PANDIT DEENDAYAL ENERGY UNIVERSITY

B.Tech Biotechnology

Department of Biotechnology

School of Energy Technology

Curriculum 2024-2028

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.

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

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.

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

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 – Batch 2024-2028

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester I	BSC	24MA102T	Mathematics for Biotechnology - I	3	1	0	4	4
	BSC	24PH103T	Modern Physics	3	0	0	3	3
	BSC	24PH103P	Modern Physics Laboratory	0	0	2	2	1
	BSC	24BT102T	Biology for Engineers	2	0	0	2	2
	BSC	24CV101T	Environmental Science	2	0	0	2	2
	ESC	24CP101T	Computer Programming - I	1	0	0	1	1
	ESC	24CP101P	Computer Programming - I Laboratory	0	0	2	2	1
	ESC	24ME101T	Workshop Practices	0	0	2	2	1
	ESC	24ME102T	Engineering Graphics	0	0	4	4	2
	HSC	24HS101T	English Communication	2	0	0	2	2
	HSC	24HS102T	Universal Human Values	1	0	0	1	1
			Total	**14**	**1**	**10**	**25**	**20**

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester II	BSC	24MA104T	Mathematics for Biotechnology - II	3	1	0	4	4
	BSC	24CH101T	Engineering Chemistry	3	0	0	3	3
	BSC	24CH101P	Engineering Chemistry Laboratory	0	0	2	2	1
	ESC	24CP102T	Computer Programming - II	1	0	0	1	1
	ESC	24CP102P	Computer Programming - II Laboratory	0	0	2	2	1
	ESC	24EE101T	Elements of Electrical and Electronics Engineering	3	0	0	3	3
	ESC	24EE101P	Elements of Electrical and Electronics Engineering Laboratory	0	0	2	2	1
	HSC	24HS103T	Indian Knowledge System	2	0	0	2	2
	HSC	24HS104T	Organizational Behaviour	1	0	0	1	1
	HSC	24HS105T	Professional Communication	2	0	0	2	2
	HSC	24YOG101	Yoga, Health and Hygiene	0	0	2	2	1
		24NSS101	National Service Scheme (NSS)					
		24NCC101	National Cadet Corps (NCC)					
			Total	**15**	**1**	**8**	**24**	**20**

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester III	PRO	24INT151	Civic and Social Service Internship	0	0	0	0	1
	BSC	24BT201T	Biophysics and Structural Biology	3	1	0	4	4
	ESC	24BT202T	Introduction to Artificial Intelligence	3	0	0	3	3
	PC	24BT203T	Principles of Biochemistry	3	0	0	3	3
	PC	24BT203P	Principles of Biochemistry Laboratory	0	0	2	2	1
	PC	24BT204T	Human Anatomy and Physiology - I	3	0	0	3	3
	PC	24BT204P	Human Anatomy and Physiology - I Laboratory	0	0	2	2	1

	PC	24BT205T	General Microbiology	3	0	0	3	3
	PC	24BT205P	General Microbiology Laboratory	0	0	2	2	1
			Total	**15**	**1**	**6**	**22**	**20**
Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester IV	ESC	24BT206T	Industry 4.0	2	0	0	2	2
	ESC	24BT206P	Industry 4.0 Laboratory	0	0	2	2	1
	PC	24BT207T	Molecular Biology and Genetics	3	0	0	3	3
	PC	24BT207P	Molecular Biology and Genetics Laboratory	0	0	2	2	1
	PC	24BT208T	Bioprocess Engineering	3	0	0	3	3
	PC	24BT208P	Bioprocess Engineering Laboratory	0	0	2	2	1
	PC	24BT209T	Human Anatomy and Physiology - II	3	0	0	3	3
	PC	24BT209P	Human Anatomy and Physiology - II Laboratory	0	0	2	2	1
	PC	24BT210T	Analytical Bioinformatics	3	0	0	3	3
	PC	24BT210P	Analytical Bioinformatics Laboratory	0	0	2	2	1
	OE	24BT221T	Biomedical Informatics	3	0	0	3	3
	PRO	24INT251	Industrial Orientation	0	0	0	0	0
			Total	**17**	**0**	**10**	**27**	**22**
Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester V	OE	MOOC	NPTEL / SWAYAM / MOOC Course	3	0	0	3	3
	HSC	24HS301T	Engineering Economics	3	0	0	3	3
	PE	24BT331T	Medical Diagnostics	3	0	0	3	3
		24BT332T	Green Biotechnology and Pollution Abatement					
		24BT333T	Computer Aided Drug Design					
	PC	24BT301T	Genomics and Proteomics	3	0	0	3	3
	PC	24BT301P	Genomics and Proteomics Laboratory	0	0	2	2	1
	PC	24BT302T	Immunology and Immunotechnology	3	0	0	3	3
	PC	24BT302P	Immunology and Immunotechnology Laboratory	0	0	2	2	1
	PC	24BT303T	Animal and Plant Biotechnology	3	0	0	3	3
	PC	24BT303P	Animal and Plant Biotechnology Laboratory	0	0	2	2	1
			Total	**18**	**0**	**6**	**24**	**21**
Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester VI	OE	24BT321T	Molecular Diagnostics	3	0	0	3	3
	PE	24BT334T	Biomaterial and Implants	3	0	0	3	3
		24BT335T	Novel Separation Processes - Dyes and Pigments					
		24BT336T	Cheminformatics and Medicinal Chemistry					
	PE	24BT337T	Pharmacokinetics and Pharmaco Dynamics	3	0	0	3	3
		24BT338T	Food Biotechnology					

		24BT339T	Next Generation Sequence Analysis					
	PC	24BT304T	Genetic Engineering Techniques	3	0	0	3	3
	PC	24BT304P	Genetic Engineering Techniques Laboratory	0	0	2	2	1
	PC	24BT305T	Tissue Engineering and Regenerative Medicine	3	0	0	3	3
	PC	24BT305P	Tissue Engineering and Regenerative Medicine Laboratory	0	0	2	2	1
	PC	24BT306T	Pharmacology of Drug Action	3	0	0	3	3
	PC	24BT306P	Pharmacology of Drug Action Laboratory	0	0	2	2	1
			Total	**18**	**0**	**6**	**24**	**21**
Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester VII	PRO	24INT451	Summer Internship	0	0	0	0	2
	OE	24BT421T	Biosimilars Technology	3	0	0	3	3
	PE	24BT431T	Pharmaceutical Biotechnology	3	0	0	3	3
		24BT432T	Synthetic and Systems Biology					
		24BT433T	Metabolic Engineering					
	PE	24BT434T	Biomass Conversion and Utilisation	3	0	0	3	3
		24BT435T	Stem Cell Technology					
		24BT436T	Molecular Data Analysis and Simulations					
	PC	24BT401T	Bioethics, IPR and Biosafety	4	0	0	4	4
	PC	24BT402T	Nanotechnology	3	0	0	3	3
	PC	24BT402P	Nanotechnology Laboratory	0	0	2	2	1
	PC	24BT403T	Downstream Processing	3	0	0	3	3
	PC	24BT403P	Downstream Processing Laboratory	0	0	2	2	1
	PRO	24PRBT451	Seminar					1
			Total	**19**	**0**	**4**	**23**	**24**
Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester VIII	PRO	24PRBT452	Major Project	0	0	24	24	12
		24PRBT453	Comprehensive Project					
			Total	**0**	**0**	**24**	**24**	**12**
			Final Total	**116**	**3**	**74**	**193**	**160**

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	PRO	Project work, Seminar or Internship in Industry or elsewhere
9	NC	Non-Credit course

Department of Biotechnology, School of Energy Technology

B.Tech Biotechnology

Course Matrix for Semester – I (Batch 2024-2028)

Sem.	Category Code	Course Code	Course Name	Th	Tut	Pra	Hrs	Cr
I	HSC	24HS101T	English Communication	2	0	0	2	2
	BSC	24MA102T	Mathematics for Biotechnology – I	3	1	0	4	4
	ESC	24CP101T	Computer Programming – I	1	0	0	1	1
	ESC	24CP101P	Computer Programming Laboratory – I	0	0	2	2	1
	BSC	24PH103T	Modern Physics	3	0	0	3	3
	BSC	24PH103P	Modern Physics Laboratory	0	0	2	2	1
	BSC	24CV101T	Environmental Science	2	0	0	2	2
	ESC	24ME101P	Workshop Practices	0	0	2	2	1
	ESC	24ME102P	Engineering Graphics	0	0	4	4	2
	HSC	24HS102T	Universal Human Values	1	0	0	1	1
	BSC	24BT102T	Biology for Engineers	2	0	0	2	2

Syllabus for the Courses of Semester – I (Batch 2024-2028)

24HS101T					English Communication					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. Understand of the fundamental elements of communication in English language.
2. Correct expression in the English language at a basic level
3. Using appropriate vocabulary, grammar, effective paragraph construction, writing in day-to-day scenarios, including digital platforms
4. To learn and apply communication skills in different public and interpersonal contexts.

UNIT 1 INTRODUCTION TO COMMUNICATION **07 HRS.**

- The Fundamentals of Language and Communication
- Why English?
- Types of Communication
- Barriers to effective Communication
- Digital Communication

UNIT II: ENGLISH GRAMMAR AND VOCABULARY **07 Hrs.**

- Tenses, Articles, prepositions, active voice passive voice and concord
- Tools for vocabulary building
- Homophones, homonyms, one word substitution, antonyms, synonyms, Root Words, Prefixes and Suffixes, Connotations. Collocations, Idioms. phrases

UNIT III: RECEPTIVE SKILLS **07 Hrs.**

- Listening Skills: Difference between listening and hearing, Active listening and passive listening
- Types of listening, Traits of good listener
- Reading Skills: Why reading is important, Effective reading techniques, Speed Reading, The SQ3R Method

UNIT IV: COMPENDIUM SKILLS **07 Hrs.**

- Note Taking and Note Making: physical, digital, collective
- Summarizing
- Creating e-content

TOTAL: 28 Hrs.

COURSE OUTCOMES

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

CO1 : Demonstrate an understanding of the fundamentals of communication, including the basic components of the communication process and its significance in personal, academic, and professional contexts.

CO2 : Apply grammatical rules accurately in written and spoken communication to enhance clarity, coherence, and precision.

CO3 : Employ effective strategies for vocabulary development, such as word association, context clues, and mnemonic devices.

CO4 : Enhance their ability to identify and interpret implicit meanings, inference, and figurative language in both written and spoken texts, contributing to deeper comprehension and critical analysis.

CO5 : Develop strong written communication skills to effectively convey complex ideas and information in a clear, concise, and coherent manner within the compendium.

CO6 : Apply ethical communication principles and standards of academic integrity when creating and sharing compendiums and avoiding plagiarism.

TEXT/REFERENCE BOOKS

1. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.
4. Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.

24MA102T					Mathematics for Biotechnology – I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

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

UNIT I: SET RELATIONS AND FUNCTIONS **10 Hrs.**

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

UNIT II: BASICS OF DIFFERENTIAL CALCULUS **10 Hrs.**

Limit, continuity, Differentiability of elementary functions, Increasing and Decreasing Functions, Maxima and Minima.

