Skeletal muscle relaxants (peripheral), Local anaesthetic agents and Non-steroidal anti-inflammatory agents, Antirheumatic drugs, Anti -asthmatic drugs.

UNIT – 3 Drugs acting on Central nervous system — 10 Hrs

Opioid analgesics, centrally acting muscle relaxants, Anti-epileptics, Antidepressants, Anti-anxiety agents, Drugs used in Parkinson's disease and Alzheimer's disease, Alcohols and disulfiram.

UNIT – 4 Antimicrobial agents — 12 Hrs

General principles of chemotherapy, Mechanism of action of Sulfonamides and cotrimoxazole. Penicillins, cephalosporins, chloramphenicol, macrolides, quinolones and fluoroquinolins, tetracycline and aminoglycosides, Antifungal agents, Antiviral drugs.

Max 42 Hrs

COURSE OUTCOMES

CO1: Understand the fundamental principles of drug action and its application in clinical practice.
CO2: Demonstrate and gain comprehensive knowledge of different categories of drugs acting on the cardiovascular system, peripheral nervous system and autocoids, central nervous system, and chemotherapy.
CO3: Analyze and compare the mechanism of action, therapeutic uses, and adverse effects of various pharmacological agents.
CO4: Apply pharmacological principles in the rational selection of drugs for the treatment of various diseases.
CO5: Evaluate and interpret the pathological processes in disease condition and the role of the pharmacological agents in modulating the process.
CO6: Investigate and develop safe pharmacological interventions through critical analysis.

TEXT / REFERENCE BOOKS

1. Mycek M.J, Gelnet S.B and Perper M.M. Lippincott's Illustrated Reviews- Pharmacology.2018
2. Rang H. P., Dale M. M., Ritter J. M., Flower R. J., Rang and Dale's Pharmacology,.Churchil Livingstone Elsevier.2018
3. Kulkarni SK. Handbook of experimental pharmacology. Vallabh Prakashan Publisher.2016
4. Katzung B. G., Masters S. B., Trevor A. J., Basic and clinical pharmacology, Tata Mc Graw-Hill.2008
5. Goodman and Gilman's, The Pharmacological Basis of Therapeutics.2005
6. Sharma H. L., Sharma K. K., Principles of Pharmacology, Paras medical publisher.2021
7. Marry Anne K. K., Lloyd Yee Y., Brian K. A., Robbin L.C., Joseph G. B., Wayne A. K., Bradley R.W., Applied Therapeutics, The Clinical use of Drugs, The Point Lippincott Williams &Wilkins.2005
8. K.D.Tripathi. Essentials of Medical Pharmacology, JAYPEE Brothers Medical Publishers (P) Ltd, New Delhi.2008
9. Modern Pharmacology with clinical Applications, by Charles R.Craig& Robert.2004

23BIO310T					Analytical Methods in Bioengineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES:

1. To understand the fundamentals of analytical methods used in Bioengineering.
2. To learn the principles and instrumentation of chromatographic techniques and spectrometric techniques.
3. To learn the principles and instrumentation of Microscopic techniques.

UNIT I INTRODUCTION 8 Hr

Light microscopy, Bright & Dark Field microscopy, Fluorescence microscopy, Phase Contrast microscopy, Electron microscopy: TEM and SEM, Atomic force microscopy and con focal scanning laser microscopy. Differential interference contrast microscopy

Unit –II CHROMATOGRAPHY 10 Hr

Principle and Operations of Chromatography, Thin layer chromatography, Ion Exchange Chromatography, High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Gel Filtration Chromatography, Affinity Chromatography.

Unit III SPECTROSCOPY **12 Hr**

Electromagnetic radiation and spectrum, Atomic absorption and Atomic emission spectroscopy, Principle, working and applications of UV-VIS, NMR, ESR and IR spectrometer, Principle and applications of Mass Spectroscopy, Circular Dichorism (CD) principles, Principle and applications of Positron Emission Tomography(PET), Basics of X-Ray diffraction analysis and their application in biotechnology .

Unit-IV APPLICATIONS **10 Hr**

Principles of 3-D printing, 3-D Bioprinting of tissues, organs and bacteria.Ideal material properties for bioprinting, Biosensors: Principles and definition, characteristics of Ideal biosensors, Biochemical components of biosensors: Enzyme based biocatalyst sensors, Bioaffinity systems, Immunosensors. Principle and working of Flow Cytometry and cell sorter.

Max 40 Hr

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Differentiate between the various microscopy techniques, outlining their specific applications and purposes in research.

CO2: Explain the fundamental principles underlying chromatographic separation techniques, including their mechanisms and classifications.

CO3: Design experimental setups for chromatographic separations, choosing appropriate stationary and mobile phases based on sample properties.

CO4: Describe the principles of electromagnetic radiation and its interaction with matter, as applied in spectroscopic techniques.

CO5: Choose appropriate spectroscopic techniques for specific biological research problems.

CO6: Explain the key principles of 3D printing and its adaptation for bioprinting tissues, organs, and bacteria.

TEXT/REFERENCE BOOKS:

1. Wilson, K, Walker, J., Principles and Techniques of Practical Biochemistry. 5th Ed. - Cambridge University Press,. Cambridge 2006.

2. Sabari Ghosal & Anupama Sharma Awasthi., Fundamentals of Bioanalytical Techniques and Instrumentation, PHI learning Second edition (2018)

3. Bioanalytical Techniques by A. Shourie and S S Chapadgaonkar. TERI Press. 2015

4. Immunoassay and Other Bioanalytical Techniques.Jeanette M. van Emon. CRC press. 2006

5. 3D Bioprinting in Regenerative Engineering: Principles and Applications, Ali Khademhosseini & Gulden Camci-Unal, CRC Press (2018)

23BIO312T					Biomedical Informatics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. To understand how to acquire, store and use biomedical data.
2. To demonstrate about the general understanding about the computer application in healthcare and biomedicine.
3. Develop knowledge in the ethics that must be followed in Biomedical and health informatics.
4. Describe the functioning of electronic health record systems and management of information in health care organizations.

UNIT 1 INTRODUCTION **10Hrs.**

Biomedical Informatics: The Science and the Pragmatics, Biomedical Data: Their Acquisition, Storage, and Use, Biomedical Decision Making: Probabilistic Clinical Reasoning, Cognitive Science and Biomedical Informatics.

UNIT 2 COMPUTER ARCHITECTURE AND STANDARDS IN BIOMEDICAL INFORMATICS: 8 Hrs.

Computer Architectures for Health Care and Biomedicine, Software Engineering for Health Care and Biomedicine, Standards in Biomedical Informatics, Natural Language Processing in Health Care and Biomedicine.

UNIT 3 HEALTH INFORMATION RESOURCES **10Hrs.**

Biomedical Imaging Informatics, Ethics in Biomedical and Health Informatics: Users, Standards, and Outcomes, Biomedical and Health Information Resources, Management of Information in Health Care Organizations, Patient-Centered Care Systems, Public Health Informatics.

UNIT 4 HEALTH CARE MANAGEMENT **10 Hrs**

Telehealth, Patient Monitoring Systems, Imaging Systems in Radiology, Information Retrieval and Digital Libraries, Clinical Decision-Support Systems, Computers in Health Care Education.

Max 38 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Classify and Compare the different health records
CO2: Gain the fundamental knowledge on patient information resources
CO3: Understand the principles of biomedical informatics
CO4: Get acquainted with the techniques for the studying and analyzing patient records
CO5: Focus professionally on ethics in biomedical and health informatics
CO6: Develop solution of telehealth and Image systems.

TEXT/REFERENCE BOOKS

1. Biomedical Informatics by Shortliffe and Cimino. 2017, Springer..
2. Health Care Informatics: An Interdisciplinary Approach by P. Englebardt, Ramona Nelson.

20IF301T					Industry 4.0					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn overview of Industry 4.0
2. Acquire and fine-tune the skills and chemical engineering applications of data and machine learning
3. Gain an understanding of IoT, and automation in chemical engineering
4. Understand recent developments of biomedical engineering.

UNIT I: INTRODUCTION AND BASIC CONCEPTS OF INDUSTRY 4.0	**6 Hr.**
Introduction to Industry 4.0, Definition, General framework, Application areas, Introduction to the Evolution of Industrial revolutions, Key features, Need and benefits, Introduction to Industry 4.0 core technologies: Big data, Advanced Robotics, Simulation, Integration, Internet of Things (IoT), Artificial Intelligence (AI), Cybersecurity, Cloud computing, Additive manufacturing and Augmented Reality. Overview of machine learning for Industry 4.0. Transformation of industrial processes through the integration of modern technologies such as sensing and actuation, communication, and computational processing.	
UNIT II: CORE CHROMATOGRAPHY PRINCIPLES	**8 Hr**
Thin layer chromatography: **Digital Image Analysis, Real-time Monitoring;** Ion Exchange Chromatography: **Process Analytical Technology (PAT), Smart Resin Technology;** High Performance Liquid Chromatography (HPLC): **Miniaturization and Microfluidics**, Gas Liquid Chromatography (GLC): **Multidimensional Systems, Sensor Integration;** Gel Filtration Chromatography: **Process Monitoring and Control**, Affinity Chromatography: **Designer Ligands, Biosensors.**	
UNIT III: Analytical Techniques for Industry 4.0	**8 Hr.**
NMR, ESR and IR spectrometer, Principle and applications of Mass Spectroscopy, Circular Dichorism (CD) principles, Principle and applications of Positron Emission Tomography(PET), Basics of X-Ray diffraction analysis and their application in biotechnology.	
UNIT IV: BIOTECHNOLOGY AND BIOMEDICAL ENGINEERING	**8 Hr.**
Targeted Drug delivery, Robotic Surgery, 3D bio printing, Biomedical image analysis: MRI, Ultrasound image, biosensors, types of biosensors, Point of Care Testing device, development of portable opto-electronic devices, role of self-propelled Micro/-nano motors in healthcare sector, AI in healthcare with emphasis on POCT devices, patient health monitoring, and telemedicine.	
	Max. 30 Hrs.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	:	Understand fundamental concepts of Industry 4.0
CO2	:	Understand the basics of AI, augmented reality, IoT, and Cyber security
CO3	:	**Describe** the fundamental principles of electromagnetic radiation and various spectroscopic techniques
CO4	:	**Identify** appropriate analytical techniques for different industrial problems
CO5	:	Evaluate the potential of spectroscopic techniques, sensor technology, and data analysis in addressing specific Industry 4.0 challenges

CO6	:	**Collect and analyze** spectral data using relevant software and instrumentation

TEXT/REFERENCE BOOKS

1. Ravi Kant, Hema Gurung," **Industry 4.0: Concepts, Processes and Systems**", Routedge Taylor and Francis group.
2. Anand Kumar Singh,"**Industry 4.0**", Shashwat publication.
3. Arvind N. Shukla,"**Advanced Biomedical Engineering**" Barnes and Noble.
4. Eric. M. H. Goh,"**Learn by Examples - A Quick Guide to IoT"** Arduino and Data Kindle Edition.

20IF301P					Industry 4.0 Lab					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To learn practical aspects of Industry 4.0
2. Acquire engineering grasp over experimental techniques
3. Gain idea of open source computational biology
4. Understand applications of machine learning for core engineers.

LIST OF EXPERIMENTS	
1	To analyze the dissolution profiles of pharmaceuticals in simulated biological fluids using a high-throughput UV-VIS plate reader.
2	To monitor changes in functional groups during a polymerization reaction in real-time using ATR-FTIR spectroscopy.
3	To track the progress of an organic reaction and identify intermediates using benchtop NMR spectroscopy.
4	To rapidly identify contaminants in a simulated sample using different mass spectrometry ionization techniques.
5	To analyze CD spectra and determine the secondary structure composition of proteins.
6	To analyze PET images for image segmentation, quantification, and diagnostic interpretation.
7	To determine the crystal structure of simple salts using XRD patterns.
8	Introduction to Schrodinger, ligand preparation and protein preparation
9	Receptor Grid generation and protein-ligand docking using Glide and their refinement
10	2D QSAR based upon physiochemical properties using LSBD and model generation
11	3D QSAR based upon pharmacophore generation
12	Validation of QSAR model
13	Molecular modeling – Small Molecule Databases
14	Molecular simulation of tripeptides and carbohydrate
15	Ab initio structure prediction
16	Homology modeling

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1	:	Understand the concept of Industry 4.0 and its significance
CO2	:	Understand the resource requirements for the implementation of Industry 4.0
CO3	:	Learn the experimental techniques for Industry 4.0
CO4	:	Explore the concept of computational biology
CO5	:	Inspect embedded platform applications for Industry 4.0
CO6	:	Synthesise the solution for the given Industry 4.0 related problem

TEXT/REFERENCE BOOKS

1. Ustundag Alp, and Emre Cevikcan,"**Industry 4.0: Managing the Digital Transformation"**, Springer,First Edition, 2018
2. Kaushik Kumar, Divya Zindani, and J. Paulo Davim, "**Digital Manufacturing and Assembly Systems in Industry 4.0"**, CRC Press, Taylor & Francis First Edition, 2019.
3. S. V. Patthankar, "**Numerical Heat Transfer and Fluid Flow –Patankar"**, CRC Publication, First Edition, 2017.
4. Sebastian Raschka and Vahid Mirjalili, "**Python Machine Learning"**, 3rd edition, Packt Publishing, 2019
5. Eric M. H. Goh," **Learn by Examples - A Quick Guide to IoT with Arduino and Data"**, Kindle Edition, SV Book, 2018.

23BIO312T					Biomedical Informatics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	0	3	25	50	25	-	-	100

COURSE OBJECTIVES

5. To understand how to acquire, store and use biomedical data.
6. To demonstrate about the general understanding about the computer application in healthcare and biomedicine.
7. Develop knowledge in the ethics that must be followed in Biomedical and health informatics.
8. Describe the functioning of electronic health record systems and management of information in health care organizations.

UNIT 1 INTRODUCTION **10Hrs.**

Biomedical Informatics: The Science and the Pragmatics, Biomedical Data: Their Acquisition, Storage, and Use, Biomedical Decision Making: Probabilistic Clinical Reasoning, Cognitive Science and Biomedical Informatics.

UNIT 2 COMPUTER ARCHITECTURE AND STANDARDS IN BIOMEDICAL INFORMATICS: 8 Hrs.

Computer Architectures for Health Care and Biomedicine, Software Engineering for Health Care and Biomedicine, Standards in Biomedical Informatics, Natural Language Processing in Health Care and Biomedicine.

UNIT 3 HEALTH INFORMATION RESOURCES **10Hrs.**

Biomedical Imaging Informatics, Ethics in Biomedical and Health Informatics: Users, Standards, and Outcomes, Biomedical and Health Information Resources, Management of Information in Health Care Organizations, Patient-Centered Care Systems, Public Health Informatics.

UNIT 4 HEALTH CARE MANAGEMENT **10 Hrs**

Telehealth, Patient Monitoring Systems, Imaging Systems in Radiology, Information Retrieval and Digital Libraries, Clinical Decision-Support Systems, Computers in Health Care Education.

Max 38 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Classify and Compare the different health records
CO2: Gain the fundamental knowledge on patient information resources
CO3: Understand the principles of biomedical informatics
CO4: Get acquainted with the techniques for the studying and analyzing patient records
CO5: Focus professionally on ethics in biomedical and health informatics
CO6: Develop solution of telehealth and Image systems.

TEXT/REFERENCE BOOKS

1. Biomedical Informatics by Shortliffe and Cimino. 2017, Springer..
2. Health Care Informatics: An Interdisciplinary Approach by P. Englebardt, Ramona Nelson.

20TP210					Industrial Orientation (3 weeks-summer break)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	0	1	-	-	-	-	-	-	100

COURSE OBJECTIVES

1. Expose students to real-world industrial processes by providing hands-on experience in biotechnology-related industries.
2. Bridge the gap between academic learning and industrial applications, enabling students to understand manufacturing, R&D, and quality control processes.
3. Enhance problem-solving skills and professional competencies by engaging students in industry-driven projects.
4. Improve communication and technical presentation skills through project report submission and evaluation by an expert committee

Suggested field of exposure is summarised below but not limited to the mentioned theme of Industrial orientation:

1. Biopharmaceuticals & Drug Manufacturing
    - GMP (Good Manufacturing Practices) in Biopharma
    - Upstream and Downstream Bioprocessing
    - Quality Control & Assurance in Drug Production
2. Fermentation Technology & Industrial Enzymes
    - Large-scale Fermentation and Enzyme Production
    - Process Optimization in Industrial Biotechnology
3. Nanotechnology & Targeted Drug Delivery
    - Nanocarriers and Liposomes in Drug Delivery
    - Polymer-based Scaffolds for Tissue Engineering
4. Food & Agricultural Biotechnology
    - Probiotics and Functional Foods
    - Plant Tissue Culture and Genetic Modification Techniques
5. Environmental & Industrial Biotechnology
    - Bioremediation and Wastewater Treatment Technologies
    - Biofuel Production and Sustainable Biotechnology
6. Medical Biotechnology & Diagnostics
    - Molecular Diagnostics and Biomarker Discovery
    - PCR, ELISA, and Next-Generation Sequencing in Diagnostics
7. Computational Biology & AI in Drug Discovery
    - Machine Learning Approaches for Drug Target Identification
    - *In-Silico* Screening and Molecular Docking Simulations

Outcomes will be assessed on a scale of 100 marks.

Presentation & Screening Format:

Each student will present before a panel of faculty and industry representatives.

- **Evaluation Criteria for Presentation:**
    - Clarity of content and technical knowledge
    - Ability to articulate industrial learning
    - Handling of Q&A session by the panel
    - Professionalism in communication

Assessment Criteria's

The assessment of the Industry Orientation program will be based on four key components. Industry attendance and supervisor feedback will evaluate student engagement, punctuality, and teamwork as observed by industry mentors. Project report submission will assess the detailed documentation of industry work, methodologies, and learning outcomes. Technical presentation and viva will measure the student's ability to present key findings before a faculty and industry expert panel. Lastly, professional skills and committee review will focus on critical thinking, problem-solving, and communication skills demonstrated during discussions with the evaluation panel.

COURSE OUTCOMES

On completion of the Industrial orientation, students will be able to

CO1: Demonstrate an understanding of industrial workflows, safety protocols, and operational standards in the biotechnology sector.

CO2: Identify and analyze industry-specific challenges related to biopharmaceuticals, drug manufacturing, nanotechnology, and environmental biotechnology.

CO3: Apply theoretical knowledge to practical industrial problems by participating in hands-on projects and technical activities.

CO4: Develop technical documentation skills by preparing an industry internship report detailing the learning outcomes and project work.

CO5: Present industry-based findings and experiences effectively to a panel of faculty and industry professionals.

CO6: Build professional networking skills and gain insights into career opportunities in the biotechnology sector.

Semester – V

Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
PC	23BIO301T	Genomics & Proteomics	4	0	0	4	4
PC	23BIO302T	Immunology and Immunotechnology	3	0	0	3	3
PC Lab	23BIO302P	Immunology and Immunotechnology - Lab.	0	0	2	2	1
PC	23BIO303T	Animal and Plant Biotechnology	3	0	0	3	3
PC Lab	23BIO303P	Animal and Plant Biotechnology - Lab.	0	0	2	2	1
CE	23BIO304T	Medical Diagnostics	3	0	0	3	3
CE	23BIO305T	Green Biotechnology and Pollution Abatement					
CE	23BIO306T	Computer Aided Drug Design					
OE	23BIO307T	Molecular Diagnostics	3	0	0	3	3
HSC	20HS301P	Communication Skills - III	0	0	2	2	1
			16	**0**	**6**	**22**	**19**

23BIO301T					Genomics and Proteomics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES:

1. To gain the fundamental knowledge of genome organisation
2. To learn the application of genome analysis
3. To understand the concepts of proteomics
4. To learn proteomics analysis and applications

UNIT 1 INTRODUCTION TO GENOMICS AND PROTEOMICS: 10 Hrs.

Introduction – Organization and structure of genomes, Genome size, Introns and Exons, Sequence complexity, Genome structure in prokaryotes / viruses, Retrofitting. Introduction to Proteomics – The Proteome, Mining proteomes, Bridging Genomics and Proteomics. Proteomics and the new biology.

UNIT 2 GENE EXPRESSION AND ANALYSIS 10 Hrs.

Traditional routes of gene identification, detecting open-reading Frames, software programs for finding genes, Identifying the function of a new gene, gene ontology, comparative genomics, Protein structural genomics, determining gene function by sequence comparison and through conserved protein structure Global expression profiling - Analysis of RNA expression, applications of genome analysis and genomics.

UNIT 3 PROTEOME ANALYSIS 10Hrs.

Analysis of proteomes – 2D page and image analysis, Mass spectrometry based methods for protein identification- De novo sequencing using mass spectrometric data, 2-DE gel electrophoresis coupled with mass spectrometry, Micro array techniques, Microarray Technology in Treating Disease.

UNIT 4 APPLICATIONS OF GENOMICS AND PROTEOMICS ANALYSIS 12Hrs.

Analysis of Genomes of different organisms – Human, Mouse, *Plasmodium falsiparum*, *Saccharomyces cerevisiae*, *Mycobacterium tuberculosis*. Application of proteome analysis- drug development and toxicology, Pharmaceutical Applications, Proteomics in drug Discovery in human, phage antibodies as tools, Glycobiology and Proteomics in plant genetics and breeding.

Total 42 hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Apply the concept of genetic information stored and the current genomic technologies
CO2: Analyze the significance of mapping with respect to the structure and function of genome
CO3: Identify the key concepts of proteomics with a mention on various aspects of proteomic studies involving the interactions of these biomolecules with other biomolecules.
CO4: Choose and compare methods for the purification of proteins and analyzing them on a high through put platform
CO5: Ponder on the various techniques for expression
CO6: Harbour the knowledge on some of latest omics concepts

TEXT/REFERENCE BOOKS

1. S. B. Primrose and R.M. Twyman - Principles of Genome Analysis and Genomics, 7 th Edition, Blackwell Publishing, 2006.
2. S. Sahai - Genomics and Proteomics, Functional and Computational Aspects, Plenum Publication, 1999.

3. Andrezej K Konopka and James C. Crabbe, Compact Hand Book - Computational Biology, Marcel Dekker, USA, 2004.
4. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1 st edition, Academic Press, San Diego, 1996.

23BIO302T					*Immunology and Immunotechnology*					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. To understand the fundamental concepts of immunology and humoral immunology
2. To know the functions of immune system.
3. Examine the role of cytokines in regulating the immune response
4. Understand the mechanisms underlying autoimmunity and hypersensitivity
5. Investigate the immunological basis of graft rejection

UNIT I FUNDAMENTAL CONCEPTS OF IMMUNOLOGY: 8 Hrs

History and Scope of Immunology, Innate and Acquired Immunity; Haematopoiesis, Cells of the immune system, Primary and Secondary lymphoid organs, Characteristics of T and B cell receptors, T and B cell maturation, activation and differentiation.

Unit –II HUMORAL IMMUNITY: 10Hrs

Antigens: Characteristics and Types of Antigens, Factors affecting the immunogenicity, Haptens, Antigenic Determinants, Adjuvants, Vaccines, Routes of Immunization. Theory ofclonal selection, Immunoglobulins: Basic structures, classes and sub classes; Molecular Biology of Immunoglobulin synthesis, Effector functions; Isotope, Allotype, Idiotype, Monoclonal antibodies, Complement system - Alternate, Classical and Lectin pathways

Unit-III CELL MEDIATED IMMUNITY: 14Hrs

Structure, types and function of MHC, Phagocytosis, Exogenous and Endogenous pathways of antigen processing and presentation; Cytokines - Structure, function, applicationand regulation of the immune response. Self-tolerance and possible mechanisms of induction of autoimmunity, Organ specific and systemic autoimmune diseases, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity, Immunological basis of graft rejection

Unit-IV IMMUNOTECHNOLOGY: 8Hrs

Antibody affinity and antibody avidity, Cross reactivity, Precipitation reactions, Agglutination reactions - Immunodiffusion and Immunoelectrophoretic techniques, Immunofluorescences, Immunoelectroscopy, RIA, ELISA. Detection of bacterial endotoxins using immunological methods (LAL Test)

Max 40Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1:- Elaborate the basics of immunity and Immunology
CO2:- Evaluate the role of B cell against extracellular pathogens
CO3:- Evaluate the role of T cell against intracellular pathogens
CO4:- Apply Ag-Ab interactions for diagnostic purposes.

CO5:- Identify the conditions due to Immune response against self-antigens
CO6:- Describe the mechanisms involved in different types of hypersensitivity, tolerance and autoimmunity

TEXT / REFERENCE BOOKS

1. Coico, R and Sunshine, G. (2009) Immunology: A Short Course (6th ed.), John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
2. Kuby J, "Immunology", Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen ; Edition, 8 ; Publisher, Macmillan Learning, 2018
3. Janeway's Immunobiology - 9th Edition. 2017
4. Roitt's Essential Immunology" by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt - 2017

23BIO302P					Immunology and Immunotechnology Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. Understand the principles and techniques involved in isolating lymphocytes from blood or spleen.
2. Gain practical experience in performing agglutination reactions
3. Familiarize with enzyme-linked immunosorbent assay (ELISA) and DOT ELISA techniques for antigen-antibody detection
4. Learn how to determine antibody titers through experimental procedures.

LIST OF EXPERIMENTS

1. Isolation of lymphocytes from blood / spleen.
2. Purification of immunoglobulins from serum
3. Assays based on precipitation reactions - Ouchterlony double immunodiffusion (DID) and Mancini radial immunodiffusion (SRID).
4. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
5. Enzyme linked immunosorbent assay (ELISA) & DOT ELISA)
6. Precipitation assays: Immunodiffusion /immunoelectrophoresis
7. Antibody Titer
8. Western blotting
9. Preparation of antigen and adjuvant emulsion (mineral oil, alum, Freund's adjuvants,etc.).
10. Immunization of mouse through intra muscular and intra peritoneal routes

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Relate various immunological components in body's defence mechanism
CO2 – Demonstrate functions of cells and organs of the immune system
CO3 – Overall understanding of immune responses and methods of clinical diagnosis for identifying Ag-Ab interactions
CO4- Interpret Western blotting results to identify specific proteins
CO5- Assess the quality of antigen-adjuvant emulsions prepared for immunization

CO6- Design experimental protocols for isolation of lymphocytes

REFRENCE/TEXT BOOKS:

1. Coico, R and Sunshine, G. (2009) Immunology: A Short Course (6th ed.), John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
2. Kuby J, "Immunology", Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen ; Edition, 8 ; Publisher, Macmillan Learning, 2018
3. Janeway's Immunobiology - 9th Edition. 2017
4. Roitt's Essential Immunology" by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt - 2017

23BIO303T					Animal and Plant Biotechnology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To gain the fundamental knowledge of biotechnology
2. Learn the significance of plant and human Biotechnology
3. To create awareness in Plant and Animal biotechnology.
4. To impart knowledge in micromanipulation techniques in cell culture.
5. To understand the principles of transgenic plants and animals.

UNIT 1 INTRODUCTION TO PLANT CELL CULTURE (10 hrs)

Introduction – culturing plant and animal cells -Tissue Culture media, Callus and suspension culture, Somoclonal Variation, Micro propagation, Organogenesis, Somatic embryogenesis, transfer and establishment of whole plants in soil, green house technology

UNIT 2 INTRODUCTION TO ANIMAL CELL CULTURE (10 hrs)

Chemically defined and serum free media. Laboratory design, Primary cell culture, Establishment of cell line, Maintenance and Preservation of cell line. Characterization, Cross contamination, Scale up of Cell cultures for Product development.

UNIT 3 DESIGN OF GENE CONSTRUCT AND ADVANCED TECHNOLOGIES (12 hrs)

Plant selectable markers; Reporter genes; Positive selection; Transgene silencing; Strategies to avoid transgene silencing; advanced technologies – cis genesis and intragenesis; RNAi technology, genome editing technology, CRISPR/Cas.