UNIT III: BASICS OF INTEGRAL CALCULUS **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 arc lengths.

UNIT IV: MATRICES AND DETERMINANTS **12 Hrs.**

Algebra of matrices. Determinant of a square matrix. Properties of determinants. Some simple types of matrices. The inverse of a matrix. The rank of a matrix, consistency of the system of linear equation upto 3^{rd} order. Eigen values and Eigenvectors of a real matrix, Properties of Eigen values and Eigen vectors, Diagonalization of a matrix.

TOTAL: 42 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 biotechnology 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 biotechnology problems.

TEXT/REFERENCE BOOKS

1. B. S. Grewal, Elementary Engineering Mathematics, Khanna Publisher.
2. Seymour Lipschutz, Schaum's Outline of Calculus, Tata McGraw Hill.
5. Nita H. Shah, Foram A. Thakkar, Matrix and Determinant Fundamentals and Applications, CRC Press

24CP101T					Computer Programming – I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
1	0	0	1	1	25	50	25	-	-	100

COURSE OBJECTIVES

1. To understand the usage of operators and data types.
2. To apply different types of Conditional and looping statement.
3. To create different types of data collections.
4. To implement user defined function.
5. To perform different operations upon files.

UNIT 1: Basics of Programming **3 Hrs.**

Introduction to Computer Programming, Features of C language, Structure of C program, program execution flow, C Tokens, variables, Data types, Operators, Decision control statements-if, switch, go to statement. Loop control structures- while, do-while, for loop, Break statement, Continue statement

UNIT 2: Derived Data types **4 Hrs.**

Array: one dimensional and multidimensional array, Declaration, initialization, Array Manipulations. Matrix operations, String-Basic Concepts, Inbuilt String manipulation Functions, Pointer, Pointer arithmetic, Pointer to pointer, Array of Pointers

UNIT 3: Functions and Structures **4 Hrs.**

Introduction to user defined functions, Types of Functions, Call by value-call by reference, recursion, pointers to functions, Structures, Array of Structure, Union

UNIT 4: Files Handling **3 Hrs.**

File handling in C, Different types of files, Operations on Files such as File creation, File deletion, File access modes such as read, write, append, File concatenation, File handling using seek function.

Total: 14 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand basics of programming.
CO2: Identify different programming constructs for a problem.
CO3: Apply appropriate derived data type for data storage.
CO4: Prepare a user defined data type based on data attributes.
CO5: Construct user defined functions for problem solving.
CO6: Analyse different data structure based on application requirement.

TEXT/REFERENCE BOOKS

1. Kernighan & Ritchie, C Programming Language, PHI
2. K. N. King , C Programming: A Modern Approach, W.W. Nortorn
3. David Griffiths and Dawn Griffiths, Head First C: A Brain-Friendly Guide, O'Reilly
4. E.Balaguruswamy, Programming in ANSI C, McGraw-Hill
5. Y.P. Kanetkar, Let us C, BPB Publication
6. Y.P. Kanetkar , Pointers in C, BPB Publications

24CP101P					Computer Programming Laboratory – I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To implement basic programming concepts.
2. To create different types of data collections.
3. To implement user defined function.
4. To perform different file handling operations.

List of Experiments:

1. **Introduction to Computer Programming**: Understanding compilation process through a simple C program, program execution flow, C Tokens, variables and keywords and identifiers, types of C constants and variables.

2. **Simple and formatted Input Output Operations:** Data types, Operators, Input /output statements in C, Formatted I/O, format specifiers, escaper sequences
3. **Decision making and branching:** if, if-else, if-else ladder, switch, go to statement, conditional operator statement

4. **Looping control structures:** while, do-while, for loop, Break statement, Continue statement
5. **Derived Data Type: Array and Strings:** One dimensional and multidimensional array, Declaration, initialization, Array Manipulations. Matrix operations, Basic Concepts, Inbuilt String manipulation with and without using inbuilt functions.
6. **Derived Data Type: Structure and Union:** structure, arrays and structures, structures and functions, pointer to structure, typedef, unions
7. **Functions:** Introduction to user defined functions, Types of Functions, Call by value-call by reference, header file creation, recursion, pointers to functions, arrays and functions
8. **Pointers:** Pointer's basics, use of &, * operator in context to pointers, Pointer arithmetic, Array and String processing using pointer, pointer to pointer, Array of Pointers
9. **File Handling in C:** File handling in C, Different types of files, Operations on Files, File handling functions.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Identify the use of appropriate naming conventions and programming style including appropriate comment density.
CO2: Implement a basic C program using appropriate control structure.
CO3: Apply appropriate derived data types based on data attributes.
CO4: Develop solutions with pointers and utilize them to access strings and structures.
CO5: Design user defined functions for problem solving and reuse them across different programs.
CO6: Apply suitable file handling functions and operations.

TEXT/REFERENCE BOOKS

1. Kernighan & Ritchie, C Programming Language, PHI.
2. K. N. King , C Programming: A Modern Approach, W.W. Norton.
3. E. Balaguruswamy, Programming in ANSI C, McGraw-Hill.
4. Y.P. Kanetkar,Let us C, BPB Publication.
5. Y.P. Kanetkar, Pointers in C, BPB Publication.

24PH103T					Modern Physics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Understanding concepts of modern physics.
2. Explaining the physics of EM waves and its propagation.
3. Applying the Acquired basic knowledge of solid state physics.
4. Analyze the Concepts of nuclear radiation physics.
5. Estimate and correlate the concepts learned so far for various engineering applications.
6. Apply the fundamentals designs of modern physics to solve complex physical problems.

UNIT I: MODERN PHYSICS **09 Hrs.**

Review of quantum concepts: particle nature of light, photoelectric effect, Compton effect, matter waves, wave packets, phase and group velocity, Interference, Diffraction and Polarization, Engineering Physics related applications. Davisson Germer experiment, Heisenberg uncertainty principle.

UNIT II: ELECTROMAGNETIC WAVES **12 Hrs.**

Physical and mathematical concepts of gradient, divergence and curl, Gauss theorem, applications in gravitation and electrostatics. Stokes' theorem and engineering Physics related applications. Equation of continuity, Biot Savart law – Ampere's law – magnetization and magnetic intensity, Faraday's law of Maxwell's equations, wave equation for electromagnetic radiation, applications of optical fibers in communication.

UNIT III: SOLID STATE PHYSICS **12 Hrs.**

Crystalline and Amorphous Solids, Ionic Crystals, Covalent Crystals, Van der Waals Bond, Band Theory of Solids, Semiconductor Devices, Electrical conductivity, Resistivity, Magnetism, Superconductivity, Introduction to BCS Theory.
Concepts of LASER, Interaction of radiation of matter-quantum mechanical view, characteristics and Types of laser, Engineering Physics related application of lasers.

UNIT IV: NUCLEAR RADIATION PHYSICS **09 Hrs.**

Mass defect, binding energy, Radioactivity, Types of Radiation, Interaction of Radiation with matter, Radiation detector, nuclear reactions, elements of nuclear reactors, fission and fusion, Engineering Physics related problems.

TOTAL: 42 Hrs.

COURSE OUTCOMES

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

CO1 : To relate to shape the engineering perspective in the student mind.
CO2 : Aims to provide an understanding to analyse the physical phenomena of various physics concepts.
CO3 : To develop an analytical perspective in the student.
CO4 : To enable understanding in the students the importance of application of already studied topics.
CO5 : To explain and relate the importance of interdisciplinary problems.
CO6 : To strengthen problem solving attitude in physics using mathematical tools.

TEXT/REFERENCE BOOKS

1. Resnick, Halliday and Krane, Physics part I and II, John Wiely
2. Ghatak, Optics, Tata McGraw Hill
3. Purcell E.M. Electricity and Magnetism - Berkeley Physics Course, Vol.2, Tata McGraw-Hill.
4. Kittel C., Knight W.O. and Ruderman M.A., Mechanics - Berkeley Physics Course, Tata McGraw-Hill.
5. Griffith D.J.H., Introduction to Electrodynamics - Prentice Hall, India.
6. M. N. Avadhanulu, A text book of engineering Physics, S. Chand & Company, Ltd.
7. Feyman R.P., Leighton R.B. and Sands M. The Feyman Lectures on Physics, Vol. 1., Narosa Publication.

24PH103P					Modern Physics Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. Understand the characteristics of waves, semiconductor, heat pump, LASER.
2. Enhance knowledge on application of physics in engineering
3. To develop intellectual communication skills and discuss the basic understanding of various experimental principles involved
4. Demonstrate practical knowledge by applying experimental methods to correlate with the theory.
5. Apply the analytical techniques and graphical analysis to the experimental data

LIST OF EXPERIMENTS

1 Determining Plank's constant and inverse square law
2 Study of Photoconductivity
3 Study of Bio-Savart's Law
4 Determining e/m by Thomson's method
5 Study of Hall Effect.
6 Experiments on single and double slit diffraction and interference with He-Ne Laser
7 Study of I-V characteristics of p-n diode.
8 Determination of thermal conductivity of different solids
9 To measure resistivity of semiconductor by Four Probe method and determination of band gap.
10 Study of Interference using Newton's Ring experiment.
11 To study G.M. tube characteristics and to calculate the dead time.
12 Energy calibration of CsI:Tl radiation detector and energy analysis of an unknown gamma source
13 To determine the numerical aperture of a given fibre optics cable using the far field measurements.
14 Experiments with heat pump
15 Study of Polarization of light using LASER

COURSE OUTCOMES

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

CO1 : Analysis the engineering problems and design the components for the solution
CO2 : Developing skills to utilize the different tools for engineering problems
CO3 : Analyse the results and correlate with theory and its application in industries
CO4 : Design the set-up and utilize for component analysis
CO5 : Identifying the problem and creating the solutions for research and development
CO6 : Analyse the scientific data and learn to be efficient as individual and a team member

TEXT/REFERENCE BOOKS

1. W.R. Runyan , Semiconductor Measurements and Instrumentation, McGraw Hill.
2. Sayer M. & Mansingh A., Measurement, Instrumentation & Experiment Design in Physics and Engineering, Prentice Hall India.
3. Melissinos A.C. and Napolitano J, Experiments in Modern Physics, Academic Press.
4. Nakra B.C. &. Chaudhery K.K , Instrumentation Measurements & Analysis, Tata McGraw Hill.
5. ORTEC Lab Manual, Experiments in Nuclear Science, ORTEC.

24CV101T					Environmental Science					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop a comprehensive perspective of environment and sustainable development
2. To understand the causes and effects of various types of pollution
3. To develop an understanding of the various strategies for controlling the pollution
4. To introduce the emerging environmental domains

UNIT I : INTRODUCTION TO ENVIRONMENT **05 Hrs.**

Sustainable Development; Sustainable Development Goals; Environmental Studies – Its importance and Multidisciplinary nature, Introduction to Environmental Parameters and their standards (air, water, soil, noise, etc.); Ecosystem and its types, Ideal ecosystem, Biodiversity : Its importance and conservation.