UNIT 4 TRANSGENICS PLANTS AND ANIMALS – APPLICATIONS (12 hrs)

Plant Genetic Transformation Methods: Chloroplast transformation and its advantages. Application of Plant Genetic transformation: Herbicide resistance: Insect resistance, Disease resistance antifungal proteins

Embryo transfer- Micromanipulation technology, In Vitro fertilization, Transgenic Animals and their significance. Ethical issues in transgenic plants and animals

(44 hrs)

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Culture of plant cells and its essentials
CO2: Maintenance and culture of animal cell
CO3: Understand the principles of Biotechnology and its industrial application
CO4: Get acquainted with the Pathogens and immunology
CO5: Focus professionally on Health, Disease and Environmental Issues
CO6: Develop solution of Health care problems and environmental issues

TEXT/REFERENCE BOOKS

1. Introduction. R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.
2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005
3. Chawala. H.S., Introduction to plant Biotechnology, Oxford and IBH Publishing Co. Pvt. LTD.New Delhi 2002.
4. Bojwani, S.S. "Plant Tissue Culture: Applications and Limitations", Elsevier science publishers, 2001.
5. Ian Freshney, "Culture of Animal Cells", Wiley-Liss, 5th edition, 2005
6. Grierson,D. "Plant Biotechnology in Agriculture Prospects for the 21st Century", Academic press, 2012

23BIO303P					Animal and Plant Biotechnology Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

Got from the same syllabus for theory

LIST OF EXPERIMENTS

1. Animal Cell Culture Biosafety and Ethical Concerns
2. Preparation of reagents and media for cell culture
3. Cell counting and plating
4. Maintenance of Adherent (Monolayer) and Suspension Cell culture
5. Cryopreservation of cell lines
6. Determination of common cell culture contaminants
7. Cell Viability Assay (MTT reagent)
8. Cell Cytotoxicity Assay (Trypan Blue Assay)
9. Transfection in mammalian Cell Lines
10. Preparation and sterilization of standard tissue culture media.
11. Sterilization of explants and generation of undifferentiated mass of cells.
12. Regeneration of plants from Callus Culture.
13. Preparation of competent cells, transformation, and colony PCR for confirmation of transformation in *Agrobacterium tumefaciens*.
14. Agrobacterium mediated transformation of plants.
15. Selection and screening of transgenic plants.
16. Use of microsatellite markers for DNA fingerprinting.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Gain knowledge on Biosafety and Ethical Concerns

CO2 – Perform primary culture and subculture

CO3 – Preparation and sterilization of standard tissue culture media

CO4 –Understand the importance of sterilization in cell culture

CO5 – Gain knowledge on Cell Viability and toxicity

CO6- Develop skills on basic cell culturing techniques

TEXT/REFERENCE BOOKS:

1. Culture of Animal Cells by R.I. Freshney.
2. Animal Cell Biotechnology 2007, Humana Press by Portner R.
3. Basic Cell Culture Second Edition, Oxford University Press by Davis, J.M.
4. Principles of Plant Genetics and Breeding by George Acquaah 2007. Blackwell Publishing.
5. An introduction to Plant Tissue culture by MK Razdan. M.K. 2003. Oxford & IBH Publishing Co, New Delhi, 2003.

23BIO307T					Molecular Diagnostics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the concept on transmission of infection and ethical and legal aspects of diagnostics.
2. To introduce pathogenicity and diagnosis.
3. To study different techniques related to diagnosis.
4. To understand the concepts and types of molecular diagnosis.

UNIT I: INTRODUCTION **10 Hrs.**

Infection –mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases. Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples. Interpretation of results. Host-Parasite relationships. Quality, Ethical, and legal implication of diagnostics, international standards, NABH standards, FDA regulation of molecular diagnostics

UNIT II: MICROBIAL PATHOGENICITY **10 Hrs.**

Pathogenicity and diagnosis of infection caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio and Mycobacterium. Diagnosis of fungal infections. Major fungal diseases: Dermatophytosis, Candidiosis and Aspergillosis.~~Pathogen~~

UNIT III: DIAGNOSTIC TECHNIQUES **10 Hrs.**

Diagnosis of DNA and RNA viruses. Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, trypanosomiasis, Leishmaniasis. Diagnosis of helminthic diseases Fasciola hepatica and Ascaris lumbricoides. Filariasis and Schistosomiasis

UNIT IV: MOLECULAR DIAGNOSIS **10 Hrs.**

Human disorders: Biochemical disorders, Immune disorders, chromosomal disorders and single cell disorders. Chromosomal disorder diagnosis -autosomal; sex chromosomal; karyotype analysis. G-banding, in situ hybridization (FISH and on-FISH), and comparative genomic hybridization (CGH). Cancer cytogenetics Spectral karyotyping Genes in pedigree. Genetic Counselling.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1	:	Identify different types of infectious diseases and the ethics in diagnosis
CO2	:	Describe methods of sample collection, transport, and processing, including interpretation of result
CO3	:	Interpret diagnostic test results to identify specific microbial pathogens.
CO4	:	Compare and contrast the clinical features of different fungal diseases to guide differential diagnosis.
CO5	:	Discuss ethical considerations in the collection, handling, and analysis of clinical specimens.
CO6	:	Critically appraise the regulatory framework for diagnostic testing and propose enhancements to ensure patient safety and quality of care.

TEXT/REFERENCE BOOKS

1. Nader Rifai, A. Rita Horvath, Carl T. Wittwer, Jason Park, "**Principles and Applications of Molecular Diagnostics - A Derivative of the Tietz Textbook of Clinical Chemistry and Molecular Diagnostics**" 6th ed.
2. Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfeld , Ernest A. Trevino, " **Bailey & Scott's Diagnostic Microbiology"** (2002), Published by C.V. Mosby.
3. Geo F. Brooks, Stephen A. Morse, Janet S. Butel, " **Jawetz, Melnick, & Adelberg's Medical Microbiology"** (2004)
4. David E. Bruns, Edward R. Ashwood, Carl A. Burtis, "**Fundamentals of Molecular Diagnostics"** (2007).. Saunders Group

23BIO305T					**Green Biotechnology and Pollution Abatement**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	0	**0**	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Gain the fundamental understanding on environmental degradation
2. Learn the different aspects of environmental toxicity
3. Understand the monitoring of environmental pollution
4. Learn the concepts of environmental degradation
5. Understand the environmental issues and their approach on prevention strategies

UNIT 1 Environmental degradation 10Hrs.

Environmental degradation, Impact of anthropogenic activities of environment: Land, Water, Air, Forest, Oceans and the coasts; Biodiversity destruction (flora and fauna); Disturbance of ecological balance United Nations Millennium ecosystem assessment. Exponential growth: Four spikes and the reason for spikes, impact and significance of exponential growth, Sustainability of exponential growth, Ecological balance and ecological footprint

UNIT 2 Environmental toxicology 10Hrs.

Toxic chemicals in the environment (air and water) – their effects and biochemical interactions; Biochemical aspects of arsenic, cadmium, lead, mercury, carbon monoxide, ozone and PAN pesticide; Mode of entry of toxic substance, its breakdown and detoxification; biotransformation of xenobiotics; Insecticides / Pesticides in environment, MIC effects. Carcinogens in environment, chemical carcinogenicity, mechanism of carcinogenicity, environmental carcinogenicity testing. Epidemiological issues of toxic compounds and metal poisoning.

UNIT 3 Environmental monitoring **10Hrs.**

Definition and environmental monitoring process; Sampling – land (site) sampling, water sampling, air sampling, Analysis – physical, chemical and biological analysis methods and process Use of microbial population for environmental monitoring – recombinant DNA technology and proteomics. Monitoring pollution; Bioindicators- markers and genetic indicators; Environment Impact Assessment: EIA complete process, Importance of EIA

UNIT 4 Biotechnological methods to pollution abatement **12Hrs.**

Biofilters, Bioremediation, Biotransformation and Biodegradation: In situ and Ex situ bioremediation; Evaluating Bioremediation; Bioremediation of VOCs. Factors affecting process of biodegradation; Methods in determining biodegradability; Contaminant availability for biodegradation; Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation; Phytoremediation: Waste water treatment using aquatic plants; Root zone treatment.

REFERENCE BOOKS

1. Bruce E Rittman and Perry L McCarty. Environmental Biotechnology, Principles and Applications by, McGrawhill Higher education, 2020
2. AS Tomar. Green Biotechnology. Daya Publishing House, 2019.
3. L K Wang et al. Environmental Biotechnology, Vol 10 Handbook of Environmental Engineering, Humana Press, 2010
4. HJ Jördening and J Winter, Environmental Biotechnology. WILEY-VCH Verlag Gmbh & Co., 2015

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Learn the sources of environmental pollution and their causes.
CO2 - Evaluate levels of various pollutants using sophisticated techniques.
CO3 - Understand the advanced treatment methods and pollution abatement techniques
CO4 - Classify the factors and parameters that affect the environmental and economic scenario
CO5 - Develop the assessment of environmental issues pertaining to industry and society
CO6 - Apply the biotechnological based methods for pollution control

Pandit Deendayal Energy University **School of Energy Technology**

23BIO306T					Computer Aided Drug Design					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	-	-	-	--	--	100

COURSE OBJECTIVES

1. Learn the specific information from the enormous and rapidly expanding chemical literature
2. Gain the fundamental on drug/receptor interactions using *in silico* techniques.
3. Create interest in learning relevant applications in QSAR and Drug Design.
4. Understand the basic SNPs and Computer Aided Drug Design.
5. Learn the concepts of target discovery technology and strategy.

UNIT 1 INTRODUCTION **10Hrs.**

Computational biology application, Major databases, Data management, computational molecular biology, Central dogma, Data retrieval, Data mining, Sequence alignment.

UNIT 2 PROTEIN STRUCTURE **10Hrs.**

Classification, Visualization, Protein structure database, Visualization tools, Tool for protein ligand interaction, Motif and domains, Protein – protein interaction.

UNIT 3 STRUCTURE PREDICTION **10Hrs.**

Methods of sequence based structure prediction, Ab-initio approach for structure prediction, Methods of 2-D structure prediction, Protein function prediction, Homologous modeling. Drug and target discovery technology and strategy, Target validation.

UNIT 4 DRUG DISCOVERY **12Hrs.**

Pharmacogenetics and pharmacogenomics application, SNPs, Important parameter for drug discovery. Drug design approaches, Structure based de novo Methods, QSAR, ADME-Tox property prediction.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Classify the computer Aided Drug Design methods and predict drug like compounds.

CO2: Gain the fundamental practice of Molecular modeling and modern drug discovery.

CO3: Understand about the rational drug design, based on three-dimensional structures and physicochemical properties of drugs and receptors.

CO4: List different force fields and their optimization for drug design and simulations.

CO5: Focus professionally on energy minimization and computer simulation

CO6: Develop solution to enhance understanding for drug target interactions.

TEXT/REFERENCE BOOKS

1. Rastogi, S. C., "Bioinformatics; Methods and applications; Genomics, Proteomics and Drug Discovery", PHI Learning Publishers, New Delhi, 2019.
2. Gautham N., "Bioinformatics", Narosa Publishing Company, New Delhi, 2016.
3. Vasantha Pattabhi and N.Gautham, "Biophysics", Narosa Publishing Company, New Delhi, 2019.
4. Lesk, A.M., "Introduction to Bioinformatics", Oxford University Press, Oxford, UK, 1st Edition, 2020.
5. Tagelsir Mohamed Gasmelseid, "Pharmacoinformatics and Drug Discovery Technologies: Theories and Applications", Idea Group, 2019. (ISBN: 978-1466603097)

23BIO304T					Medical Diagnostics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To acquire the knowledge on concepts of medical diagnostics and process involved in the diagnostic laboratories
2. To explore different diagnostic techniques and technologies
3. To understand the molecular diagnostic and imaging tools to assist the clinical diagnosis.
4. To discuss the role of diagnostics in patient management and treatment

UNIT I: FUNDAMENTAL OF DIAGNOSTICS **10 Hrs.**

Concepts of diagnosis and its importance in health care, Assessment of clinical history, Laboratory test (Serology, Hematology, Urine & stool), Molecular Diagnostics (PCR), Histological procedures in sample Collection, Preservation & processing of tissue specimens, Fundamental of radiological assessment. Model case presentation.

UNIT II: DIAGNOSTIC MEDICAL MICROBIOLOGY AND RECENT ADVANCES **10 Hrs.**

Diagnostic medical microbiology: Microbial pathogenesis, Collection, culturing, identification procedures: Updated immunologic or molecular diagnostic tests. The diagnostic laboratory tests for identification of *Staphylococcus aureus, E. coli, shigella, Salmonella etc.,* including bacteriologic methods for isolation, serologic methods of diagnosis. Test for bacterial Sensitivity tests against antimicrobial agents and its clinical implications and interpretation.

UNIT III: LABORATORY DIAGNOSIS OF VIRUS INFECTION **10 Hrs.**

Laboratory Diagnosis of Virus Infection: Viral pathogenesis, Specimen collection and submission, Cultivation & assays for virus, Purification & identification of virus. Immunopathological Methods in Clinical laboratories: Detection of various allergic agents and immunopathology of allergy.

UNIT IV: RADIOLOGY AND ADVANCED IMAGING TECHNOLOGY **10 Hrs.**

Radiology and Advanced Imaging Techniques: Introduction to Radiology- X Ray, Ultrasound, MR, CT, PET, Radiographic, High-throughput diagnostics in clinics: DNA chips, diagnosis of genetic disorders, human genome project in diagnostics and Microarrays.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1	:	Understand the fundamental principles of medical diagnostics
CO2	:	Demonstrate various techniques in clinical, histopathological and radiological laboratories
CO3	:	Analyze the process to diagnose common infections and interpretation of diagnostic tests and results.
CO4	:	Classify and compare the diagnostic techniques and imaging techniques
CO5	:	Discuss the role of diagnostics in patient management and treatment.
CO6	:	Develop critical thinking skills in evaluating diagnostic approaches and methodologies.

TEXT/REFERENCE BOOKS

1. Elmer W. Koneman, **"Color Atlas and Textbook of Diagnostic Microbiology**", Jones & Bartlett Learning.
2. Mary Louise Turgeon, "**Linne and Ringsrud's Clinical Laboratory Science: Concepts, Procedures, and Clinical Applications**", Mosby.
3. Kumar, Abbas, and Aster, "**Robbins Basic Pathology**", Elsevier India.

4. Turgeon, Mary Louise. "**Clinical Hematology: Theory and Procedures**", Lippincott Williams and Wilkins.
5. Strasinger, Susan King, and Marjorie Schaub Di Lorenzo. "**Urinalysis and Body Fluids**",F.A Davis company.
6. Rifai, Nader, Horvath, Andrea R., and Wittwer, Carl T. Tietz , "**Textbook of Clinical Chemistry and Molecular Diagnostics**", Elsevier India.
7. Thrall, Donald E.,"**Textbook of Veterinary Diagnostic Radiology**", Elsevier.

END SEMESTER EXAMINATION

Max. Marks: 100 **Exam Duration: 3 Hr.**

20HS301P					**Communication Skills – III (Semester – V/VI) (Third Year)**					
Teaching Scheme					**Examination Scheme**					
					Theory			**Practical**		**Total Marks**
L	**T**	**P**	**C**	**Hrs/Week**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	
0	**0**	**2**	**1**	**2 hours per week**	**--**	**--**	**--**	**50**	**50**	**100**

Course Objectives:

1. To understand communication and its process and effect on giving and receiving information.
2. To learn and apply communication skills in different public and interpersonal contexts.
3. To develop analytical, research, and organizational skills through communication skills for a fulfilling career.

Syllabus:

Unit I **10 hrs**

- Writing research proposals
- Writing technical projects

Unit II **15 hrs**

- The Art of Presentation
  - ✓ *Sapiens: A Brief History of Humankind* (2011), Yuval Noah Harari
  - ✓ *Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations* (2016), Thomas L. Friedman
  - ✓ (Presentation in teams of 4 students each, not more than two from the same branch, with a view to promote cross-disciplinary research)

Unit III **5 hrs**

- Uploading portfolios on SlideShare
  - ✓ Uploading Video modules

Max.: 30hrs

Course Outcomes:

On completion of the course, student will be able to

CO1 **:** Demonstrate enhanced communications skills for enhanced team work for a better result.
CO2 **:** Apply critical analysis for innovative thinking and well-rounded perspectives in different settings and contexts.
CO3 **:** Analyse situations to identify opportunities for professional and career growth through strong communication skills.

CO4 : Develop high competence of oral, written and visual communication skills for a workplace ready professional.

CO5 : Demonstrate a realization and application of communication skills and language processes for multiple perspectives and interdisciplinary approach in profession.

CO6 : Evaluate the application of communication skills for improved research, organizational, and critical thinking and perspective.

Text/Reference Books:

- Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
- Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.
- Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.
- Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.

Assessment Tools:

Component	Marks	Assignments
Lab Work	50	• Business Proposal – 15 • Research Project Proposal – 15 • Reviews on the two books – 20
Lab Exam/Viva	50	• Presentation on the reviews of the two books (Intra Branch) – 15 • Presentation on a technical topic (Inter Branch) – 15 • Slideshare/Video Modules (Prescribed Texts) – 20

Semester – VI

Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
PC	23BIO308T	Genetic Engineering techniques	3	0	0	3	3
PC Lab	23BIO308P	Genetic Engineering - Lab.	0	0	2	2	1
PC	23BIO309T	Tissue Engineering and Regenerative Medicine	4	0	0	4	4
PC Lab	23BIO310P	Biomaterials and Tissue Engineering - Lab.	0	0	2	2	1
CE	23BIO311T	Biomaterial and Implants	3	0	0	3	3
CE	23BIO312T	Novel Separation Processes - Dyes and Pigments					
CE	23BIO313T	Cheminformatics and Medicinal Chemistry					
CE	23BIO314T	Pharmacokinetics and Pharmaco Dynamics	3	0	0	3	3
CE	23BIO315T	Food Biotechnology					
CE	23BIO316T	Next Generation Sequence Analysis					
OE	23BIO317T	Biosimilars Technology	3	0	0	3	3
Project	20TP310	Industrial Training / IEP (6 weeks-summer break)	0	0	0	0	2
			16	0	4	20	20

23BIO308T					Genetic Engineering Techniques					
Teaching Scheme					Examination Scheme					
					Theory			Practical		Total Marks
L	T	P	C	Hrs./Week	MS	ES	IA	LW	LE/VIVA	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. The objective of the course is to teach basics of theory and practical aspects of recombinant DNA technology
2. Provide theoretical bases for the application of versatile DNA modifying enzymes, cloning strategies, vector types
3. The course will also outline the applications of this knowledge for the development of diagnostics, therapeutics and vaccines.
4. Students will be introduced to prominent nucleic acid labelling techniques

UNIT I: Introduction 10Hrs

Overview of gene cloning. Restriction, modification systems and DNA modifying enzymes, DNA analysis by electrophoresis. Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors for E. coli like pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. Ti plasmid, BAC and YAC.

UNIT – 2: Introduction of DNA into cells and selection of recombinants 10Hrs Ligation of DNA molecules. Introduction of DNA into cells, Transformation, selection for transformed cells. Identification of recombinants, blue-white selection. Identification of recombinant phages. cDNA and Genomic libraries.

UNIT – 3 Polymerase chain reaction, DNA sequencing 10Hrs Fundamentals of polymerase chain reaction, designing primers for PCR. DNA sequencing by Sanger's method and automated DNA sequencing, Vectors for expression of foreign genes in E. coli, cassettes and gene fusions. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

UNIT – 4 Techniques in Biotechnology 10Hrs

Blotting technique, RT-PCR, In-situ hybridization, RAPD, RFLP, Antisense RNA and Ribozyme technology, CRISPR/Cas9 gene editing, Site-directed mutagenesis and protein engineering; Applications of recombinant DNA technology; Safety regulations related to genetic engineering

Max. 40 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to;

CO1: At the end of the course the students will learn the Principles and importance of gene cloning
CO2: Various methods for screening of recombinants and identification of cloned gene
CO3: Polymerase chain reaction and DNA sequencing
CO4: Application of recombinant technology in the production of Biopharmaceutical processes and products such as insulin, vaccines and DNA finger printing.
CO5: Evaluate structure and organization of different vectors used in gene transfer
CO6: Design primers for amplification of genes

TEXT/REFERENCE BOOKS

1. Brown, T. A. (2020) Gene Cloning and DNA Analysis: An Introduction, (8th ed.)Wiley-Blackwell Publishing (Oxford, UK); ISBN: 978-1-119-07256-0
2. Glick, B.R., Pasternak, J.J., Patten, C. L. Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th ed.). ASM Press (Washington DC); ISBN: 978-1-55581-498-4. (2010)
3. Principles of Gene Manipulation; S. B. Primrose, R. Twyman, R.W. Old; Wiley-Blackwell; 7th Edition. 2013
4. Molecular Biology of the cell by Bruce Alberts, 6th edition. New York: Garland Science; 2014
5. Genetic Engineering: Principles and Methods by Jane K. Setlow, Alexander Hollaender. Volume 6. 2006

23BIO308P					Genetic Engineering Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To demonstrate the components required for gene manipulation
2. To apply the knowledge of genetic material and their transformation at molecular and cellular levels
3. To Enhance Critical Thinking and Problem-Solving Skills in Gene Manipulation
4. To Promote Ethical Awareness and Responsibility in Genetic Engineering

LIST OF EXPERIMENTS

1. Making competent *E. coli* cells using chemical methods.
2. Transformation of *E. coli* and calculation of competence.
3. Cloning and expression of GFP sequence in the expression vector
4. Transformation and antibiotic selection or Blue white selection method
5. Restriction digestion with plasmid and lambda Phage DNA
6. Methods of Restriction mapping, using online NEB cutter tools
7. Ligation process (Joining of DNA)
8. In vitro amplification of DNA by PCR or gene pulling
9. DNA elution in agarose gel
10. Agarose gel electrophoresis and visualization using gel doc

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Design construct the recombinant vector and develop genetically modified organisms
CO2 – Apply concepts of gene cloning principles
CO3 – Paraphrase various methods to transfer foreign genes
CO4- Analyze experimental data obtained from molecular biology experiments
CO5- Develop innovative approaches for gene manipulation, recombinant DNA technology
CO6- Evaluate the ethical implications and societal impact of genetic engineering practices

REFERENCES:

1. Primrose, S.B. and Twyman, R.M. Principles of Gene Manipulation and Genomics. 8th Edition, Blackwell Publishing Co. UK. 2012
2. Brown, T. A. (2020) Gene Cloning and DNA Analysis: An Introduction, (8th ed.). Wiley-Blackwell Publishing (Oxford, UK); ISBN: 978-1-119-07256-0
3. Christopher Howe Gene Cloning and Manipulation, 2nd Edition, Cambridge University Press, UK. 2015
4. Ausubel, F.M. et al. (2012). Current protocols in molecular biology. New York: John Wiley & Sons.
5. Green, M. R., & Sambrook, J. Molecular cloning: A laboratory manual (4th ed., Vol. 1-3). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. (2012)

23BIO310P					Biomaterials and Tissue Engineering Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	0	0	0	50	50	100

COURSE OBJECTIVES

1. To understand techniques involved polymerization
2. To Observe quality control tests of common biomaterials
3. To design appropriate parameters to evaluate the properties of biomaterials
4. To introduce basic concepts of validation of biomaterials

Experiment Sessions would be simulation based covering but not limited to following topics:

1. To perform polymerization reaction using Self cure resin
2. To fabricate polymer blends
3. To perform physical properties of hardening of metals
4. To perform absorption spectra of ocular biomaterial
5. Fabrication of hydroxyapatite and PEG complexes
6. To analyze the setting temperature of bone cement
7. To analyze the surface texture of the polymers
8. To analyze the tensile strength of the polymers
9. To perform cellulose biomaterial preparation
10. To perform the elctrospun matrix of the blended polymers

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Study the fundamentals of biomaterials and their properties

CO2: Understand the nature and characteristic features of biomaterials

CO3: Apply the technology in biomaterial fabrication

CO4: Analyze the applications of biomaterials

CO5: Evaluate quality test for biomaterials

CO6: Design and fabricate bio implants

TEXT/REFERENCE BOOKS

1) Biomaterials, By Sujata V. Bhatt, Narosa Publishing House, New Delhi, India,2019

2) Biomaterials Science: An introduction to materials in medicine, Edited by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Elsevier.2013

3) Biomedical Materials, R.Narayan (ed.), Springer Science.2009

4) Biomaterials: Principles and Applications, Edited by Joon B. Park, Joseph D. Bronzino, CRC Press.2002

5) Biomaterials: An introduction, By Joon B. Park, Roderic S. Lakes, Springer.1992

6) Biomaterials Medial Devices and Tissue Engineering By Fredrick H. Silver Chapman and Hall.1994

7) Biomaterials science and engineering By J. B. Park Plenum press, New York.1984

23BIO309T					Tissue Engineering & Regenerative Medicine					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. Learn the fundamentals of tissue engineering and tissue repairing
2. Understand the basic concept behind tissue engineering focusing on the stem cells,biomaterials and its applications.
3. Acquire knowledge on clinical applications of tissue engineering

UNIT I: Tissue Architecture 10Hr.

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing. Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix & Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

UNIT II: Biomaterials 10 Hr.

Biomaterials: Properties of biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology.

UNIT III: Biology of Stem Cell 10 Hr.

Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pleuri potent stem cells.

UNIT IV: Clinical Applications 12 Hr.

Stem cell therapy, Molecular therapy, *In vitro* organogenesis, Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopaedic applications, Stem cells and Gene therapy. 3D bioprinting of tissues and organs. Tissue engineered product characterization, components, safety, efficacy. Preservation –freezing and drying. Patent protection and regulation of tissue-engineered products, ethical issues.

Max. 42 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Gain the fundamental knowledge of tissue architecture.

CO2: Understand the mechanism of tissue repair.

CO3: Classify different categories of Biomaterials used in tissue engineering.

CO4: Get acquainted with stem cell characteristics and their relevance in medicine.

CO5: Focus on properties and broad applications of biomaterials.

CO6: Design and develop 3D scaffolds and engineered substitutes for clinical conditions.

TEXT/REFERENCE BOOKS

1. Bernhard O.Palsson, Sangeeta N.Bhatia, "Tissue Engineering" Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P.Fundamentals of Tissue Engineering andRegenerative Medicine.2009.
3. Bernard N. Kennedy (editor). Stem cell transplantation, tissue engineering, and cancer applications,Nova Science Publishers, 2008.
4. Raphael Gorodetsky, Richard Schäfer. Stem cell-based tissue repair. RSC Publishing, 2011.
5. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two- Volume, Volume1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, Academic Press, 2004.
6. R. Lanza, J. Gearhart etal (Eds), Essential of Stem Cell Biology, Elsevier Academic press,2006.
7. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenerative Medicine" Artech House, INC Publications,2008.
8. Naggy N. Habib, M.Y. Levicar, L. G. Jiao and N. Fisk, Stem Cell Repair and Regeneration, volume-2,Imperial College Press,2007.

23BIO311T					Biomaterial & Implants					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Learn the fundamentals of Biomaterial & Implants
2. Understand the basic concept of bio materials that are used in medical devices.
3. Acquire knowledge on Bio-materials and the Medical devices

UNIT I: Introduction to Biomaterials **10Hr.**

Biomaterial, Types of Biomaterials, Biocompatibility, Biological material, Biodegradable material, Bioresorbable material, Bio-inert material, Bio-active material, Minimum Requirements of Biomaterials, Surface Properties of Biomaterials, Desirable Properties of Biomaterial.

UNIT II: Different types of Biomaterials **8 Hr.**

Different types of metallic and polymeric biomaterials. Applications and Performance of Biomaterials. Impact of material corrosion and its prevention strategies.

UNIT III: Biocompatibility Testing & Response of Biomaterial **12 Hr.**

Biocompatibility Testing: Introduction, *In-Vitro* Testing, *In-Vivo* Testing, Hypersensitivity, Haemocompatibility, Odontocompatibility, Osteocompatibility, Cytotoxicity, Genotoxicity, Carcinogenicity. Response of Biomaterial to Human Body: Blood-Biomaterial Interactions, Biomaterials-Tissue Interactions, Tissue response to Implants, Inflammation, Wound Healing, and ForeignBody Response, Impact of Biofilm formation on biomaterials.

UNIT IV: Bio-implants **10 Hr.**

Stent, Vascular grafts, Artificial Heart valves, Contact lenses, Intra-ocular lenses, Artificial Silicon Retina, Temporary fixation Devices, Total Hip Replacement, Total Knee Replacement, Dental filling & Restoration material, Dental implants, Suture materials, Wound dressings, Tissue Adhesives.

Max. 40 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Summarise the classifications and properties of different biomaterials, their properties, performance specification andbiological applications

CO2: Demonstrate the applications of Metallic & Ceramic based biomaterials

CO3: Illustrate the types and applications of Bio-implants

CO4: Analyze the essential qualities and requirement of biomaterials for implant fabrication.

CO5: Compare different testing protocols for specific biomaterial/implant and evaluate the response ofbiomaterial/Implant on biological environment.

CO6: Apply the knowledge of biomaterials to judge which material in order to Design and develop suitable Bio-implants.

TEXT/REFERENCE BOOKS

1) Biomaterials, By Sujata V. Bhatt, Narosa Publishing House, New Delhi, India
2) Biomaterials: An introduction, By Joon B. Park, Roderic S. Lakes, Springer.
3) Biomaterials Science: An introduction to materials in medicine, Edited by Buddy D. Ratner, Allan S.Hoffman, Frederick J. Schoen, Jack E. Lemons, Elsevier.
4) Biomedical Materials, R.Narayan (ed.), Springer Science.
5) Biomaterials: Principles and Applications, Edited by Joon B. Park, Joseph D. Bronzino, CRC Press.
6) Biomaterials Medial Devices and Tissue Engineering By Fredrick H. Silver Chapman and Hall.
7) Biomaterials science and engineering By J. B. Park Plenum press, New York.

23BIO312T					Novel Separation Processes – Dyes and Pigments					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Students will be to understand the pigmentary property, chemistry behind the colorants.
2. They will be able to explain its applications in various field according to the chemistry involved.
3. Student will be made aware to testing of pigments synthesis processing and applications of dyes pigments lakes
4. Will be able to narrate basic aspects of separation processes
5. Understand the environmental issues and their approach and prevention strategies

UNIT 1 Novel separation process **10Hrs.**

Introduction – Need for separation process – Overview of separation processes – types and classification. Membrane processes – choice of membranes- Membrane filtration – micro, nano and ultrafiltration. Dialysis and reverse osmosis. Chromatographic separations –Ion-exchange separation. Liquid and gaseous separations.