UNIT II : MULTI-SCALE ENVIRONMENTAL POLLUTION (GLOBAL, REGIONAL AND LOCAL) **06 Hrs.**

Pollution, Causes and Effects of different types of pollution : Air Pollution, Water Pollution, Soil Pollution, Solid Waste (organic and Inorganic) Pollution, Hazardous Waste Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Radioactive Pollution; Introduction to man-made disasters like floods, heat waves, landslides, etc., Introduction to the various instruments for measuring air pollution, water pollution, noise, etc.

UNIT III : ENVIRONMENTAL POLLUTION CONTROL STRATEGIES **09 Hrs.**

Multi-approaches for reducing various types of pollution: Introduction to Water and Wastewater treatment technologies, Air and Noise pollution control techniques, Introduction to different environmental management concepts like Swachh Bharat Mission, Mission LiFE (Lifestyle For Environment), etc. Indian Culture and Traditional Wisdom for managing environment

UNIT IV: EMERGING ENVIRONMENTAL MANAGEMENTS DOMAINS **08 Hrs.**

Concept of Zero Liquid Discharge (ZLD) and the reuse of the treated wastewater, Green Credit Rules - 2023, Clean Development Mechanisms (CDM) and Carbon Credits, Green Buildings, Carbon Footprint and Water Footprint, Green Business, International Environmental Laws, Environmental Auditing

TOTAL: 28 Hrs.

COURSE OUTCOMES:

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

CO-1: Demonstrate comprehension of sustainable development and environmental aspects.
CO-2: Recognize the interdisciplinary characteristics inherent in Environmental studies.
CO-3: Evaluate the impact of various pollutants on the environment.
CO-4: Assess the efficacy of different technologies for environmental pollution control.
CO-5: Analyze different environmental management policies and their implications.
CO-6: Synthesize knowledge about emerging environmental management paradigms.

TEXT-BOOK AND REFERENCE BOOKS:

1. Bharucha Erach, Textbook for Environmental Studies, UGC New Delhi.
2. Daniel B. Botkin & Edwards A. Keller, Environmental Science, Wiley India edition.
3. Miller T. G. Jr., 2006. Environmental Science, Clengage Learning.
4. R. Rajagopalan, Environmental Studies, Oxford University Press.
5. Gilbert Masters and Wendell P. Ela, Introduction to Environmental Engineering and Science, PHI.

24ME101P					Workshop Practices					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To understand safety in various manufacturing processes.
2. Learn how to use various measuring tools for engineering applications.
3. Hands on training and preparation of job using wood, metal and sheet as per drawing.
4. Understand various manufacturing processes like machining, welding, soldering and 3D printing for prototypes.

LIST OF EXPERIMENTS

1 Introduction to Workshop safety, layout and identification of various materials- plastic, wood, metals-ferrous and nonferrous, rubber, glass etc.
2 Use of measuring tools for engineering applications
3 Fitting job: Detailed drawing of work piece, use of fitting tools and job preparation.
4 Carpentry job: Detailed drawing of work piece, use of carpentry tools and job preparation.
5 Sheet metal job: Detailed drawing of work piece, use of sheet metal working tools and job preparation.
6 Plumbing job: Internal/External threading, piping network using Tees, Elbows, Reducer, Bends etc
7 Hands on training on mini lathe and milling machine
8 Demonstration of welding, brazing and soldering
9 Soldering and desoldering for PCB
10 3D printing using polymer and metal.

COURSE OUTCOMES

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

CO1 : Define workshop safety and various engineering materials
CO2 : Understand various measuring equipment
CO3 : Apply various workshop tools in preparing job for carpentry, fitting, sheet metal and plumbing
CO4 : Examine various manufacturing operations like welding and machining
CO5 : Evaluate soldering operation for PCB
CO6 : Create prototype using 3D printing

TEXT/REFERENCE BOOKS

1. S. K. Hajra Choudhury, Elements of Workshop Technology, Vol. I & II, Media Promoters and Publishers.
2. H. S. Bawa, Workshop Practice, Tata-McGraw Hill.
3. Kalpakjian S. And Steven S. Schmid, Manufacturing Engineering and Technology, Pearson Education India Edition.
4. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, Tata McGraw Hill House.

24ME102P					Engineering Graphics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
0	0	4	2	4	--	--	--	50	50	100

COURSE OBJECTIVES

1. To cover the fundamental of engineering drawing and standards used in drawing.
2. To explain the students to communicate ideas using orthographic and isometric projection methods.
3. To help students to use CAD software to prepare drawings.
4. To demonstrate the presentation of drawing using sketching and 3D modelling in CAD tool.

LIST OF EXPERIMENTS

1 Introduction to Engineering Graphics: Principles of engineering graphics and their significance, drawing instruments & accessories, lettering and numbering, types of lines, dimensioning methods, basic geometric drawing, reading a drawing.

2 Orthographic Projection: Introduction to projection, types of projection, 1st angle and 3rd angle projection

3 Isometric Projection: Principles of isometric projection – isometric scale, isometric views, conventions, conversion of isometric views to orthographic views and vice-versa

4 Projection of Solids and Development of Surface: Classification of solids, projections of solids like cylinder, cone, pyramid, and prism with its inclination to reference plane, development of surfaces of right regular solids - prism, pyramid, cylinder and cone.

5 Introduction of Computer Aided Engineering Drawing: Demonstrating knowledge of the theory of CAD software, use of software in drawing, CAD software user interface, commands, Coordinate System, menus and toolbars, planes, dimensioning, saving of files, Select and erase objects, zoom tools, and others

6 Basic sketching using CAD tool: Sketch entities using tools – origin, points, lines, circle, arcs, polygons, fillets and chamfer, trim, extend and offset, copy, cut, delete and others

7 Advanced sketching using CAD tool: Sketching entities using relation constrains, Mirror, Patterning, full definition of drawing and others

8 Basic 3D modelling using CAD tool: Extrude, cut, drawing on different planes, editing, symmetric, revolving, and others

9 Computer aided drawing sheets: Preparing drawing sheets, creating different views, section view, drawing templates, and others

COURSE OUTCOMES

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

CO1 : Recalling the fundamentals of engineering graphics by considering basic rules of drawing, dimensioning, and labelling.
CO2 : Explain the principle of projection using orthographic and isometric projection.
CO3 : Represent the 2-dimensional drawing using CAD tool.
CO4 : Construct the 3-dimensional geometries using CAD tool.
CO5 : Apply the concept of engineering drawing by organizing drawing views and applying necessary dimensions by preparing drawing sheets
CO6 : Analyse the intricate details of solid using projection of solid, sectioning of solid and development of lateral surfaces.

TEXT/REFERENCE BOOKS

1. Bhatt N.D., Panchal V.M. & Ingle P.R., Engineering Drawing, Charotar Publishing.
2. Shah P.J., Engineering Graphics, S. Chand Publishing.
3. Agrawal, B. & Agrawal C. M., Engineering Drawing, Tata McGraw Hill Publishers.
4. Hanifan R, Perfecting Engineering and Technical Drawing, Springer International Publishing Switzerland.
5. Corresponding Set of CAD Software Theory and User Manuals.

24HS102T					Universal Human Values					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
1	0	0	1	1	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the need of nurturing human values through the process in value-based education system.
2. To understand and develop a holistic perspective on self-exploration and being in harmony with family, society and nature.
3. To facilitate the students in understanding harmony at all the levels and applying in their profession and work place to lead an ethical life.

UNIT I: HUMAN VALUES AND PROCESS OF VALUE EDUCATION **04 Hrs.**

Human values, human aspirations and the ultimate goal, understanding happiness and prosperity, appraise the meaning of satisfaction and happiness in current scenario, harmony and compatibility, values imbibed education system and process

UNIT II: KNOWING SELF - HARMONY WITH SELF **04 Hrs.**

Understanding self, capabilities and challenges, understanding material (physical facilities) and spiritual needs - need of mind and body, understanding body as an instrument, harmony between mind and body, synchronizing physical health and mental health, practicing healthy habits for healthier me

UNIT III: HARMONY IN RELATIONSHIP – FAMILY, SOCIETY AND NATURE **03 Hrs.**

Harmony in relationships, values for harmony in any human-human interaction, harmony in family, and society, trust and respect for others, self esteem and ego, equality, equity, inclusion and liberation, concept of '*Vasudhaiva Kutumbakam',* understanding co-existence and sync with nature

UNIT IV: HARMONY IN PROFESSION AND ETHICAL BEHAVIOR **03 Hrs.**

Ethical human conduct, acceptance and respect, appraising the qualities of others, professional competence for enabling harmony in system and enabling universal human order, scope of eco-friendly systems, strategies to reach the harmonious ecosystem to reach Universal Human Order '*Sarvabhauma Vyavastha*'

TOTAL : 14 Hrs.

COURSE OUTCOMES

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

- CO1 - Understand the significance of human values, its need, and process of value education.
- CO2 - Appraise the meaning of happiness and prosperity as short- and long-term goal of life. Understand them and in context of the current scenario
- CO3 - Distinguish between the mind and body, physical and spiritual wellbeing for harmony within self
- CO4 - Assess the value of harmonious relationship based on trust, respect and enduring its role in all human-human relationships to build harmonious society
- CO5 - Understand the importance of harmony with nature and appreciate co-existence for harmonious ecosystem.
- CO6 - Create the perfect professional place and work environment following the ethical practices and strategize to uphold the human values at all the levels and interactions.

TEXT/REFERENCE BOOKS

1. R. R. Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and Professional Ethics, Excel books.
2. A. Nagraj, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
3. A. N. Tripathi, Human Values, New Age Intl. Publishers.
4. M. K. Gandhi. The Story of My Experiments with Truth, Fingerprint Publishing.
5. Ivan Illich, Energy & Equity, The Trinity Press, Worcester, and Harper Collins.
6. E. F. Schumacher, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
7. Sussan George, How the Other Half Dies, Penguin Press.

24BT102T					Biology For Engineers					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the basic biological concepts and their engineering applications.
2. To introduce the students with an understanding of biodesign principles to create novel devices and structures.
3. To provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems.
4. To study the development of interdisciplinary vision of biological engineering.

UNIT I: INTRODUCTION TO BIOMOLECULES **7 Hrs.**

Cell as the basic unit of life, Overview of cell structure and functions. Carbohydrates: Properties and biological functions. Nucleic
Acids: Structure and roles of DNA and RNA. Proteins: Structure, and its functions, Significance of lipids. Role of biomolecules: Characteristics and roles of enzymes, vitamins, and hormones.

UNIT II: NATURE-BIOINSPIRED MATERIALS AND MECHANISMS (QUALITATIVE) **7 Hrs.**

Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf
effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes- hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).

UNIT III: ENGINEERING PERSPECTIVES OF BIOLOGICAL SCIENCES **7 Hrs.**

Biology and engineering crosstalk –Hybridoma technology, Plant Tissue Culture, Animal Tissue Culture; Tissue Engineering,
Introduction to Biomimetics and Biomimicry, Nanobiotechnology, Introduction to Radiology, High-throughput diagnostics in clinics, Bioprocessing and Biomaterials.

UNIT IV: TRENDS IN BIOENGINEERING **7 Hrs.**

Stem cell and its applications, Bio printing techniques and materials. Applications of Bioinformatics, Artificial Intelligence for
diagnosis and detection of communicable and non-communicable diseases, Biosensors in healthcare, Environmental monitoring.

TOTAL: 28 Hrs.

COURSE OUTCOMES

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

CO1 : Gain fundamental knowledge of origin of life.
CO2 : Explain the functions of cell and its components.
CO3 : Evaluate the principles of design and development, for exploring novel bioengineering projects.
CO4 : Compare biology with engineering
CO5 : Corroborate the concepts of biomimetic for specific requirements
CO6 : Think critically towards exploring innovative biobased solutions for socially relevant problems.

TEXT/REFERENCE BOOKS

1. Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M., **"Biology for Engineers**", Tata McGraw-Hill, New Delhi, 2012.
2. Arthur T. Johnson, **"Biology for Engineers"**, CRC Press, Taylor and Francis, 2011
3. Geoffrey M.Cooper**, "The Cell: A molecular approach"**, ASM Press, 2007.
4. Sohini Singh and Tanu Allen, **"Biology for Engineers"**, Vayu Education of India, New Delhi, 2014.
5. Yoseph Bar-Cohen, **"Biomimetics: Nature-Based Innovation**" , 1st edition, 2012, CRC Pres

Department of Biotechnology, School of Energy Technology

B.Tech Biotechnology

Course Matrix for Semester – II (Batch 2024-2028)

Sem.	Category Code	Course Code	Course Name	Th	Tut	Pra	Hrs	Cr
II	HSC	24HS105T	Professional Communication	2	0	0	2	2
	BSC	24MA104T	Mathematics for Biotechnology – II	3	1	0	4	4
	ESC	24CP102T	Computer Programming – II	1	0	0	1	1
	ESC	24CP102P	Computer Programming Laboratory – II	0	0	2	2	1
	BSC	24CH101T	Engineering Chemistry	3	0	0	3	3
	BSC	24CH101P	Engineering Chemistry Laboratory	0	0	2	2	1
	ESC	24EE101T	Elements of Electrical and Electronics Engineering	3	0	0	3	3
	ESC	24EE101P	Elements of Electrical and Electronics Engineering Laboratory	0	0	2	2	1
	HSC	24HS103T	Indian Knowledge System	2	0	0	2	2
	HSC	24YOG101	Yoga, Health & Hygiene	0	0	2	2	1
		24NSS101	National Service Scheme (NSS)					
		24NCC101	National Cadet Corps (NCC)					
	HSC	24HS104T	Organizational Behaviour	1	0	0	1	1

Syllabus for the Courses of Semester – II (Batch 2024-2028)

24HS105T					Professional Communication					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To strengthen the communication skills of professionals to make them ready for the modern workplace.
2. To fine tune their professional skills and expertise using communication skills.
3. To participate in the life-long learning process with confidence and certainty.
4. To develop analytical, research, and organizational skills through communication skills for a fulfilling career.

UNIT 1 TECHNICAL WRITING **07 HRS.**

- E-mails
- Report Writing
- Proposal writing (Project, Research and Business)
- Review Writing (Books and Articles)

UNIT II: ORATORY SKILLS **07 Hrs.**

- Art of Introducing oneself
- Presentation Skills
- Public speaking

UNIT III: EMPLOYABILITY SKILLS **07 Hrs.**

- Deciphering JD (Job Descriptions)
- Cover Letter Drafting
- Resume Writing
- Group Discussion
- Interview Skills

UNIT IV: ADVANCED READING AND CRITICAL THINKING **07 Hrs.**

- Critical Thinking
- Language and Communication:
- Ethical Considerations:
- Interdisciplinary Perspective:
- Communication Skills:
- Philosophy of Science

TOTAL: 28 Hrs.

COURSE OUTCOMES

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

CO1 : Develop the technical writing skills essential for effective communication in professional settings, including business environments, academic institutions, and research organizations.

CO2 : Master the art of public speaking by delivering clear, engaging, and persuasive presentations to diverse audiences, demonstrating confidence, poise, and effective communication techniques.

CO3 : Demonstrate the ability to decipher job descriptions, extracting key requirements, and qualifications to align their skills and experiences effectively.

CO4 : Effectively prepare for and participate in group discussions, demonstrating active listening, critical thinking, and the ability to articulate ideas coherently and persuasively.

CO5 : Understand the importance of clear, honest communication in engineering practice and ethical decision-making in upholding privacy rights and societal well-being.

CO6 : Explore interdisciplinary approaches to problem-solving.

TEXT/REFERENCE BOOKS

1. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.
4. Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.

24MA104T					Mathematics for Biotechnology – II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
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 biotechnology problems using the methods of solving ODEs.
3. To study the use for double and triple integral to find area and volume.
4. To be able to evaluate problems related to probability and distribution.

UNIT I: FUNCTIONS OF SEVERAL VARIABLES **10 Hrs.**

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

UNIT II: MULTIPLE INTEGRALS **12 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.

UNIT III: 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 biotechnology problems.

10 Hrs.

UNIT IV: PROBABILITY AND DISTRIBUTION

Sample Space and Events; Axioms, Interpretations and Properties of Probability; Expectation; conditional Probability; Total probability, Bayes' Rule, Random variables; Measures of central tendency and dispersion.

Total: 42 Hrs.

COURSE OUTCOMES

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

CO1 : Understand the basic concepts of multivariable calculus, and differential equations.
CO2 : Demonstrate the use of multivariable calculus, differential equations.
CO3 : Apply appropriate tool/method to extract the solutions of biotechnology problems.
CO4 : Analyze the obtained solution in context with theory.
CO5 : Evaluate area, volume using multiple integrals.
CO6 : Create a mathematical model of biotechnology interest.

TEXT/REFERENCE BOOKS

1. B. S. Grewal, Elementary Engineering Mathematics, Khanna Publisher.
2. M. D. Raisinghania, Ordinary and partial differential equations, S Chand Publication.
3. S. C. Gupta and V. K. Kapoor, Fundamental of Mathematical Statistics, S. Chand and Sons
4. Sheldon M. Ross, Introduction to probability and statistics for engineers and scientists, Academic Press publication.

24CP102T					Computer Programming – II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
1	0	0	1	1	25	50	25	-	-	100

COURSE OBJECTIVES

1. To impart the basic concepts of Python Programming language
2. To be familiar with data structures available in Python.
3. To understand the concept of function & object-oriented programming.
4. To use the file and exception handling for designing applications

UNIT 1 INTRODUCTION AND LANGAUGE FUNDAMENTALS **4 Hrs.**

Definition and its historical background, Comparison with other programming languages. Python IDEs **Tokens:** Identifiers, Keyword **Data Types:** Int, Float, Bool, Complex, Str, List, Tuple, Dictionary and Set, Type conversion, Concept of mutability, immutability and reusability **Operators:** Arithmetic, Relational, Logical, Identity and Membership, Input and Output methods Control Flow Conditional statements: If, elif and else, nesting, Iterative or loop statement: for, while, for else and while else, Transfer statements: break, continue, pass.

UNIT 2 FUNCTIONS **3 Hrs.**

Function Declaration and calling, Types of Function arguments, scope of variable, Recursive function Recursive function **Types of function:** Anonymous or lambda, Map, Filter, Reduce, Function aliasing, Nested function, Decorator function, Decorator chaining Generator function

UNIT 3 OBJECT ORIENTED PROGRAMMING **4 Hrs.**

Class, Object, Object reference, Constructor and self-variable, Types of variables, Types of method, Destructor, Composition, Aggregation, Inheritance, Polymorphism, Abstract classes.

UNIT 4 FILE AND EXCEPTION HANDLING **3 Hrs.**

File handling Types of files, writing and reading with text file, important functions of file handling, working with directories, CSV file handling, pickling and unpickling **Exception Handling** exceptions handling using try-except blocks. Raising exceptions and custom exception classes.

14 Hrs.

COURSE OUTCOMES

CO1- Understand the basic concepts of programming with python.
CO2- Demonstrate proficiency in using different data types, operators, and control structures in Python programs.
CO3- Demonstrate the usage of both built-in and user-defined functions
CO4- Define and use classes in Python to represent attributes and methods, and demonstrate composition, aggregation, inheritance and polymorphism.
CO5- Implement exception handling mechanisms to deal with errors.
CO6- Demonstrate file operations and exception handling.

TEXT/REFERENCE BOOKS

1. John V Guttag, Introduction to Computation and Programming Using Python, Prentice Hall of India.
2. Allen Downey, Jeffrey Elkner and Chris Meyers, How to think like a Computer Scientist, Learning with Python, Green Tea Press.
3. Al Sweigart, Automate the Boring Stuff with Python
4. Martin C. Brown, Python: The Complete Reference, Osborne, McGraw-Hill
5. R. Nageswara Rao, Core Python Programming, Dreamtech Press

24CP102P					Computer Programming Laboratory – II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To impart the basic concepts of Python programming language
2. To be familiar with data structures available in Python.
3. To understand the concept of function & object-oriented programming.
4. To use file and exception handling for designing applications

List of Experiments:

1. **Language fundamentals**:
   Understanding interpretation, program execution flow, tokens, variables and keywords and identifiers, constants and variables
2. **Input Output Operations:**
   Basic data types, mutability, immutability, Operators, Input /output statements, format specifiers, escape sequences
3. **Decision making, Looping control structures**
   If, elif and else, nesting, Iterative or loop statement: for, while, for else and while else, Transfer statements: break,
4. **Advanced datatypes**
   String, List, Tuples, Dictionary, Set
5. **Functions:**
   Basics of functions, types of arguments
6. **Types of functions**
   Anonymous function, function aliasing, nested function, decorator function and generator function
7. **Object Oriented programming**
   class, object, types of variable and methods, composition, aggregation, inheritance, types of inheritance
8. **File Handling:**
   writing and reading with text file and csv file, working with directories, pickling and unpickling

COURSE OUTCOMES

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

CO1- Apply the concepts of variables, decision making and looping with python.
CO2- Apply various data structures available in Python to solve computational problems.
CO3- Implement advanced function concepts such as decorator chaining and generator functions.
CO4- Design and implement object-oriented solutions to programming problems using composition, aggregation, inheritance and polymorphism.
CO5- Develop Python scripts, for file handling tasks.
CO6- Create and manage files in python.

TEXT/REFERENCE BOOKS

1. John V Guttag. “Introduction to Computation and Programming Using Python”, Prentice Hall of India.
2. Allen Downey, Jeffrey Elkner and Chris Meyers "How to think like a Computer Scientist, Learning with Python", Green Tea Press.
3. Al Sweigart, “Automate the Boring Stuff with Python”
4. Martin C. Brown, “Python: The Complete Reference, Osborne, McGraw-Hill
5. R. Nageswara Rao, “Core Python Programming”, Dreamtech Press

24CH101T					Engineering Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop the fundamental understanding about traditional materials.
2. To provide the knowledge about structural features, synthesis, properties of various categories of advanced materials.
3. To develop the knowledge and skills for different characterization techniques of materials.
4. To provide the knowledge about the role of chemistry in modern engineering applications.