UNIT 2 Polymers **10Hrs.**

Introduction, Classification of Polymers - origin, structure, intermolecular interactions, Types of polymerization – addition, condensation, radical, ionic and copolymerization. Inorganic polymers, organic polymers, biodegradable polymers, Photonic polymers, fire retarding polymers, membranes and smart materials – Introduction, types and applications

UNIT 3 Dyes and Pigments **12Hrs.**

Introduction, Nomenclature and Classification of Natural and Synthetic dyes, Color and constitution - chromospheres and auxochromes with suitable examples, Azo dyes - types of azo dyes, synthesis of acidic and basic azo dyes. Natural dyes – structure determination and synthesis of alizarine, Quinazarin and Indigo. Food colours. Introduction to Fluorescence dyes and Introduction to laser dyes. Pigments: Introduction, Structures of Porphyrins, plant pigments and classification, Bile pigments. Synthesis of Haemin and Chlorophyll. Synthetic pigments – preparation of Phthalocyanines.

UNIT 4 Remediation processes **10Hrs.**

Impact of the textile and leather dye Industry on the environment, Pollution of water with dyes and pigments, Toxicity of food colors, Need for remediation, Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes, Effluent Treatment Strategies

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Able to narrate the separation process

CO2: Understand the different kinds of polymers

CO3: Able to understand fundamental knowledge on basics of chemistry involved in the colorants

CO4: Able to explain the types of dyes on the basis of application, properties.

CO5: Able to explain the synthetic methods used for azo dyes and their properties.

CO6: Health care problems and environmental issues related to industrial dyes

TEXT/REFERENCE BOOKS

1. Color Chemistry –Synthesis, Properties and Applications of Dyes and Pigments, Zollinger H., 2nd ed., Weinheim – VCH, 1991
2. Natural Dyes and their Applications in Textiles by M. L. Gulrajani, IIT Delhi 17.
3. Handbook on Natural Dyes for Industrial Applications by P. S. Vankar, National Institute of Industrial Research
4. Textbook of Polymer Science, F. W. Billmeyer Jr, John Wiley & sons
5. V. K. Jain. Fundamentals of Plant physiology. S. Chand & Co Ltd.2022

23BIO313T					Cheminformatics & Medicinal Chemistry					
Teaching Scheme					Examination Scheme					
					Theory			Practical		Total
L	T	P	C	Hrs./Week	MS	ES	IA	LW	LE/VIVA	Marks
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. This course for biotechnology students introduces the small molecule-ligand-oriented *in silico* Physico-chemical aspects of rational drug design.
2. Gain insight on chemoinformatics
3. To Introduce Computational Chemistry Techniques in Drug Design
4. To Explore Applications of Chemoinformatics in Drug Discovery

UNIT – 1 **10Hrs**

Chemistry & Information technology: Overview of Rational Drug Design, Ligands and Targets, *in-silico* representation of chemical information. Chemical Databases: Data Mining, Chemical/biochemical data collation, retrieval, analysis & interpretation.

UNIT – 2 **10Hrs**

Molecular Drawing and Interactive Visualization: Building molecules on a computer, Molecular Modeling. Computer-Aided Drug Design: Overview, Structural Homology Modeling Tools, Docking Tools, and Screening Tools. Chemical data science: Artificial intelligence in chemistry, simulation methods for molecules and materials

UNIT – 3 Mechanism **10Hrs**

Stereochemistry and mechanism, coordination chemistry for drug design, *in silico* tools for medicinal chemistry (docking, MD, *de novo* drug design), Organic reaction mechanism, Logic in organic synthesis, QSAR, pharmacological screening, chemistry of drug action, Pharmaceutical Preformulation, Solid State Pharmaceutics, Drug metabolism, pharmacokinetics, pharmacodynamics.

UNIT – 4 Structure Activity Relationships **10Hrs**

Antihistaminic agents, anti-anginal, vasodilator, calcium channel blocker, Diuretics, Anti-hypertensive agents, Anti-arrhythmic drugs, anti-hyperlipidemic agents, coagulants & anticoagulants, drug used in congestive Heart failure, Drugs acting on Endocrine system, Antidiabetic agents.

Max 40Hrs

COURSE OUTCOMES

On completion of the course, student will be able to;

CO1: Investigate chemicals and materials that are not practical for laboratory analysis

CO2: Develop individual model molecules or the behaviors of chemical compounds within the natural world; create and/or work with databases to catalog, categorize, organize, and search the structures of chemicals

CO3: Employ computational chemistry to simplify problems and make calculations that are used in laboratory experimentation

CO4: Apply computational chemistry techniques and chemoinformatics tools to investigate chemical compounds

CO5: Synthesize and analyze chemical data using computational methods

CO6: Evaluate the effectiveness and limitations of computational chemistry methods and chemoinformatics tools in rational drug design

TEXT/REFERENCE BOOKS

1. Muthukumarasamy Karthikeyan and Renu Vyas. Practical chemoinformatics. Springer, soft-cover ISBN 9788132234913, 2014.
2. Silverman, Richard B., and Mark W. Holladay. The organic chemistry of drug design and drug action. Academic Press, 2014
3. Bajorath, Jurgen. Chemoinformatics for Drug Discovery. John Wiley & Sons, 2013.
4. Cramer, C.J., Essentials of Computational Chemistry, 2nd Ed., John Wiley & Sons Ltd., 2004.
5. Essentials of Foye's Principles of Medicinal Chemistry – 2016.

23BIO314T					Pharmacokinetics & Pharmacodynamics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/ Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/VIVA	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. Understand the basic concepts of pharmacokinetics /Pharmacodynamics and their significance.
2. To describe the kinetics of drug absorption, distribution, metabolism, excretion, elimination.
3. To impart the clinical importance of drug action and drug interactions
4. To analyse various pharmacokinetic & pharmacodynamics parameters, their significance & applications.
5. To compare the Bioavailability and bioequivalence of drug products and their significance.

Unit 1 – Absorption and Distribution **10 Hr**

Absorption **-** Introduction, Mechanisms of Drug Absorption, Factors Influencing Drug Absorption, Distribution – Factors influencing Distribution of Drug, Volume of Distribution and its significance.

Unit 2 – Metabolism and Excretion **10 Hr**

Drug Metabolism - Introduction, Drug Metabolism, Metabolic Pathways, Factors Affecting drug metabolism. Excretion -Introduction, Renal Excretion of Drugs, Factors Affecting the Renal Excretion of Drugs,Clearance, Renal Clearance, Non-renal Routes of the Drug Excretion.

Unit 3 – Pharmacodynamics & Drug Interactions **10 Hr**

Principles and Mechanism of Drug action, Drug interactions: Effect of protein- binding interactions, the effect of tissue-binding interactions, cytochrome p450-based drug interactions, drug interactions linked to drug-drug, drug-food, drug-alcohol interactions.

UNIT 4– Application of Pharmacokinetics and Dynamics 10 Hr

Dose response relationship, Therapeutic index, factors modifying drug action. Modified-Release Drug formulations, Targeted Drug Delivery Systems. Bioavailability and Bioequivalence. Clinical significance of bioavailability and bioequivalence studies.

Max. 40 Hr.

Course outcomes

CO1 – Gain fundamental knowledge on Absorption, Distribution, Metabolism and Elimination CO2 – Understand the key steps involved in pharmacokinetics and Pharmacodynamics

CO3 - Analyze and compare different types of drug interaction and its clinical significance

CO4 – Get acquainted with metabolic pathway and excretion mechanism

CO5 – Focus on Application of Pharmacokinetics in Bioavailability and Bioequivalence

CO6 – Design and develop pharmaceutical formulations and validate its bioavailability and bioequivalence.

TEXT BOOK/REFERENCES:

1. Bio pharmaceutics and Pharmacokinetics-A Treatise, By D. M. Brahmankar and Sunil B.Jaiswal,Vallabh Prakashan Pitampura, Delhi .2017.
2. Applied biopharmaceutics and pharmacokinetics, Leon Shargel and Andrew B.C.YU 4th edition,Prentice-Hall Inernational edition.USA.2022
3. Remington's Pharmaceutical Sciences, By Mack Publishing Company, Pennsylvnia.2012
4. Dissolution, Bioavailability and Bioequivalence, By Abdou H.M, Mack, Publishing Company,Pennsylvania 1989.
5. Clinical Pharmacokinetics, Concepts and Applications: By Malcolm Rowland and Thomas, N. Tozen, Lea and Febrger, Philadelphia, 1995.
6. Biopharmaceutics and Clinical Pharmacokinetics by Milo Gibaldi.2005

23BIO315T					Food Biotechnology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the fundamentals of food biotechnology
2. To learn the concepts of food processing and preservation
3. To understand some emerging concepts in food technology
4. To emphasize the concept of functional foods and different fermented foods
5. To comprehend the principles behind important analytical techniques employed in biotechnology as well as in genetic modification of foods.

UNIT 1 Food processing and preservation 10Hrs.

Introduction to food processing of various foods including dairy, bakery, brewing, fruit and vegetable products, plantation products, oilseeds, meat, fish, poultry; pro and prebiotics and nutraceuticals. Principles of food preservation by dehydration, thermal treatments like pasteurization, sterilization, canning, retorting etc., low temperature i.e., chilling and freezing, chemical preservation/ bio-preservation, traditional methods like salting/ syruping, pickling, fermentation etc., non- thermal processes like MAP, irradiation, high pressure processing etc., and hurdle technology

UNIT 2 Food Biotechnology 10Hrs.

Fermentative production of enzymes used in food industry; solid state fermentation; recovery of enzymes from natural sources; cheese making and whey processing, impact of enzyme technology (bioethanol, protein hydrolysates, bioactive peptides); enzymatic processing of fruit juices. Role of enzymes in baking, meat and meat processing; comparative methods of toxicity test in (novel) foods; biosensors; enzymatic approach to tailor made fats; catabolic processes and oxygen-dependent reactions in food; use of lipases and reactions in organic solvents and two phases.

UNIT 3 Fermentation food biotechnology 12Hrs.

Fermented foods: eg dairy products, oriental fermentations, alcoholic beverages, and food ingredients; the role of biotechnology in fermented food products (dairy, meat, vegetable); Starter culture development, process development; Enzymes in the dairy industry: cheese making and whey processing, impact of enzyme technology; Functional foods. Nutraceuticals, Use of Antibiotics & Hormones in Food Processing & Agricultural Practices etc.

UNIT 4 Food safety and Regulation 12Hrs.

Role of WHO to improve evaluation of GM food, Benefits & Controversies, Irradiated Food, Labelling of Irradiated Food. Freeze dried food, Functional Foods & Nutraceuticals, Functional foods from plant sources, animal sources, dietary supplements, Regulation. FAO in India, Technical Cooperation programmes, Biosecurity in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC); Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

TEXT BOOKS/REFERENCE BOOKS

1. Byong H.Lee, (2015), Fundamentals of food biotechnology. Wiley-Blackwell.
2. Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin, (2005) Food biotechnology. CRC Press.
3. Roger Angold, Gordon A. Beech, John Taggart, (1989), Food Biotech. Cambridge University Press.

COURSE OUTCOMES

CO1 - Understand basic concepts of food sciences and properties of foods, and chemical and enzymatic factors affecting these properties.
CO2 - Comprehend different food standards for various categories of foods.
CO3 - Understand different analytical techniques employed across various categories of foods.
CO4 - Describe the effect of food constituents on food quality.
CO5 - Grasp the fundamentals of food processing and preservation.
CO6. Understand some emerging concepts in food technology.

23BIO316T					Next Generation Sequence Analysis					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Learn the specific information of of Next Generation Sequencing
2. Gain the fundamental on the various platforms used in NGS.
3. Create interest in learning the tools and techniques used in NGS data analysis.
4. Learn the applications and scopes of genomics research using the latest genome-wide data centric approaches.

UNIT 1 INTRODUCTION 12Hrs.

Historical perspective of sequencing technologies. Overview of modern sequencing technologies. Next Generation sequencing platforms. Data acquisition and base calling. Quality of sequencing data. Read mapping and genome assembly. Structural and functional annotation of genomes. Statistics and algorithms used in different steps in data analysis..

UNIT 2 TECHNOLOGIES FOR TRANSCRIPTOMICS AND REGULATORY GENOMICS 10Hrs.

Chip- seqAnlysis. Peak finding. Motif Discovery. RNA-seq Analysis. Differential gene expression analysis. Exome sequencing and analysis. Exome sequencing.

UNIT 3 SOFTWARE AND PIPELINES FOR NGS DATA ANALYSIS 10Hrs.

Chip-seq analysis Piplines. RNA-seq analysis pipelines. Software used for assembly and differential gene analysis. Basics of Genome Browsers. Annotation pipelines.

UNIT 4 GENOME SEQUENCING AND APPLICATIONS IN GENETICS STUDIES 10Hrs.

Algorithms and application in studying regulation of gene expression. Emerging technologies of single-cell gene expression analysis. Metagenomics. Variant detection. Time series analysis. Pathway Analysis.

Max 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Classify the different sequencing technologies.

CO2: Gain the fundamental practice of transcriptomics and genomics.

CO3: Understand about the pipelines for RNA Seq analysis.

CO4: List different mapping and genome assembly methods.

CO5: Focus professionally on software's and tools for NGS data analysis

CO6: Develop solution to enhance understanding for genome sequencing and genetic studies.

TEXT/REFERENCE BOOKS

1. JM Bower and H Bolouri, eds, "Computational modeling of genetic and biochemical networks", MIT Press 2019
2. Deep Sequencing Analysis by Noam Shomrom, Springer, 2018
3. Fall, C.P., Marland, E.S., Wagner, J.M., Tyson, J.J, "Computational Cell Biology", Springer, 2018.
4. Genomic Data Analysis by Megahed Mohammad, LAP Lambert Academic Publishing, 2017
5. Choi Sangdun, "Introduction to System Biology", Humana Press/Trtowa/New Jersey, 2013.