UNIT I: CHEMISTRY OF ENGINEERING MATERIALS **12 Hrs.**

Traditional Materials: Introduction and classification of materials; metallic materials, polymeric, ceramic materials Advanced Materials: Introduction to nanomaterials: Properties and application; Carbonaceous materials (fullerene, carbon nanotube, graphene, etc.); Composite materials; Liquid crystals: Classification and Application

UNIT II: MODERN ANALYTICAL TECHNIQUES **10 Hrs.**

Instrumentation, principle and characterization of materials: X-ray diffraction (XRD), Electro analytical techniques; FTIR, UV-visible spectroscopy; Thermal analysis (TGA-DTA-DSC); Chromatographic techniques (GC, HPLC)

UNIT III: ADSORPTION, CATALYSIS AND KINETICS **10 Hrs.**

Adsorption - Characteristics, Classification, Application , Adsorption isotherms- Freundlich, Langmuir & BET Chemical Kinetics - Rate law, Arrhenius equation, Transition state theory, Collision theory; Complex reactions Catalysis - Homogeneous and Heterogeneous Catalysis; Mechanism of Catalysis; Industrial Applications of catalysts

UNIT IV: CHEMISTRY OF ENERGY DEVICES **10 Hrs.**

Principles of primary and secondary batteries, Fuel Cells and their operation principles, Principles and uses of supercapacitors; Photocatalytic hydrogen production: Principles and challenges; Traditional and new generation solar cells.

TOTAL : 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Remember** the structural features and properties of different classes of traditional materials
CO2 : **Classify** advanced materials like nanomaterials, carbonaceous and composite materials, and liquid crystals
CO3 : **Apply** the skills by understanding various instrumental techniques for characterisation of materials.
CO4 : **Analyze** the key concepts in engineering chemistry viz. adsorption and chemical kinetics and laterally ponder over the applications of such concepts in engineering challenges.
CO5 : **Justify** the important insights into the industrial application of different types of catalysis via analysing mechanisms of catalysis.
CO6 : **Develop** the knowledge on the role of chemistry in various modern engineering applications such as in energy devices.

TEXT/REFERENCE BOOKS

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

24CH101P					Engineering Chemistry Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
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.

LIST OF EXPERIMENTS

1 **Iodometry**– To determine the strength of given copper sulphate solution by titrating against N/20 sodium thiosulphate (hypo) solution

2 **Iodimetry**– To determine the strength of given ascorbic acid by titrating against standard N/10 iodine solution

3 **Complexometric Titration**– To determine the total, permanent and temporary hardness of given water by complexometric titration using standard 0.01M EDTA solution

4 **pH metric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a pH-metric titration

5 **Conductometric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a conductometric titration

6 **Chemical Kinetics**– To study the kinetics of decomposition of sodium thiosulphate by a mineral acid

7 **Drawing chemical structures** - To Draw Chemical Structures of organic molecules using ChemDraw

8 **Colorimetric determination**: To determine the concentration of copper present in the effluent of electroplating industries by using colorimeter.

9 **Detection of biomolecule**: Detection of the presence of carbohydrates in test solution by using Benedict's reagent

10 **Preparation of drug molecule**: Preparation of Aspirin from salicylic acid

11 **Polymerization**– To prepare a polymer (Nylon 6,10), identify the functional groups by FT-IR

COURSE OUTCOMES

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

CO1 : Recall the concepts learned in chemistry and engineering to the real-world situations.
CO2 : Show the ability to identify, analyse and interpret the results from the experiments.
CO3 : Experiment with the instrumental method using conductometer and pH meter.
CO4 : Analyse compounds by titrimetric, gravimetric and instrumental methods.
CO5 : Determine the concentration of unknown solutions by spectrophotometric method.
CO6 : Predict the reaction rate and predict the order and rate constant.

TEXT/REFERENCE BOOKS

1. V. K. Ahluwalia, S Dhingra, A. Gulati, College Practical Chemistry, Universities Press.
2. J.B. Baruah, P Gogoi, Foundations of Experimental Chemistry, PharmaMed Press.
3. S. S. Sawhney, M. S. Jassal, S.P. Mittal, A Text Book of Chemistry Practical, Vol. I & II, APH Publishing Corp.

24EE101T					Elements of Electrical and Electronics Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart knowledge on DC and AC circuits.
2. To learn construction, working principle and characteristics of transformer and induction machines.
3. To introduce students to various means for electrical safety, protection of electrical installations and Batteries
4. To understand rectification through p-n junction diode, applications of diode and Transistor Characteristics

UNIT I: BASICS OF ELECTRONICS **10 Hrs**

Semiconductor Diodes and Applications, Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices–LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings, Applications.

Transistor Characteristics covering, Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Field Effect Transistor (FET) – Construction, Characteristics of Junction FET.

UNIT II: DC CIRCUITS **10 Hrs**

Electrical circuit elements (R, L and C), voltage and current sources, dependent and independent sources, Ohms Law, temperature co-efficient of resistance, Kirchhoff current and voltage laws, voltage and current divider circuit, Thevenin and Norton Theorems and their equivalents, maximum power transfer and superposition theorems, nodal and mesh analysis, star-delta transformation, Time domain analysis/natural response of first order RL and RC Circuit.

UNIT III: AC CIRCUITS **10 Hrs**

Generation of AC voltage, representation of sinusoidal waveforms, RMS values of different sinusoidal waveforms, Rectangular and Polar representation of phasor, Sinusoid representation in time and frequency domain, Analysis of single-phase ac series circuits consisting of R, L, C, RL, RC, RLC combinations, instantaneous power, average power and reactive power, complex power and power factor.AC parallel circuit and its solution in admittance form, resonance in AC series and parallel circuits, polyphase circuits, star and delta representation of polyphase circuits, power measurement in polyphase circuits.

UNIT IV: INTRODUCTION TO ELECTRICAL MACHINES AND ELECTRICAL INSTALLATION **12 Hrs**

Magnetic materials and its B-H characteristic, Faraday's Law of Electromagnetic Induction; **Single Phase Transformers:** Construction, working principle, types, EMF equation, ideal transformer, practical transformer, Operation of transformer on no-load and load, **Induction Machine:** construction, types of 3-phase induction motors, working principle, production of rotating magnetic field, operation, starting and running torques, Torque-slip characteristics, Power Stages in an induction motor.

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing, Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, Electrical safety rules.

TOTAL : 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Demonstrate application of different diodes in circuits and Understand the Transistor characteristics

CO2 – Understand electrical circuits using network theorems.

CO3 – Compare the behaviour of R, L and C and their combinations in AC circuits.

CO4 – Analyze balanced polyphase systems in star and delta configurations

CO5 – Understand the construction, working and basic characteristics of transformer and induction machines

CO6 -- Recognize the importance of protective devices, electrical safety measures and characteristics of Batteries

TEXT/REFERENCE BOOKS

1. J. Bird, **"Electrical Circuit Theory and Technology"**, Routledge, Tailor and Francis Group
2. D. P. Kothari and I. J. Nagrath, **"Basic Electrical Engineering"**, Tata McGraw Hill
3. B. L. Theraja, **"Electrical Technology",** Vol. 1, S. Chand Publication, New Delhi.
4. Surjit Singh, **"Electrical Estimating and Costing"**, Dhanpat Rai and Co.
5. Boylestad and Nashlesky, "**Electronic Devices and Circuit Theory**", PHI

24EE101P					Elements of Electrical and Electronics Engineering Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To gain practical knowledge on DC and AC circuits
2. To learn operation of electrical instruments and electrical machines
3. To introduce students to various means for electrical safety, protection of electrical installations
4. To understand characteristics and applications of semiconductor diodes and transistors.

LIST OF EXPERIMENTS

1. Introduction to elements of electrical engineering laboratory and to study different electrical measuring instruments.
2. To Verify Ohm's law with linear resistors and find power dissipation in resistor.
3. To validate Thevenin's and Norton theorem for DC circuits.
4. To validate Superposition and Maximum Power Transfer theorem for DC circuits.
5. To evaluate the AC R, L and R-L series circuit performance and to measure the active power, the reactive power and the apparent power connected with single phase AC supply.
6. To evaluate performance of AC R-L parallel circuit and to measure the active power, the Reactive power and the apparent power connected with single phase AC supply.
7. To perform a direct load test on a single-phase transformer and determine the efficiency and voltage regulation at different loads.
8. To measure three phase power using two wattmeter method.
9. To draw the time-current characteristics of MCB and study the function of ELCB.
10. To obtain the VI characteristic of silicon and germanium diodes.
11. To obtain reverse characteristics of Zener diode.
12. To study half wave, full wave and bridge rectifiers.
13. To determine the DC Characteristics of BJT in CE Configuration.
14. To study the types of batteries and their characteristics

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – To understand the basic operation of electrical equipment's & measuring instruments.
CO2 – To perform various network theorems for DC circuits.
CO3 – To understand the performance of AC circuit with R, L load.
CO4 – To evaluate star and delta configuration of polyphase system and measure power in polyphase system.
CO5 – To evaluate the performance of single phase transformer.
CO6 – To understand the working principle of semiconductor diodes, transistor characteristics and its applications.

24HS103T					Indian Knowledge System					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
1	0	0	1	1	25	50	25	--	--	100

COURSE OBJECTIVES

1. To connect with the tradition of IKS
2. The students will be able to define Philosophical foundations of IKS.
3. To understand Fundamentals of Art and Architecture, Traditional and Historical Town Planning & Ancient Indian Art & Architecture.

UNIT 1 INTRODUCTION TO IKS **07 Hrs.**

- What is IKS? Historical and philosophical foundations
- Knowledge Framework and classifications in IKS
- Indian scheme of knowledge
- The knowledge triangle
- Framework for establishing valid knowledge
- Deductive or inductive logic framework
- Potential fallacies in the reasoning process

UNIT II: IKS AND ENGINEERING DISCIPLINES **07 Hrs.**

- Engineering marvels of ancient India
- Civil engineering: Urban planning, water management
- Materials engineering: Sustainable materials, traditional construction techniques Material science and Metallurgy in IKS
- Mechanical engineering: Robotics and automation in ancient India
- The role of IKS in addressing climate change challenge
- IKS principles for resource management and conservation

UNIT III: IKS AND MATHEMATICS **07 Hrs.**

- IKS and Indian Mathematics, Algebra, Geometry, Trignometry, Binary Mathematics, Magic
- IKS and Indian Astronomy, Pañcāṅga – The Indian calendar system
- Astronomical Instruments -Yantras

UNIT IV: IKS AND OTHER DISCIPLINES **07 Hrs.**

- Indian Administration
- Concept of state,
- Anushashan Parwa of Mahabharat
- Kautilya's Arthshastra
- Social and Political Philosophies of Ancient India
- IKS and Medicine: Ayurveda - A Holistic Approach to Health and Wellbeing

TOTAL: 28 Hrs.

COURSE OUTCOMES

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

CO1 : Define the fundamental concepts of Indian Knowledge System
CO2 : Describe various cost concepts of IKS relevant from engineering perspective.
CO3 : To Apply Mathematics in the Vedas and Śulva SūtraSystems employed for representing numbers Spherical trigonometry &Celestial Sphere
CO4 : To Analyse the science of Astronomy and the different units of time discussed in the texts
CO5 : To be able to weigh the IKS systems vis s vis the current applications in various spheres of understanding
CO6 : To design applications and processes by incorporating thebl traditional knowledge to the present day concerns

TEXT/REFERENCE BOOKS

1. Introduction To Indian Knowledge System: Concepts and Applications by by B. Mahadevan, Nagendra Pavana, Vinayak Rajat Bhat.
2. The Vedas by Sri Chandrasekharendra Saraswati/Sankaracharya of Kanchi Kamakoti Peetham (Author)
3. Indian Knowledge Systems – Vol 1 & 2 by Avadhesh K. Singh, Kapil Kapoor

24YOG101					Yoga, Health & Hygiene					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To impart the students with the basic concepts of physical education, sports, and yoga for health and wellness.
2. To familiarize the students with health-related exercises, sports, and yoga for overall growth and development.
3. To create a foundation for professionals in physical education, sports, and yoga.
4. To impart the basic knowledge and skills to teach physical education, sports, and yoga activities.

ACTIVITY I: KINESIOLOGY AND CARDIO FITNESS TEST

Introduction to Kinesiology and the Physiological Basis of Conditioning, Sports Psychology, and the Cooer Cardio Fitness Test 12-Minutes Run/Walk: How to Start Walking/Runing: Get expert tips, tools, and training.

ACTIVITY II: YOGA

Introduction to Yogasana and Yoga Therapy: A Rehabilitation Tool and the Effect of Yoga on Exercise Endurance as Assessed by Cardiorespiratory Efficiency Tests: Studt on yogic practices that promote and improve respiratory and cardiovascular function and enhance physical fitness.

ACTIVITY III:GAMES AND SPORTS LEAGUE

Practice sessions for outdoor and indoor games, event-wise practice, and team games organized on the sport, game-wise practice as per the student's interest: Football, Chess, Cricket, Tennis, Basketball, Volleyball, Athletics (Relay), Pickleball.

COURSE OUTCOMES

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

CO1 : Discover the balance of health and happiness through the basic principles and practices of physical education, sports, and yoga.
CO2 : Understand that the students will be able to be instructed on physical activities, sports, yoga practices, theories, and rules of various games for healthy living.
CO3 : Analyze emerging trends and issues in world sports and develop leadership qualities among students to conduct, organize, and officiate physical education, sports, and yoga events at schools, colleges, and the community.
CO4 : Practice on the field and in the indoor yoga hall.
CO5 : Develop a spirit of teamwork and fair play.
CO6 : Demonstrate understanding by participating in games and sports leagues.

TEXT/REFERENCE BOOKS

1. Athletic Track and Court Marking Handbook of Games And Sports – Rajesh Agola.
2. Asana, Pranayama, and Kriyas - Swami Satyanand Swami.Munger.
3. Sports Games and Rule, Regulation - Pankaj Vinayak Pathak
4. Yogic Prakriyanche Margdarshan – Dr.M.L.Gharote - (The Lonavala Yoga Research Institute,Lonavala)

24NSS101					National Service Scheme (NSS)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To develop a sense of civic and social responcibility.
2. To identify the needs and problems of the community and involve them in problem-solving.
3. To engage in creative and constructive social action.
4. To develop social character and leadership through NSS.

ACTIVITY I: ENVIRONMENT AND SUSTAINABILITY -WATER - WAST MANAGEMENT

Volunteering work for Environment & Sustainability (water and waste management) and Tree Plantation.

ACTIVITY II: NSS 7 DAYS SPECIAL CAMP

Volunteering for tree planting, agriculture compost, tree guard,Gujarat Skill Development Mission, and social activities in the village as per the government NSS manual.

ACTIVITY III: FIT INDIA MISSION

Volunteering for Cardio Fitness, Yoga, Running, Mission Olympics, Self-Defense, and Agneepath Mission.

COURSE OUTCOMES

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

CO1 : Identify the needs and problems of the community.
CO2 : Understand the importance of his / her responsibilities towards society.
CO3 : Analyze the environmental and societal problems/issues.
CO4 : Evaluate the existing system and propose practical solutions for the sustainable development.
CO5 : Develop a government or self-driven projects effectively in the field.
CO6 : Understand the government or self-driven projects effectively in the society.

TEXT/REFERENCE BOOKS

1. NSS Course Manual, Published by NSS Unit,PDEU (https://www.pdpu.ac.in/nssreport.html)
2. Government of Gujarat NSS Cell (https://nss.gov.in/gujarat-1)
3. Government of India NSS Cell, Activities reports and manual (https://nss.gov.in/)

24NCC101					National Cadet Corps (NCC)					
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 students
2. To develop youth leadership qualities in the students.
3. To induce social consciousness among students through various NCC camps

ACTIVITY I: INTRODUCTION TO NCC

Introduction to NCC, aims and objectives, structure and organization of NCC, cardinals of NCC, NCC Flag, oath of NCC, NCC Song, incentives of NCC

ACTIVITY II: NATIONAL INTEGRATION

Importance of national integration and awareness, necessity, national interests, objectives, threats and opportunities, unity in diversity

ACTIVITY III: NCC CAMPS, SOCIAL SERVICE, AWARENESS AND COMMUNITY DEVELOPMENT ACTIVITIES

Social awareness & community development, health & hygiene, environment awareness and conservation, cadets will participate in various activities e.g., blood donation camp, swachhata abhiyan, constitution day, etc., participation into NCC camps like ATC, CATC, NIC, COC, TSC, RDC, leadership camps, etc.

ACTIVITY IV: DRILL, WEAPON TRAINING AND ADVENTURE ACTIVITIES

Types of drill, foot drill, general and words of command, saluting, weapon training, map reading, field craft & battle craft, Introduction to infantry weapons & equipment, obstacle and weapon training (during camps), adventure training, participation into Republic and Independence day ceremonial parades at university.

COURSE OUTCOMES

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

CO1 : Know about the history of NCC, its organization, and incentives of NCC for their career prospects.
CO2 : Understand the importance of Nation building and individual contribution to the same
CO3 : Maintain discipline and team spirit
CO4 : Build the character and leadership qualities
CO5 : Understand that drill as the foundation for discipline and to command a group for common goal.
CO6 : Develop the sense of self-less social service for better social & community life.

TEXT/REFERENCE BOOKS

2. Cadet's Handbook SD/SW- Common Subjects, all wings by DG NCC, New Delhi

24HS104T					Organizational Behaviour					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE	
1	0	0	1	1	25	50	25	--	--	100

COURSE OBJECTIVES

1. To enable the development of a perspective to diagnose & efficiently deal with matters of human behaviour in organisations
2. To enrich understanding of the dynamics of interaction and integration between the individual and the organization.
3. To explore the organization system in entirety to capture the full complexity of organizational behaviour.
4. Critically appraise the potential effects of important developments in the external environment on organizational behaviour

UNIT 1 INTRODUCTION TO ORGANIZATIONAL BEHAVIOUR **04 HRS.**

Definition and scope of organization, behaviour, and organizational behaviour, Historical developments and emerging concerns in OB, Perception in organizational behaviour: elements, principles, and biases, Learning theories, conditioning, application in organizations, Personality theories, Attitudes in the workplace.

UNIT II: EMOTIONS, STRESS MANAGEMENT, GROUP DYNAMICS AND INTERPERSONAL RELATIONSHIPS **04 Hrs.**

Understanding emotions in organizational behaviour, Emotional labor, Stress management techniques in organizational settings, Group formation and dynamics in organizations, Group decision-making techniques and their application, Team building strategies and effective communication, Influence, power dynamics, and organizational politics

UNIT III: LEADERSHIP AND ORGANIZATIONAL CULTURE **03 Hrs.**

Leadership theories: overview and application in organizational settings, Leadership styles and their impact on organizational behaviour, Understanding organizational culture and climate

UNIT IV: ORGANIZATIONAL CHANGE AND STRUCTURE, BALANCING WORK AND LIFE **03 Hrs.**

Organizational change processes, Resistance management during organizational change, Organizational structure and design, Job satisfaction: determinants and impact on employee behaviour, Stress prevention and management techniques, Work-life balance strategies and their role in organizational behaviour

TOTAL: 14 Hrs.

COURSE OUTCOMES

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

CO1 : Critically gage the potential effects of important developments in the external environment on organizational behaviour.
CO2 : Analyze organizational behavioural issues in the context of organizational behaviour theories, models, and concepts.
CO3 : Analyze the behaviour of individuals and groups in organizations in terms of the crucial factors that effect organization behaviour.
CO4 : Analyze organizational behavioural matters in the context of organizational behaviour theories, models, and concepts.
CO5 : Demonstrate how the organizational behaviour can integrate in understanding the motivation (why) behind behaviour of people in the organization.
CO6 : Manage conflict in organizational context and deal with stress.

TEXT/REFERENCE BOOKS

1. Fiona M. Wilson, Organizational Behaviour and Work, Oxford University Press, 5th Edition, 2018.
2. Stephen P. Robbins, Timothy A. Judge, Neharika Vohra, Organization Behaviour, Pearson Education, 18th Edition, 2019.
3. Ashwathappa, K., Organizational Behaviour, Himalaya Publication, 12th Edition 2019.
4. wathappa, K., Organizational Behaviour, Himalaya Publication, 12th Edition 2019.

Department of Biotechnology, School of Energy Technology

B.Tech Biotechnology

Course Matrix for Semester – III (Batch 2024-2028)

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 3	BSC	24BT201T	Biophysics & Structural Biology	3	1	0	4	4
	ESC	24BT202T	Introduction to Artificial Intelligence	3	0	0	3	3
	PC	24BT203T	Principles of Biochemistry	3	0	0	3	3
	PC	24BT203P	Biochemistry Lab	0	0	2	2	1
	PC	24BT204T	Human Anatomy and Physiology - I	3	0	0	3	3
	PC	24BT204P	Human Anatomy and Physiology – I Laboratory	0	0	2	2	1
	PC	24BT205T	General Microbiology	3	0	0	3	3
	PC	24BT205P	General Microbiology Laboratory	0	0	2	2	1
	Pro	24INT151	Civic and Social Service Internship	0	0	0	0	1

24BT201T					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. 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 I: INTRODUCTION 10 Hrs.

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 II: CONFORMATIONAL ANALYSIS OF PROTEINS 10 Hrs.

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 III: CONFORMATIONAL ANALYSIS OF NUCLEIC ACIDS 10 Hrs.

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 IV: TECHNIQUES FOR THE STUDY OF BIOLOGICAL STRUCTURE AND FUNCTION 10 Hrs.

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.

TOTAL HOURS: 40 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. I.N. Levine, "Quantum Chemistry", (2020), Pearson Educ., Inc., New Delhi.

24BT202T					Introduction to Artificial Intelligence					
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 Artificial Intelligence
2. Learn the applications of artificial intelligence in bioinformatics
3. Learn some basic search algorithms for problem solving; knowledge representation and reasoning; pattern recognition; fuzzy logic; and neural networks.
4. Understand the advancements of designing the intelligent systems that can solve general purpose problems, represent and process knowledge, plan and act, reason under uncertainty.

UNIT I: INTRODUCTION 10 Hrs.

Introduction to Artificial Intelligence (AI): Introduction to Artificial Intelligence, Problems, Approaches and tools for Artificial Intelligence. Introduction to search, Search algorithms, Heuristic search methods, Optimal search strategies. Use of graphs in Bioinformatics. Current Techniques of Artificial Intelligence: Introduction to probability, Bayes' theorem, Bayesian networks and Markov networks.