23BIO317T					BIOSIMILARS TECHNOLOGY					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand how a protein's structure dictates its function.
2. To compare the different host-expression systems as vectors required for biosimilar production
3. To study the different steps and techniques involved in processing of biosimilar
4. To categorize the levels and guidelines of clinical trials

UNIT I: INTRODUCTION	**10 Hrs.**
Introduction, protein and its broad functions, outline of protein synthesis and its importance, post-translation modifications, therapeutic proteins. Introduction to biosimilars, definition, examples, uses and applications. Overview of Pharmaceutical Biotechnology and Biosimilars technology	
UNIT II: HOST EXPRESSION SYSTEMS	**10 Hrs.**
Biologics/Biosimilars: A Regulatory Overview, Different expression hosts with history and genotypes Prokaryotes - E.coli DH5 alpha , E.coli BL21A1, E.coli BL21DE3 etc. Eukaryotes – Yeast hosts like Pichia pastoris , Mammalian hosts like CHOK1, CHO DuxB11, CHO DG44, NS0, SP02 cell line	
UNIT III: PROCESSING OF BIOSIMILARS	**10 Hrs.**
Primary processing using microbial cultures, Microbial and Mammalian protein purification, cell separation, cell disruption, protein isolation, protein purification processes – chromatography and ultrafiltration. Formulation of biosimilar drugs, stability studies pre-packaging and post packaging of biosimilar drugs. Types and source of impurities in biosimilars and method of identifying impurities.	
UNIT IV: CLINICAL TRIALS	**10 Hrs.**
Regulatory Compliance for Biopharmaceuticals and Other Biologics, Concepts of non-clinical animal trials and clinical trials on human volunteers (Phase I, II, III, IV clinical trials), Guidelines and Case studies	
	TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1	:	Explain the different functions of proteins, therapeutic proteins
CO2	:	Understand the different course expression systems in prokaryotes and eukaryotes involved in the production of biosimilars
CO3	:	Apply the methods of Pharmaceutical technology for the production of biosimilars
CO4	:	Classify the different vector systems used in biosimilar production
CO5	:	Appraise the production and processing of biosimilars and therapeutics
CO6	:	Formulate the animal and clinical trials for the testing and validation of therapeutics

TEXT/REFERENCE BOOKS

1. Grindley, Jill E. Ogden. **Understanding Biopharmaceuticals: Manufacturing and Regulatory Issues**. CRC Press
2. Crommelin D.J.A. , Sindelar R. D ,Bernd Meibohm. **Pharmaceutical Biotechnology, II edition,** Springer
3. Gary Walsh. **Pharmaceutical Biotechnology.** Wiley
4. O. Kayser, R. H. Muller **Pharmaceutical Biotechnology**. Wiley - VCH
5. Jay P Rho, Stan G Louie. **Handbook of Pharmaceutical Biotechnology**. Haworth Press.

20TP310					Industrial Training / IEP (6 weeks-summer break)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	0	2	-	-	-	-	-	-	100

COURSE OBJECTIVES

1. Provide students with a comprehensive understanding of industrial biotechnology, including biopharmaceutical manufacturing, fermentation technology, nanotechnology, and targeted drug delivery, emphasizing real-world applications.
2. Expose students to emerging trends and challenges in vaccine development, antibody engineering, and medical diagnostics, fostering an appreciation for regulatory compliance, quality assurance, and preclinical validation.
3. Enhance technical expertise in computational biology and AI-driven drug discovery, enabling students to explore bioinformatics, molecular docking, and machine learning approaches for precision medicine.
4. Develop problem-solving and research skills through exposure to environmental biotechnology, food and agricultural biotechnology, and sustainable bio-manufacturing, promoting innovation in bioremediation, biofuels, and functional foods.

Suggested field of exposure is summarised below but not limited to the mentioned theme of Industrial orientation:

1. Biopharmaceuticals & Drug Manufacturing
   - GMP (Good Manufacturing Practices) in Biopharma
   - Upstream & Downstream Bioprocessing
   - Quality Control & Assurance in Drug Production
   - Monoclonal Antibody Production & Purification
   - Recombinant Protein Expression & Therapeutic Development

2. Fermentation Technology & Industrial Enzymes
   - Large-Scale Fermentation & Bioreactor Operations
   - Enzyme Production & Optimization for Industrial Applications
   - Microbial Biotechnology for Sustainable Bio-Manufacturing

3. Nanotechnology & Targeted Drug Delivery
   - Nanocarriers and Liposomes for Drug Delivery
   - Polymer-Based Scaffolds for Tissue Engineering
   - Nano-Encapsulation for Controlled Drug Release
   - Nanosensors for Disease Detection & Monitoring

4. Food & Agricultural Biotechnology
   - Probiotics, Prebiotics & Functional Foods
   - Plant Tissue Culture & Genetic Modification Techniques
   - Biotechnology in Crop Improvement & Stress Resistance
   - Microbial Biotechnology for Soil Health & Biofertilizers.

5. Environmental & Industrial Biotechnology
   - Bioremediation & Wastewater Treatment Technologies

- Biofuel Production & Sustainable Biotechnology
- Microbial Fuel Cells & Bioconversion Processes
- Biosensors for Environmental Monitoring & Pollution Control

6. Vaccine Development & Immunobiotechnology
   - Vaccine Formulation & Antigen Development
   - mRNA-Based Vaccines & Future Innovations
   - Clinical & Preclinical Validation of Vaccines
   - Regulatory & Quality Control Aspects in Vaccine Production

7. Medical Biotechnology & Diagnostics
   - Molecular Diagnostics & Biomarker Discovery
   - PCR, ELISA, and Next-Generation Sequencing in Diagnostics
   - Point-of-Care Diagnostic Technologies
   - Stem Cell Research & Regenerative Medicine

8. Computational Biology & AI in Drug Discovery
   - Machine Learning for Drug Target Identification
   - In-Silico Screening & Molecular Docking Simulations
   - Bioinformatics & Systems Biology for Disease Modeling
   - Computational Approaches in Precision Medicine

9. Antibody Engineering & Biologics
   - Hybridoma Technology for Monoclonal Antibody Production
   - Recombinant Antibody Engineering & Therapeutics
   - Biosimilar Development & Biopharmaceutical Regulations

10. Pharmaceutical Research & Preclinical Validation
    - Preclinical Drug Screening & Toxicology Studies
    - Pharmacokinetics & Pharmacodynamics Analysis
    - Regulatory Compliance & Clinical Trials
    - Personalized Medicine & Drug Repurposing Strategies

Outcomes will be assessed on a scale of 100 marks.

Presentation & Screening Format:

- Each student will present before a panel of faculty and industry representatives.
- **Evaluation Criteria for Presentation:**
  - Clarity of content and technical knowledge
  - Ability to articulate industrial learning
  - Handling of Q&A session by the panel
  - Professionalism in communication

Assessment Criteria's

The assessment of the Industry Orientation program will be based on four key components. Industry attendance and supervisor feedback will evaluate student engagement, punctuality, and teamwork as observed by industry mentors. Project report submission will assess the detailed documentation of industry work, methodologies, and learning outcomes. Technical presentation and viva will measure the student's ability to present key findings before a faculty and industry expert panel. Lastly, professional skills and committee review will focus on critical thinking, problem-solving, and communication skills demonstrated during discussions with the evaluation panel.

COURSE OUTCOMES

On completion of the Industrial orientation, students will be able to

CO1: Demonstrate an understanding of biopharmaceutical manufacturing processes, including GMP standards, monoclonal antibody production, recombinant protein expression, and quality control in drug development.

CO2: Analyze the principles and applications of fermentation technology and industrial enzyme production, focusing on large-scale bioprocessing, microbial biotechnology, and process optimization.

CO3: Evaluate nanotechnology-based drug delivery systems, such as nanocarriers, polymer scaffolds, and nanosensors, for biomedical and pharmaceutical applications.

CO4: Apply knowledge of food, agricultural, and environmental biotechnology to real-world challenges, including plant tissue culture, probiotic development, bioremediation, and biofuel production.

CO5: Investigate the latest advancements in vaccine development, immunobiotechnology, and medical diagnostics, understanding their role in disease prevention, molecular diagnostics, and regenerative medicine.

CO6: Utilize computational biology and AI tools for drug discovery, molecular docking, bioinformatics analysis, and personalized medicine applications, integrating technology with biotechnology research.

Semester – VII

Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
PC	23BIO401T	Bioethics, IPR and Biosafety	3	0	0	3	3
PC	23BIO402T	Nanotechnology	3	0	0	3	3
PC Lab	23BIO402P	Nanotechnology - Lab.	0	0	2	2	1
PC	23BIO403T	Downstream Processing	3	0	0	3	3
PC Lab	23BIO403P	Down Stream Processing - Lab.	0	0	2	2	1
CE	23BIO404T	Pharmaceutical Biotechnology	3	0	0	3	3
CE	23BIO405T	Synthetic and Systems Biology					
CE	23BIO406T	Metabolic Engineering					
CE	23BIO407T	Biomass Conversion and Utilisation	3	0	0	3	3
CE	23BIO408T	Stem Cell Technology					
CE	23BIO409T	Molecular Data Analysis and Simulations					
Project	20TP410	Mini Project	0	0	6	6	3
		Total	15	0	10	25	20

23BIO401T					Bioethics, IPR and Biosafety					
Teaching Scheme					Examination Scheme					
					Theory			Practical		Total
L	T	P	C	Hrs./Week	MS	ES	IA	LW	LE/VIVA	Marks
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
2. To make students aware about current trends in IPR and Govt. supports in promoting IPR
3. To classify the role of regulatory committees in controlling the risk.
4. To Explore the Role of Intellectual Property in Innovation and Entrepreneurship
5. To Examine Ethical Considerations in Biotechnology Research

UNIT – 1 INTELLECTUAL PROPERTY RIGHTS 10Hrs

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India: Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights. Plagiarism; Citation and acknowledgement

UNIT – 2 PATENT RIGHTS 10 Hrs

Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence. DESIGN- Meaning, Definition, Object, Registration of Design. TRADE MARKS— Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks.

UNIT – 3 BIOETHICS 10Hrs

Institutional Biosafety Committee, Institutional Animal ethics committee, Institutional review board, Human Genome project and ethical issues, Animal cloning, human cloning and their ethical issues, Experimentation on animals, Hazardous materials used in biotechnology, their handling and disposal.

UNIT 4– BIOSAFETY 10Hrs

Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Safety in genetic and tissue engineering research; GMOs & LMOs; protocol of drug administration dosage and radiation dosage. Social and ethical implications of biological weapons.

Max. 40 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to;

CO1: The students shall get an adequate knowledge on patent, Trademark and copyright. This provides further way for developing their idea or innovations

CO2: Identify the role of significance of patent rights

CO3: Students should get enough information on ethical issues linked to research on animal models, transgenic, clinical trials

CO4: Get acquainted with Intellectual Property (IP) and Regulatory affairs as a career option.

CO5: Understand the basics about biosafety

CO6: Evaluating the ethical dilemmas associated with animal experimentation, genetic engineering, and bioprospecting

TEXT/REFERENCE BOOKS

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3. V Sreekrishna, 2017. Bioethics and Biosafety in Biotechnology by New Age International publishers.
4. Goel D, "IPR, Bio safety and Bioethics", Pearson Education, 2013.

23BIO402T					Nanotechnology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	IA	ES	LW	LE/VIVA	
3	0	0	3	3	25	25	50	-	-	100

COURSE OBJECTIVES

1. To understand the fundamentals of Nanotechnology.
2. Explain the nanoscale paradigm in terms of properties at the Nano scale dimension. Identify current nanotechnology solutions in design, engineering and manufacturing.
3. To understand and learn about the applications of nanoscale materials and the application of the principles of Nano chemistry in real world problems.

UNIT I INTRODUCTION 10Hrs

Introduction and History of Nanotechnology, Nano-materials and their properties: physical, chemical and biological properties from their constituent atoms or molecules and from the bulk materials. Case studies demonstrating non-classical behavior at nanoscale in successful and emergent nanotechnologies.

Unit –II SYNTHESIS 10Hrs

Synthesis of nano materials, bottom-up approach: self-assembly and self-organization, vapor phase deposition, plasma assisted deposition processes, colloidal, sol-gel, or simple pyrolysis, top-down approach: miniaturization of smaller structures from larger ones like milling, lithography, machining will be presented with suitable examples.

Unit III CHARACTERIZATION 10Hrs

Detailed characterization technique based on radiation matter interactions and their analytical applications like Transmission electron microscope (TEM), Scanning electron microscope (SEM), Atomic force microscope (AFM), scanning tunneling microscope (STM), Dynamic light scattering (DLS), Spectroscopy. The safety and storage issues and the impact of nanotechnology on the environment will be stressed at the end.

Unit-IV APPLICATIONS OF NANOSCALE MATERIALS 10Hrs

Applications of Nanoscale materials: Catalysis, Sensing, Energy storage, Environmental remediation, etc.; Energy Conversion and Storage (solar cells, Fuel Cells, Li/Na-ion Batteries); Nanoscale materials for waste reduction and improved energy efficiency, nanotechnology-based water treatment strategies. Nano sensors and Devices.

Max. 40 Hr.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: - Tell the basics of Nanotechnology along with properties. CO2:

- Explain the chemical methods for synthesis of nanoparticles.

CO3: - Develop various nanomaterials and basic understanding in the relevant analytical techniques.

CO4: - Categorize the various techniques for nano-materials characterization.

CO5: - Explain the physical methods for synthesis of nanoparticles.

CO6: - Discuss the different applications of nano scale materials.

TEXT/REFERENCE BOOKS

1. "Nanostructures and Nanomaterials: Synthesis, Properties and Applications" by Cao G, 2011
2. "Carbon Nanotubes – Basic Concepts and Physical Properties" by Reich S and Maultzsch J, 2008
3. "Introduction to Nanoscience and Nanotechnology" by Chattopadhyay K K, 2009
4. "Introduction to Nanoscience and Nanotechnology" by Gabor L Hornyak and H F Tibbals, 2008
5. "Nanotechnology: Principles and Practices" by Sulabha K Kulkarni, 2014
6. "Introduction to Nanoscience" by Gabor L Hornyak and Joydeep Dutta, 2008

23BIO402P	Nanotechnology lab

Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To understand physical methods for synthesis of nanoparticles.
2. To understand the limitations of the synthesis techniques.
3. To understand various advancement in Techniques for synthesis at nanoscale.
4. To understand the use of nanotechnology in Energy Storage.

LIST OF EXPERIMENTS

1. Ball milling route for making nanoparticles and particle size distribution estimation.
2. Sol-gel synthesis and characterization of CdS nanocrystals.
3. Preparation and characterization of ZnO nanoparticles embedded in silica matrix
4. Microwave-assisted synthesis of ZnO nanoparticles.
5. Eco-Friendly Bio-Chemical synthesis of nanomaterials.
6. Synthesis and Characterization of carbon nanotubes by cracking of gas mixture
7. Physical vapor deposition and chemical vapor deposition techniques for thin film deposition.
8. Fabrication of suitable structures on thin films for device applications.
9. To investigate refluxing and distillation techniques for the synthesis of II-VI ceramic nanostructures.
10. To study the solvo thermal synthesis method of nanoparticles

COURSE OUTCOMES

On completion of the course, students will be able to

CO1:- Explain the basics of nanotechnology along with its properties. CO2:- Explain the chemical methods for the synthesis of nanoparticles.
CO3: Develop various nanomaterials with relevant analytical techniques.
CO4: Categorize the various techniques for nanomaterial characterization.
CO5:- Explain the physical methods for the synthesis of nanoparticles.
CO6:- Discuss the use of nanotechnology in Energy Storage.