UNIT II: CLASSIFICATION METHODS 10 Hrs.

Linear Classifiers & Logistic Regression ,Linear Classifiers, Overfitting & Regularization in Logistic Regression, Decision Trees, Preventing Overfitting in Decision Trees, Handling Missing Data, Clustering and retrieval of data, Nearest Neighbour Search, Clustering with k-means, Hierarchical Clustering.

UNIT III: SUPERVISED/ UNSUPERVISED LEARNING 10 Hrs.

parametric/non-parametric algorithms, support vector machines, kernels, neural networks, Unsupervised learning - clustering, dimensionality reduction, recommender systems, deep learning, Best practices in machine learning (bias/variance theory; innovation process in machine learning and AI, Support vector machines (SVMs), case studies and applications..

UNIT IV: APPLICATIONS OF AI IN BIOTECHNOLOGY 10 Hrs.

Genetic programming and Bioinformatics applications. Bayesian Networks and Fuzzy Neural Networks with case studies. Decision trees –Statistical Learning methods - Introduction to deep learning. Syntactic processing, semantic processing, Gesture recognition, face recognition, speech recognition.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

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

CO1 : Learn about concepts of artificial intelligence and their applications in Bioinformatics
CO2 : Use the knowledge acquired for both problem solving and for reasoning
CO3 : Understand the basic ideas and techniques underlying the design of intelligent computer Systems
CO4 : Use the Techniques and algorithms to address those problems.
CO5 : Focus on problems, the ethical, legal and social issues involved in the field of AI
CO6 : Develop solution AI application in health and biotechnology sector.

TEXT/REFERENCE BOOKS

1. K. G. Srinivasa, G. M. Siddesh, S. R. Manisekhar, "Statistical Modelling and Machine Learning Principles for Bioinformatics Techniques, Tools, and Applications", published by Springer Nature, 2020. ISBN: 9789811524455.
2. Stuart Jonathan Russell and Peter Norvig "Artificial Intelligence: A Modern Approach", Prentice Hall, 2016. ISBN 9781537600314
3. Zheng Rong Yang , "Machine Learning Approaches to Bioinformatics", World Scientific Publishing Co. Pte. Ltd, 2010.ISBN 981-4287-30-X.
4. Vincent François-Lavet, Peter Henderson, Riashat Islam, "An Introduction to Deep Reinforcement Learning", Now Publishers, 2019. ISBN: 9781680835380.

24BT203T					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	50	50	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
4. Develop an understanding of the metabolic pathways of biomolecules and their regulation in biological systems.

UNIT I: INTRODUCTION 10 Hrs.

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 Hrs.

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 Hrs.

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 AND LIPIDS 10 Hrs.

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.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student 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.

TEXT/REFERENCE BOOKS

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

24BT203P					Principles of Biochemistry 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 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, student 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

TEXT/REFERENCE BOOKS

1. Lehninger, “Principles of Biochemistry”, W H Freeman & Co; 8th edition.
2. Robert K. Murry, Daryl K. Granner and Victor W. Rodwell ,”Harper’s Biochemistry”, McGraw-Hill Education.
3. D. Satyanarayan and U.Chakrapani ,”Biochemistry”, Elsevier
4. Conn and Stump, “Outlines of Biochemistry”, New York : Wiley

24BT204T					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	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Gain fundamental knowledge on Structure and functions of the various organs of the human body
- Learn the homeostatic mechanisms and their imbalances in the human body
- Understand the different Various vital physiological parameters of the human body and their clinical significance.
- 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

24BT204P					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 introduce the fundamentals of human anatomy and physiology through practical experiments.
2. To develop skills in using laboratory equipment and performing hematological assessments.
3. To understand and identify the structure and functions of bones, tissues, and organs.
4. To learn vital physiological measurements and their clinical relevance.

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: Demonstrate basic knowledge of human anatomy and physiology through hands-on experiments.

CO2: Identify and describe axial and appendicular bones using charts, models, and specimens.

CO3: Perform hematological tests, including the determination of bleeding and clotting time.

CO4: Accurately measure and interpret physiological parameters like heart rate, pulse rate, body temperature, and blood pressure.

CO5: Use laboratory equipment effectively for studying tissues and physiological processes.

CO6: Apply standard laboratory protocols to analyze physiological data and ensure accuracy in experimentation.

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.

24BT205T					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	50	50	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 I: HISTORY AND CLASSIFICATION 10 Hrs.

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 II: MICROSCOPY AND STAINING 10 Hrs.

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: SUBCELLULAR STRUCTURES 10 Hrs.

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 IV: STERILIZATION & MEDIA AND TECHNIQUES 10 Hrs.

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.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student 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

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

24BT205T					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: Microscopic examination of stained cell preparation-Preparation of bacterial smears
5 Simple staining and gram staining
6 Microscopic examination of live bacterial population-Hanging drop method
7 Biochemical Activities of Microorganisms: IMViC, catalase, oxidase
8 The Fungi Cultivation and identification of unknown fungi by lactophenol cotton blue staining
9 Microbiology of food-Methylene Blue Reductase Test and Microbiological Analysis of Food products
10 Microbiology of water Standard Qualitative analysis of water: Presumptive test, Confirmedtest, Completed Test

COURSE OUTCOMES

On completion of the course, student 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.

TEXT/REFERENCE BOOKS

1. Melvyn Kay, "**Practical Handbook of Microbiology** "(2nd edition), CRC Press, 2008.
2. M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl, **"Brock Biology of Microorganisms"**, 15th Edition. Pearson Education. 2018.

Department of Biotechnology, School of Energy Technology

B.Tech Biotechnology

Course Matrix for Semester – IV (Batch 2024-2028)

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 4	ESC	24BT206T	Industry 4.0 (Department Specific)	2	0	0	2	2
	ESC	24BT206P	Industry 4.0 - Lab (Department Specific)	0	0	2	2	1
	PC	24BT207T	Molecular Biology and Genetics	3	0	0	3	3
	PC	24BT207P	Molecular Biology & Genetics Laboratory	0	0	2	2	1
	PC	24BT208T	Bioprocess Engineering	3	0	0	3	3
	PC	24BT208P	Bioprocess Engineering Lab	0	0	2	2	1
	PC	24BT209T	Human Anatomy and Physiology - II	3	0	0	3	3
	PC	24BT209P	Human Anatomy and physiology Lab -II	0	0	2	2	1
	PC	24BT210T	Analytical Bioinformatics	3	0	0	3	3
	PC	24BT210P	Analytical Bioinformatics Lab	0	0	2	2	1
	OE	24BT221T	Biomedical Informatics	3	0	0	3	3
	Pro	24INT251	Industrial Orientation	0	0	0	0	0

24BT207T					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	50	50	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 12 Hrs.

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: MICROBIAL PATHOGENICITY 12 Hrs.

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 8 Hrs.

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 10 Hrs.

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

TOTAL HOURS: 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 genetic information.
CO4 : Analyse the processes of transcription and translation in both prokaryotes and eukaryotes at 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. Jocelyn Krebs, Stephen Kilpatrick and Elliott Goldstein, "Lewin B., Genes XI", International Edition, Jones & Bartlett Learning, 2017, ISBN 978-1-4496-5985-1
2. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts "Molecular Biology of the Cell", W.W. Norton & Company, ISBN: 0815344643
3. Harvey Lodish, Arnold Berk, Chris Kaiser, Monty Krieger, Matthew Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, "Molecular Cell Biology" by W.H. Freeman publisher, ISBN: 142920314
4. 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.
5. D. Peter Snustad, Michael J. Simmons, "Principles of Genetics", 7th Edition, Wiley 2015.

24BT207P					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

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
CO5 : Evaluate, troubleshoot and validate the molecular biology experiments
CO6 : Design experiments incorporating fundamentals of molecular biology.

TEXT/REFERENCE BOOKS:

1. Jocelyn Krebs, Stephen Kilpatrick and Elliott Goldstein, “Lewin B., Genes XI”, International Edition, Jones & Bartlett Learning, 2017, ISBN 978-1-4496-5985-1
2. D. N. Bharadwaj “Textbook on Molecular Genetics” (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.

24BT208T					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	50	50	100

COURSE OBJECTIVES

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

UNIT I: INTRODUCTION 10 Hrs.

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 II: MEDIA DESIGN AND STERILIZATION KINETICS 10 Hrs.

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 III: DESIGN OF BIOREACTORS 10 Hrs.

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 IV: APPLICATIONS OF BIOPROCESS ENGINEERING 10 Hrs.

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

TOTAL HOURS: 40 Hrs.

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

24BT208P					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
4. To find the non-catalytic homogeneous liquid phase reaction

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

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

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

TEXT/REFERENCE BOOKS

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

24BT209T					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	50	50	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.

24BT209P					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.

24BT210T					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	50	50	100

COURSE OBJECTIVES

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

UNIT I: INTRODUCTION 10 Hrs.

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 II: SEQUENCE ALIGNMENT AND DYNAMIC PROGRAMMING 10 Hrs.

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

UNIT III: SEQUENCE DATABASES, MAPPING AND ALIGNMENT 10 Hrs.

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 IV: MOLECULAR PREDICTION 10 Hrs.

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.

40 Hrs.

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, 2022.
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.

24BT210P					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	--	--	--	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

LIST OF EXPERIMENTS

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. Orpita Bosu, “Bioinformatics: Experiments, Tools, Databases, and Algorithms (Oxford Higher Education)”, 2017.
2. Dev Bukhsh Singh (Editor), Rajesh Kumar Pathak, “Bioinformatics: Methods and Applications”, 1st Edition. 2019
3. Jean-Louis Lassez, “Introduction to Bioinformatics Using Action Labs”, 2020

24BT221T					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 I: INTRODUCTION 10 Hrs.

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 II: COMPUTER ARCHITECTURE AND STANDARDS IN BIOMEDICAL INFORMATICS 10 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 III: HEALTH INFORMATION RESOURCES 10 Hrs.

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 IV: 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.

40 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. Shortliffe and Cimino, “Biomedical Informatics” 2017, Springer.
2. P. Englebardt, Ramona Nelson, “Health Care Informatics: An Interdisciplinary Approach”, Springer 2021, 2nd edition.

Department of Biotechnology, School of Energy Technology

B.Tech Biotechnology

Course Matrix for Semester – V (Batch 2024-2028)

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 5	OE	MOOC	Open Elective 2 ((NPTEL/SWAYAM/MOOC))	3	0	0	3	3
	HSC	24HS301T	Engineering Economics	3	0	0	3	3
	PE	24BT331T	Medical Diagnostics	3	0	0	3	3
		24BT332T	Green Biotechnology and Pollution Abatement					
		24BT333T	Computer Aided Drug Design					
	PC	24BT301T	Genomics & Proteomics	3	0	2	5	4
	PC	24BT301P	Genomics & Proteomics Laboratory	0	0	2	2	1
	PC	24BT302T	Immunology and Immunotechnology	3	0	2	5	4
	PC	24BT302P	Immunology and Immunotechnology Laboratory	0	0	2	2	1
	PC	24BT303T	Animal and Plant Biotechnology	3	0	2	5	4
	PC	24BT303P	Animal and Plant Biotechnology Laboratory	0	0	2	2	1

24BT331T					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.