TEXT/REFERENCE BOOKS

1. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Guozhong Cao and Ying Wang, 2011
2. Introduction to Nanoscience and Nanotechnology by Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, 2008

23BIO403T					Downstream Processing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To apply the fundamental concepts of bio-separation engineering.
2. To learn and design downstream processing for product isolation and purification.
3. To recognize and troubleshoot problems associated with purification of bio products.

UNIT I: Introduction to schematics of downstream processing 10Hr.

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. Cell disruption techniques: Mechanical and Non-mechanical methods of cell disruption, Mechanical Cell disruption methods Cell disruption kinetics for a bead mill

and high-pressure homogenizer.

UNIT II: SEPARATION 12 Hr.

Flocculation and sedimentation, Centrifugation-differential and density gradient. Filtration: incompressible and compressible cakes, Pre-treatment of fermentation broth, Filter media and equipment for batch and continuous Filtration. Membrane separation processes: Basic principles and advantages, Modes of operation, Pressure-driven processes (MF, UF, NF & RO), Concentration-driven processes (Dialysis &Pervaporation), and Electrically-driven processes (Electro dialysis); Applications of the different types of membrane separation processes. Chromatographic separation processes.

UNIT III: EXTRACTION AND PRECIPITATION 12 Hr.

Extraction processes - solvent extraction principles, operating modes of extraction, Extraction of biomolecules by aqueous –aqueous, aqueous two-phase, reverse micellar, and supercritical fluid extraction. Colloidal stability of protein solutions, precipitation of biomolecules by isoelectric, salting out, organic solvent, non-ionic polymers, Poly- electrolyte addition and selective denaturation of unwanted proteins.

UNIT IV: FINISHING OPERATIONS 8 Hr.

Crystallization, Drying, Lyophilization and Formulation, Industrial-scale Crystallizers and Dryers

Max. 42 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Assess the significance of downstream processing in a bio- product separation

CO2: Apply the knowledge of unit operations for the separation of insoluble from fermentation broth

CO3 Propose and design recovery and purification of biomolecules by applying concepts of mass transfer operation.

CO4: Examine skills needed to function in modern bio separation engineering.

CO5: Design and demonstrate adsorption and chromatography processes for the purification of bio molecules.

CO6: Demonstrate the skills and techniques to design a process for product purification.

TEXT/REFERENCE BOOKS

1. Bioseparations - Principles and techniques, B. Sivasankar, Prentice Hall of India, N Delhi, 2005, pp 280
2. Product recovery in Bioprocess technology (1992) Butterworth- Heinemann, Biotol series.
3. Mukesh D, Gaikar V and Anil Kumar Biotransformation's& Bioprocesses, Marcell Dekker, New york,(2004).

23BIO403P					Downstream processing lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	0	0	0	50	50	100

COURSE OBJECTIVES

1. Learn Basic Extraction and Purification of Biomolecules
2. Implement Diverse Separation Strategies
3. Extract and Isolate Natural Pigments
4. Employ Adsorption Techniques for Sample Enrichment

List of experiments

1. A: Partial purification of intracellular/ extracellular products from microbial /plant source - Extraction of intracellular metabolites by cell lysis.
2. Concentrating the intracellular extract by membrane filtration.

3. Separation of proteins based on the solubility by precipitation using salt.
4. Removal of salt from the protein solution and buffer exchange by dialysis
5. B: Isolation of carbohydrate digesting enzymes from cereal kernels – Drying ; milling and solid-liquid (aqueous) extraction
6. Separation of proteins using liquid-liquid extraction – Aqueous two phase / reverse micellar process
7. Separation of metabolites based on molecular mass - gel filtration
8. Separation of pigments from selected flowers -Use of organic solvent extraction for separating the metabolites
9. Use of adsorption as the sample enrichment aid

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: Perform partial purification of intracellular/extracellular products from microbial or plant sources.

CO2: Utilize membrane filtration to concentrate intracellular extracts.

CO3: Apply salt precipitation techniques to separate proteins based on solubility.

CO4: Perform dialysis for salt removal and buffer exchange of protein solutions.

CO5: Isolate carbohydrate-digesting enzymes from cereal kernels using drying, milling, and aqueous extraction.

CO6: Implement liquid-liquid extraction (aqueous two-phase or reverse micellar) for protein separation.

CO7: Utilize gel filtration chromatography to separate metabolites according to molecular mass.

CO8: Employ organic solvent extraction to isolate pigments from selected flowers.

CO9: Apply adsorption techniques for sample enrichment and purification.

TEXT/REFERENCE BOOKS

1. Bioseparations - Principles and techniques, B. Sivasankar, Prentice Hall of India, N Delhi, 2005, pp 280.

23BIO406T					**Metabolic Engineering**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hours/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	**0**	**0**	**3**	**3**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

1. Analyze Mechanisms of Metabolic Control
2. Evaluate Strategies for Enhancing Primary Metabolite Production
3. Understand the Regulation of Secondary Metabolite Biosynthesis
4. Design and Analyze Bioconversion Strategies

UNIT I: Introduction **12Hr.**

Induction-Jacob Monod Model, catabolite regulation, glucose effect, camp deficiency, feed back regulation, regulation in branched pathways, differential regulation by isoenzymes, concerted feed back regulation, cumulative feed back regulation, amino acid regulation of RNA synthesis, energy charge, permeability control passive diffusion, facilitated diffusion, active transport group transportation.

UNIT II: SYNTHESIS OF PRIMARY METABOLITES **10 Hr.**

Alteration of feed back regulation, limiting accumulation of end products, feed back, resistant

mutants, alteration of permeability.

UNIT III: BIOSYNTHESIS OF SECONDARY METABOLITES **8 Hr.**

Precursor effects, prophophase, idiophase relationships, enzyme induction, feed back regulation, catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites.

UNIT IV: BIOCONVERSIONS **10 Hr.**

Advantages of Bioconversions, specificity, yields, factors important to bioconversions, regulation of enzyme synthesis, mutation, permeability, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances.

Max. 40 Hr.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: Explain the Mechanisms of Gene Regulation
CO2: Analyze the Regulation of Metabolic Pathways
CO3: Strategies for Manipulating Primary Metabolite Synthesis
CO4: Understand the Biosynthesis of Secondary Metabolites
CO5: Analyze the Principles of Bioconversions
CO6: Apply Knowledge to Design Bioconversion Strategies

TEXT/REFERENCE BOOKS

1. Wang D. I. C., Cooney C. L., Demain A. L., Dunnil P., Humphrey A. E., Lilly M. D., Fermentation and Enzyme Technology, John Wiles and Sons., 1980.
2. Stanbury P. F. and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.
3. Zubay G., Biochemistry, Macmillan Publishers, 1989.

23BIO407T					**Biomass Conversion and Utilization**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	0	**0**	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. This course will enable students to learn types of biomass
2. To apply the concepts in the production and utilisation of biodiesel
3. To differentiate the various biomass conversions procedures
4. To introduce the energy conversion technologies related to biomass
5. To familiarize the properties of biomass and its energy products
6. To analyze the feasibility of power production from biomass sources

UNIT 1 Biomass – Energy Source **10Hrs.**

Introduction: Types of biomass, advantages and dis advantages in use of biomass as energy, sources of biomass, current biomass applications and trends, Biological – Thermal – Chemical – Hybrid conversions – Application of biomass conversion.

UNIT 2 Thermal and Chemical conversion **10Hrs.**

Thermo chemical conversion: Combustion, gasification, pyrolysis, hydrothermal liquefaction, hydropyrolysis, torrefaction, choice of thermal process based on biomass type and product requirement. Economics of thermo chemical conversion.

UNIT 3 Biological Conversion 12Hrs.

Biodegradation and biodegradability of substrate - Biochemistry and process parameters of biomethanation - Biogas digester types - Digester design and biogas utilization. Biomethanation Process - Economics of biogas plant with their environmental and social impacts - Bioconversion of substrates into alcohol - Methanol & ethanol Production - Organic acids – Solvents - Amino acids - Antibiotics etc

UNIT 4 Biodiesel and Biomass gasification 12Hrs.

Biomass gasification – chemistry – types of gasifiers – gasifier design : TDR, throughput, A/F ratio and equivalence ratio calculations – advanced gasification – fluidized bed gasifier – component design – cold fluidization tests – Electrical power production – Biomass combustion – types of combustors – Co-combustion and Co-firing – applications – Eutectic point of biomass ash. Chemical Conversion: Hydrolysis & hydrogenation - Solvent extraction of hydrocarbons - Solvolysis of wood - Biocrude and biodiesel - Chemicals from biomass

COURSE OUTCOMES

CO1 – Demonstrate different types of biomass, advantages and limitations of bio mass,
CO2 - Explain thermo chemical conversion processes of biomass.
CO3 - Describe various biological conversion processes of bio mass.
CO4 - Discuss about chemical conversion processes of bio mass.
CO5 - Explain concepts of power generation using biomass.
CO6 – Analyze the sources and properties of bio mass
CO7 – Apply the biomass assessment techniques.

TEXT/REFERENCE BOOKS

1. DB Pal, P. Singh Utilization of Waste Biomass in Energy, Environmeent and Catalysis, CRC Press, 2022
2. NP Nghiem, TH Kim, CG Yoo. Biomass utilization Conversion Strategies Springer, 2023.
3. Erik Dahlquist, Biomass as Energy Source: Resources, systems and applications, Sustainable Energy Developments series, 2013, CRC Press, Taylor and Francis Group.
4. D.P.Kothari, K.C Singal and Rakesh Ranjan “Renewable Energy Sources And Emerging Technologies”, 2011, PHI Learning Private Ltd, New Delhi.

23BIO408T					Stem Cell Technology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/VIVA	
3	0	0	3	3	25	50	25	-	-	100

COURSE OBJECTIVES

1. To impart knowledge of wide-ranging topics related to stem cells and regenerative biology, including a brief history of the field
2. To impart, research on animal models of regeneration, tissue engineering, social and ethical issues related to stem cell research.
3. To Explore the Interdisciplinary Nature of Stem Cell Research
4. To Foster Critical Analysis of Stem Cell Research Methods and Applications

UNIT – 1 Introduction to Stem Cells and Stem Cell Niche 10Hrs

Principles and properties of stem cells, types of stem cells, comparison of embryonic and adult stem cells. Introduction to stem cell niches in gut epithelium, bone marrow, epidermis, testis, and neural tissues

UNIT – 2 Cell Cycle and Development & Epigenetic Control 10Hrs

Cell cycle regulators and checkpoints, cell fusion, differentiation of stem cells and their role in self-renewal DNA-methylation and histone modifications, genomic imprinting, telomerase regulation, X-chromosome inactivation, reprogramming of cells, induced

UNIT – 3 Types and Regeneration 10Hrs

Early asymmetric division and generation of symmetry in developing embryo in animals and plants; organogenesis and morphogenesis, metamorphosis, animal life cycle, sex determination and role of apoptosis in organ development; Role of morphogens and their gradient in axis patterning and determination. Concept of anteroposterior, dorso-ventral, and medio-lateral axis formation

UNIT – 4 Therapeutic applications of stem cells and ethical issues 10Hrs

Gene Therapy: Introduction, History and evolution of Gene therapy, optimal disease targets, Failures and successes with gene therapy and future prospects, Genetic Perspectives for Gene Therapy, Gene Delivery methods: Viral vectors and Non-viral Vectors, Regulatory and Ethical Considerations of stem cell and Gene Therapy, Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies.

Max. 40Hrs

COURSE OUTCOMES

On completion of the course, student will be able to;

CO1: Gain fundamental knowledge on developmental biology of plant and animals.

CO2: Understand the biology of Cell cycle regulators

CO3: Classify and compare the animals and plants; organogenesis and morphogenesis

CO4: Get acquainted with techniques on Stem Cell isolation

CO5: Focus on applications of stem cells.

CO6: Analyze experimental data and scientific literature in stem cell biology

TEXT/REFERENCE BOOKS

1. Hematopoietic Stem Cell Transplantation by Treleaven, J., first edition 2009.
2. Essentials of Stem Cell Biology by Lanza, R., second Edition, 2009 Academic Press.

3. Molecular Cell Biology by Lodish et al., sixth Ed., W.H. Freeman & Co. 2021.
4. Stem Cells: From Bench to Bedside by Bongso and Ariff. 2010
5. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer. 2006

23BIO409T					Molecular Data Analysis and Simulations					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Learn the critical relationship among bimolecular structure, function and force field models.

1. Gain the fundamental on drug/receptor interactions using *in silico* techniques.
2. Create interest in learning molecular mechanics, molecular dynamics simulations and homology modeling.
3. Understand the basic modeling techniques to explore biological phenomena at the molecular level.
4. Learn the concepts of energy minimisation and force fields.

UNIT 1 INTRODUCTION **10Hrs.**

Useful Concepts in Molecular Modelling, Coordinate Systems, Internal Coordinates, Potential Energy Surfaces, Molecular Graphics, Surfaces, Computer Hardware and Software, The Molecular Modelling Literature.

UNIT 2 FORCE FIELDS **10Hrs.**

Force Fields, Bond Stretching, Angle Bending, Torsional Terms, Introduction to Non-bonded Interactions: Electrostatic Interactions; Vander Waals Interactions, Hydrogen Bonding in Molecular Mechanics, Force Field Models for the Simulation of Liquid Water.

UNIT 3 MOLECULAR DYNAMICS AND MONTE CARLO SIMULATION **10Hrs.**

Molecular dynamics simulation methods, Constant temperature and pressure, Monte Carlo simulation of molecules, Models used in Monte Carlo simulations of polymers, Molecular modeling software: BIOSUITE and AMBER.

UNIT 4 ENERGY MINIMISATION AND COMPUTER SIMULATION **12Hrs.**

Energy minimization and related methods for exploring the energy surface, Non-Derivative methods and Derivative methods, 1st and 2nd order minimisation methods, Computer simulation methods, Simple thermodynamic properties and phase space, Boundaries, Analyzing the results of a simulation and estimating errors, GROMACS and DESMOND.

Max 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Classify the computer Aided Drug Design methods and predict drug like compounds.

CO2: Gain the fundamental practice of Molecular modeling and modern drug discovery.

CO3: Understand about the rational drug design, based on three-dimensional structures and physicochemical properties of drugs and receptors.

CO4: List different force fields and their optimization for drug design and simulations.

CO5: Focus professionally on energy minimization and computer simulation

CO6: Develop solution to enhance understanding for drug target interactions.

TEXT/REFERENCE BOOKS

1. Leach A.R. 2019. Molecular Modelling Principles and Application. 4th Edition. Pearson – Prentice Hall, New Delhi.
2. Satya P.G. 2020. QSAR and Molecular Modeling. Springer - Anamaya Pub, New Delhi.
3. Claude N. C. 2019. Molecular Modeling in Drug Design. Academic Press, California.
4. Kunal R. 2018. Advances in QSAR Modeling: Applications in Pharmaceutical, Chemical, Food, Agricultural and Environmental Sciences. Springer. ISBN 978-3-319-56849-2.

23BIO404T					**Pharmaceutical Biotechnology**					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs./Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/VIVA**	
3	**0**	**0**	**3**	**3**	**25**	**50**	**25**	**-**	**-**	**100**

COURSE OBJECTIVES

6. To understanding the importance pharmaceutical products.
7. To develop the skills necessary for employing pharmaceutical biotechnology principles.
8. To learn the significance of pharmaceutical preparation and method of production of Vaccines and protein based drugs
9. To evaluate the different regulations and strategy involved in the current and future biotechnology related products on the market.

UNIT I: PHARMACEUTICAL PREPARATIONS 12Hrs

Classification of Dosage forms I. Solid Dosage: Powders, Tablets, Capsules, and Granules. II. Semi solid Dosage: Creams, Gels, Ointment and Paste. III. Liquid Dosage: Monophasic (Syrups & Elixirs), Biphasic liquids: Suspension, Emulsion. IV. Gas Dosage: Aerosols. Different routes of drug administration: Oral, Parenteral, Dermal, Nasal, Ocular, Rectal and their merits & demerits. Types of impurities in pharmaceuticals, Analytical Techniques for Impurity Profiling, Role of stability studies in impurity profiling.

UNIT II: VACCINES 10Hrs

General method of the preparation of bacterial vaccines, viral vaccine, antitoxins. Screening of vaccines in animal models.

UNIT III: PHARMACOLOGY OF PROTEIN DRUGS 10 Hrs

Types of immunity and hypersensitivity reactions, Classification and Pharmacology of Immunosuppressant including Glucocorticoids, Calcineurin inhibitors, m-TOR inhibitors, IL-receptor antagonist and TNF inhibitors.

UNIT IV: PHARMACEUTICAL PRODUCT DEVELOPMENT 10Hrs

Biosensors-Types, Working and applications of biosensors in Pharmaceutical Industries. Pre-clinical studies: (Safety and Efficacy), Clinical studies (Phase I-IV), CDSCO- Regulatory requirements and approval, Drug distribution cycle.

Max.42 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to;

CO1: Demonstrate the challenges in the development of pharmaceutical products

CO2: Evaluate the biotechnology based pharmaceutical products and its screening methods

CO3: Analyze the scope and opportunities of different dosage forms and protein based drugs in treating different medical conditions in healthcare sectors.

CO4: Build the biotechnology applications in the pharmaceutical field

CO5: Illustrate the pharmacological mechanisms of protein based drugs

CO6: Develop and validate newer formulation and protein based drugs using modern biotechnology concepts

TEXT/REFERENCE BOOKS

1. R. S. Satoskar, S. D. Bhandarkar, Nirmala N. Rege," **Pharmacology and pharmacotherapeutics**", Popular Prakashan P. Ltd.- New Delhi.2014
2. Rang H. P., Dale M. M., Ritter J. M., Flower R. J, "**Rang and Dale's Pharmacology**",Churchil Livingstone Elsevier.2018
3. Katzung B. G., Masters S. B., Trevor A. J,"**Basic and clinical pharmacology"**, Tata Mc Graw-Hill.2008
4. K.D.Tripathi, "**Essentials of Medical Pharmacology**", JAYPEE Brothers Medical Publishers (P) Ltd, New Delhi.2008
5. Ashok Mulchandani and Kim Rogers, "**Enzyme and Microbial Biosensors: Techniques and Protocols**",Springer,1998.
6. Bjorn Knollmann, "**Goodman and Gilman's, The Pharmacological Basis of Therapeutics**", McGraw-Hill Education, 2005
7. Sharma H. L., Sharma K. K., "**Principles of Pharmacology**", Paras medical publisher.2021
8. Lachman Liebermans., "**The Theory and Practice of Industrial Pharmacy**", 4th Edition, CBS publisher (2020).
9. Loyd.V.Allen., " **Ansel's Pharmaceutical Dosage Form and Drug Delivery System**", 11th Edition, Wolters Kluwer India Pvt. Ltd publisher (2018).
10. Parthasarathi G, Karin Nyfort-Hansen, Milap C Nahata, "**A textbook of Clinical Pharmacy Practice- essential concepts and skills**, Orient Longman Private Limited publisher (2004).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hr.**

23BIO405T					Synthetic and Systems Biology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Learn the specific information of synthetic circuits
2. Gain the fundamental on the various models for modelling biological circuit.
3. Create interest in learning the tools and techniques used in network expression data analysis.
4. Learn the applications and scopes of genomics and proteomics research

UNIT 1 INTRODUCTION **12Hrs.**

Transcriptional and Post-transcriptional regulation: Biology & engineering systems, modeling foundation: Chemical kinetics (M-M equation and Hill function), Deterministic models, Stochastic models Spatiotemporal models. Noise in gene expression: Origin, propagation, consequences, and control, Robustness and evaluability of genetic networks, Bacterial circuits

UNIT 2 SYNTHETIC CIRCUITS **10Hrs.**

Genetic Circuits in Eukaryotes: How to build genetic circuits in yeast Logic gates in yeast Scale up to mammalian cells, Introduction to non-coding RNAs, ncRNAs Characteristics, biogenesis, and activities in cell physiology and developmental process, Application of ncRNAs on circuit designs Riboswitches ; microRNAs ; siRNAs.

UNIT 3 NETWORK BIOLOGY AND APPLICATIONS **10Hrs.**

Network biology and human diseases; Signal Transduction and Gene Networks; Protein–protein interaction networks. Gene regulatory networks (DNA–protein interaction networks); Gene co-expression networks (transcript–transcript association networks).

UNIT 4 METHOD AND SOFTWARE PLATFORM FOR SYSTEMS BIOLOGY **10 Hrs.**

SBML models and MATHSBML, Cell designer, Systematic detection of Biological Networks, Storing, Searching and Dissecting experimental proteomic data.

Max 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Classify the different biological circuits.

CO2: Gain the fundamental practice of non-coding RNAs.

CO3: Understand about the pipelines for cell based circuit designs and riboswitches.

CO4: List different genetic networks and expression networks.

CO5: Focus professionally on methods and platforms for synthetic and systems biology

CO6: Develop solution to enhance understanding for biological circuit and expression networks.

TEXT/REFERENCE BOOKS

1. Dokholyan, Nikolay, "Computational Modeling of Biological Systems: From Molecules to Pathways" Springer-Verlag New York, 2019
2. Klipp E Wolfran L, "System Biology: A Text Book" Wiley-VH Verlag Gmbh ,2018

3. Alon Uri, “Introduction to Systems Biology: Design Principles of Biology Circuits” Chapman & Hall/CRC/, 2020
4. JM Bower and H Bolouri, eds, “Computational modeling of genetic and biochemical networks”, MIT Press 2018
5. Fall, C.P., Marland, E.S., Wagner, J.M., Tyson, J.J, “Computational Cell Biology”, Springer, 2018.
6. Choi Sangdun, “Introduction to System Biology”, Humana Press/Trtowa/New Jersey, 2018.

20TP410					Mini Project					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	6	3	6	-	-	-	-	-	100

COURSE OBJECTIVES

1. Develop hands-on research skills by engaging students in independent mini-projects focused on emerging areas of biotechnology, including biopharmaceuticals, nanotechnology, computational biology, and environmental biotechnology.
2. Enhance problem-solving and technical competencies by allowing students to design, execute, and analyze experimental or computational studies relevant to industrial and research applications.
3. Strengthen teamwork, professional communication, and documentation abilities through collaborative research, project reports, and technical presentations.
4. Foster innovation and critical thinking by encouraging students to explore novel approaches in biotechnology, including process optimization, molecular modeling, biomaterials, and sustainable biomanufacturing.

The proposed research areas are outlined below; however, they are not limited to the specified themes.

Phase 1: Project Proposal and Planning

- Selection of research area and problem statement in consultation with faculty mentors.
- Literature survey and development of research objectives.
- Preparation of methodology and experimental design.
- Ethical considerations and biosafety compliance.

Phase 2: Experimental/Computational Work (Weeks 4-9)

Students will conduct hands-on or computational research in selected focus areas, including:

1. Biopharmaceuticals & Drug Development
    - Expression and purification of recombinant proteins
    - Formulation of nanoparticle-based drug delivery systems
    - Quality control and characterization of biomolecules
2. Fermentation & Industrial Biotechnology
    - Optimization of enzyme production
    - Fermentation-based production of bioactive compounds
    - Microbial metabolic engineering for biofuels and probiotics
3. Nanotechnology & Targeted Therapy
    - Development of nanocarriers for controlled drug release
    - Fabrication of polymer-based scaffolds for tissue engineering
    - Biosensor development for disease detection
4. Environmental & Agricultural Biotechnology
    - Bioremediation of pollutants using microbial consortia
    - Development of biofertilizers and plant growth promoters
    - Tissue culture and genetic modification for plant resilience
5. Medical & Computational Biotechnology

- In-silico screening and molecular docking studies
- AI and machine learning models for drug discovery
- PCR-based diagnostics and biomarker discovery

Phase 3: Data Analysis, Report Writing & Presentation (Weeks 10-12)

- Data interpretation and statistical validation of experimental results.
- Preparation of a comprehensive research report detailing objectives, methodology, results, and conclusions.
- Final presentation and defense of findings before a faculty panel.

The project will be evaluated for **100 marks.**

Presentation & Screening Format:

- Each student will present before a panel of faculty and industry representatives.
- **Evaluation Criteria for Presentation:**
  - Clarity of content and technical knowledge
  - Ability to articulate industrial learning
  - Handling of Q&A session by the panel
  - Professionalism in communication

Assessment Criteria's

The assessment of the mini-project will be based on multiple key components. The **project proposal and research design** will evaluate the clarity of research objectives, methodology, and problem statement. **Experimental or computational execution** will assess the student's ability to conduct hands-on work, troubleshoot challenges, and follow research protocols. **Data analysis and interpretation** will focus on accuracy, logical reasoning, and the application of appropriate analytical tools. **Final report submission** will be judged on the quality of documentation, technical writing, and coherence of findings. Lastly, **oral presentation and defense** will evaluate the student's ability to effectively communicate their research, respond to questions, and demonstrate professionalism.

COURSE OUTCOMES

On completion of the mini project, students will be able to

CO1: Design and execute a small-scale research or industrial problem-solving project, applying theoretical knowledge to practical applications.
CO2: Develop and optimize experimental or computational protocols, utilizing appropriate laboratory techniques, bioinformatics tools, or process design methodologies.
CO3: Analyze and interpret data using statistical, computational, or experimental approaches, demonstrating critical thinking and problem-solving skills.
CO4: Effectively communicate research findings through technical reports, research posters, or oral presentations, fostering scientific documentation skills.
CO5: Demonstrate teamwork, leadership, and project management abilities by collaborating effectively in a group setting.
CO6: Evaluate the relevance of their research findings in biotechnology industries, healthcare, agriculture, or environmental applications, identifying future research directions.

Semester – VIII

Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs.	Credits
Project	20TP422	Major Project Internship with Industry	0	0	26	26	13

20TP422					Major Project Internship with industry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	26	13	26	-	-	-	50	50	100

COURSE OBJECTIVES

1. To design and execute independent biotechnology research projects
2. To demonstrate effective scientific communication skills in both written and oral formats
3. To critically evaluate the potential of biotechnology to address global challenges in healthcare, agriculture, and industry.
4. To master laboratory techniques essential for biotechnology research

1. Medical Biotechnology:

- Drug development and discovery: Identify new drug targets, develop novel therapeutics (small molecules, antibodies, gene therapies) for diseases, and optimize drug delivery systems.
- Diagnostics: Use tools like PCR, biosensors, and next-generation sequencing to design rapid and sensitive diagnostics for infectious diseases, cancers, and genetic disorders.
- Regenerative medicine: Focus on tissue engineering, stem cell therapies, and biomaterial development for repairing or replacing damaged organs and tissues.
- Personalized medicine: Use genomics, proteomics, and bioinformatics to tailor diagnosis and treatment strategies to an individual's genetic makeup.

2. Bioinformatics:

- Molecular Modelling and Drug Design: Focuses on using machine learning and deep learning algorithms to predict the three-dimensional structure of proteins, vital for understanding protein function and advancing drug design.
- Disease Association Studies: Targets the identification of genetic variants linked to diseases by analyzing large-scale genomic data, aiming to uncover the genetic basis of complex diseases and improve diagnostics and therapies.
- Multi-Omics Integration: Involves integrating genomics, transcriptomics, proteomics, and other 'omics' data to gain a comprehensive understanding of biological systems, aiding in the discovery of new biomarkers and therapeutic targets.
- Computational Systems Biology: Modeling and simulating biological systems using mathematical modeling, network analysis, and high-throughput data to decipher the mechanisms of biological processes and pathways.

3. Agricultural Biotechnology:

- Crop improvement: Enhance crop yields, stress tolerance (drought, salinity), and nutritional value of crops through genetic engineering or CRISPR-based gene editing.
- Pest and disease management: Develop bio pesticides and disease-resistant crops to reduce reliance on chemical inputs.
- Sustainable agriculture: Use microbes for nutrient optimization, study plant-microbe interactions, and develop strategies to improve soil health.

4. Industrial Biotechnology:

- Biofuel production: Develop microbial systems for converting biomass into bioethanol, biodiesel, and other biofuels.
- Bioremediation: Harness the power of microbes or enzymes to clean up contaminated environments (oil spills, polluted water).
- Bio-based materials production: Create sustainable alternatives to plastics, textiles, and other materials using bio-resources.

5. **Environmental Biotechnology:**
    - Wastewater treatment: Design innovative microbial systems for effective treatment of industrial and municipal wastewater.
    - Biomonitoring: Biosensors and microorganisms are used to assess environmental quality and detect pollutants.
    - Biodiversity conservation: Apply biotechnology tools for analyzing species diversity and developing conservation strategies.

Additional Research Areas

- Food Biotechnology: Improving food safety, preservation, nutritional value, flavor profiles, waste reduction
- Marine Biotechnology: Exploring marine organisms and their bioactive compounds for pharmaceutical and industrial applications and understanding ocean ecosystems.
- Forensic Biotechnology: Using DNA analysis and other biotechnological tools in criminal investigations.