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.

24BT332T					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. To gain the fundamental understanding on environmental degradation
2. To Learn the different aspects of environmental toxicity
3. Understand the monitoring of environmental pollution
4. Understand the environmental issues and their approach on prevention strategies

UNIT I: ENVIRONMENTAL DEGRADATION 10 Hrs.

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 II: ENVIRONMENTAL TOXICOLOGY 10 Hrs.

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 III: ENVIRONMENTAL MONITORING 10 Hrs.

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 IV: BIOTECHNOLOGICAL METHODS TO POLLUTION ABATEMENT 10 Hrs.

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.

40 Hrs.

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

TEXT/REFERENCE BOOKS

1. Bruce E Rittman and Perry L McCarty, “Environmental Biotechnology, Principles and Applications”, 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

24BT333T					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	25	50	25	--	--	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 I: INTRODUCTION 10 Hrs.

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

UNIT II: PROTEIN STRUCTURE 10 Hrs.

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

UNIT III: STRUCTURE PREDICTION 10 Hrs.

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

UNIT IV: DRUG DISCOVERY 10 Hrs.

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

40 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. Rastogi, S. C., "Bioinformatics; Methods and applications; Genomics, Proteomics and Drug Discovery", PHI Learning Publishers, New Delhi, 2021.
2. Gautham N., "Bioinformatics", Narosa Publishing Company, New Delhi, 2020.
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)

24BT301T					Genomics and Proteomics					
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	50	50	100

COURSE OBJECTIVES

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

UNIT I: 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 II: 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 III: PROTEOME ANALYSIS 10 Hrs.

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 IV: APPLICATIONS OF GENOMICS AND PROTEOMICS ANALYSIS 10 Hrs.

Analysis of Genomes of different organisms – Human, Mouse, *Plasmodium falciparum*, *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.

40 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. B. Alberts, R. Herald, A. Johnson, D. Morgan, M. Raff, K. Roberts and P. Walter. “Molecular Biology of the Cell”, 7th Edition, Norton and Co., publishers, Canada, 2022
2. A. Sobti, M. Mukesh and RC Sobti. “Genomics, Proteomics and Biotechnology”, Taylor and Francis, 2022
3. S. B. Primrose and R.M. Twyman – “Principles of Genome Analysis and Genomics”, 8 th Edition, Blackwell Publishing, 2012.

24BT301TP					Genomics and Proteomics 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 view and use the various molecular modelling databases available on the World Wide Web.
2. To retrieve the Nucleic Acids structural modeling
3. To identify the Protein structure function relationship activity
4. To predict Molecular Dynamics simulation

LIST OF EXPERIMENTS

1 Molecular Dynamics simulation
2 Monte Carlo simulation
3 Visualization of Molecular Dynamics
4 Molecular Docking studies
5 Protein structure function relationship activity
6 NGS different Platforms
7 Sequence Data analysis
8 NGS Resources Tools & Databases
9 Whole Genome Sequencing & Exome Sequencing
10 Genome Annotation (gene fusions, isoforms, and structural variants)

COURSE OUTCOMES

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

CO1 : Retrieve a Molecular simulation of tripeptides and carbohydrate
CO2 : Analyse the structural modelling
CO3 : Analyse and retrieve the different visualizations of Molecular Dynamics
CO4 : Analyse different tools and databases of NGS platform
CO5 : Analyse and retrieve different Genome Annotation
CO6 : Explore the algorithms for assembling NGS data

TEXT/REFERENCE BOOKS

1. Megahed Mohammad, “Genomic Data Analysis” LAP Lambert Academic Publishing, 2019
2. Noam Shomrom “Deep Sequencing Analysis”, Springer, 2018
3. JM Bower and H Bolouri, eds, “Computational modeling of genetic and biochemical networks”, MIT Press 2005
4. Orpita Bosu, “Bioinformatics: Experiments, Tools, Databases, and Algorithms” (Oxford Higher Education) by, 2017.
5. Dev Bukhsh Singh (Editor), Rajesh Kumar Pathak “Bioinformatics: Methods and Applications” 1st Edition . 2019
6. Jean-Louis Lassez “Introduction to Bioinformatics” Using Action Labs, 2020

24BT302T					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	50	50	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 10 Hrs.

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 14 Hrs.

Structure, types and function of MHC, Phagocytosis, Exogenous and Endogenous pathways of antigen processing and presentation; Cytokines - Structure, function, application and 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 8 Hrs.

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

TOTAL HOURS: 40 Hrs.

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 : Illustrate 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. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen,” Kuby J, Immunology”,; Edition, 8 ; Publisher, Macmillan Learning, 2018
3. Janeway's Immunobiology - 9th Edition. 2017, Garland Science
4. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt, Roitt's Essential Immunology"2017, Wiley-Blackwell

24BT302P					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 : 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

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. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen," Kuby J, Immunology",; Edition, 8 ; Publisher, Macmillan Learning, 2018
3. Janeway's Immunobiology - 9th Edition. 2017, Garland Science
4. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt, Roitt's Essential Immunology"2017, Wiley-Blackwell

24BT303T					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	50	50	100

COURSE OBJECTIVES

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

UNIT I: 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 II: 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 III: DESIGN OF GENE CONSTRUCT AND ADVANCED TECHNOLOGIES 10 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 IV: TRANSGENICS PLANTS AND ANIMALS – APPLICATIONS 10 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

40 Hrs.

COURSE OUTCOMES

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

CO1 : Demonstrate the propagation of plant cultures
CO2 : Perform the maintenance and culturing of animal cell
CO3 : Understand the principles of gene construct
CO4 : Get acquainted with the ethical issues involved in transgenic organisms
CO5 : Focus professionally on latest technologies like genome editing
CO6 : Apply their knowledge on transgenic plants in day to day life

TEXT/REFERENCE BOOKS

4. R. Ian Freshney, “Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications”, Eight Edition. Publisher, John Wiley & Sons, 2021.
5. Animal cell culture 3rd ed., by John R.W. “Masters A Practical Approach” Wiley Blackwell Publishers – 2010
6. S. Park. “Plant Tissue Culture: Techniques and Experiments”, Fourth Edition, Elsevier science publishers, 2021.
7. Chawala. H.S., “Introduction to plant Biotechnology”, Third Edition, Oxford and IBH Publishing Co. Pvt. LTD.New Delhi 2021.
8. Grierson,D. “Plant Biotechnology in Agriculture Prospects for the 21st Century”, Academic press, 2012

24BT303P					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

1. To introduce students to the principles of animal and plant cell culture, emphasizing biosafety and ethical practices.
2. To provide hands-on experience in preparing media, maintaining cell cultures, and cryopreserving cell lines.
3. To train students in detecting contaminants and evaluating cell viability and cytotoxicity using standard assays.
4. To teach advanced molecular techniques such as transfection, transformation, and DNA fingerprinting.
5. To develop skills in plant tissue culture, including creating transgenic plants and regenerating tissues for research and applications.

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 Preparation of primary cultures
5 Performance of cell passaging
6 Maintenance of Adherent (Monolayer) and Suspension Cell culture
7 Cryopreservation of cell lines
8 Determination of common cell culture contaminants
9 Cell Viability Assay (MTT reagent)
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 Agrobacterium mediated transformation of plants.
14 Selection and screening of transgenic plants.

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. R. Ian Freshney. “Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications”, Eight Edition. Publisher, John Wiley & Sons, 2021
2. George Acquaah. “Principles of Plant Genetics and Breeding”. Third Edition, Blackwell Publishing, 2020

Department of Biotechnology, School of Energy Technology

B.Tech Biotechnology

Course Matrix for Semester – VI (Batch 2024-2028)

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 6	OE	24BT321T	Molecular Diagnostics	3	0	0	3	3
	PE	24BT334T	Biomaterial and implants	3	0	0	3	3
		24BT335T	Novel Separation Processes – Dyes and Pigments					
		24BT336T	Cheminformatics and Medicinal chemistry					
	PE	24BT337T	Pharmacokinetics and Pharmaco Dynamics	3	0	0	3	3
		24BT338T	Food Biotechnology					
		24BT339T	Next Generation Sequence Analysis					
	PC	24BT304T	Genetic Engineering techniques	3	0	0	3	3
	PC	24BT304P	Genetic Engineering techniques Laboratory	0	0	2	2	1
	PC	24BT305T	Tissue Engineering and Regenerative Medicine	3	0	0	3	3
	PC	24BT205P	Tissue Engineering and Regenerative Medicine Laboratory	0	0	2	2	1
	PC	24BT306T	Pharmacology of Drug Action	3	0	0	3	3
	PC	24BT306P	Pharmacology of Drug Action Laboratory	0	0	2	2	1

24BT321T					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

24BT334T					Biomaterial & Implants					
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 learn the fundamentals of Biomaterial & Implants
2. To understand the basic concept of bio materials that are used in medical devices.
3. To acquire the knowledge on Bio-materials
4. To compare the testing protocols of wide range of Bio implants and devices

UNIT I: INTRODUCTION TO BIOMATERIALS 10 Hrs.

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 Hrs.

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 Hrs.

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 Foreign Body Response, Impact of Biofilm formation on biomaterials.

UNIT IV: BIO-IMPLANTS 10 Hrs.

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.

40 Hrs.

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

24BT335T					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. To understand the pigmentary property, chemistry behind the colorants.
2. To explain its applications in various field according to the chemistry involved.
3. To create awareness on testing of pigments synthesis processing and applications of dyes pigments lakes
4. To narrate basic aspects of separation processes

UNIT I: NOVEL SEPARATION PROCESS 12 Hrs.

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 II: POLYMERS 10 Hrs.

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 III: DYES AND PIGMENTS 10 Hrs.

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 IV: REMEDIATION PROCESSES 10 Hrs.

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 for industrial dye removal

42 Hrs.

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. Jens Nielsen, Gregory Stephanopoulos, Sang Yup Lee, “Metabolic Engineering: Concepts and Applications”, Wiley , 2021
2. P. Wankat “Separation Process Engineering”. Fifth Edition. 2022
3. AM Lane. “Separation Process Essentials”. CRC Press 2020.
4. F. W. Billmeyer Jr. “Textbook of Polymer Science” John Wiley & sons , 2017
5. P. S. Vankar “Handbook on Natural Dyes for Industrial Applications”, National Institute of Industrial Research, 2016

24BT336T					Cheminformatics & Medicinal 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

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

UNIT I: CHEMISTRY & INFORMATION TECHNOLOGY 10 Hrs.

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 II: MOLECULAR DRAWING AND INTERACTIVE VISUALIZATION 10 Hrs.

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 III: MECHANISM 10 Hrs.

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 IV: STRUCTURE ACTIVITY RELATIONSHIPS 10 Hrs.

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.

40 Hrs.

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,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. Foye. “Essentials of Foye's Principles of Medicinal Chemistry” – 2016.

24BT337T					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. To understand the kinetics of drug absorption, distribution, metabolism, excretion, elimination.
2. To impart the Pharmacodynamics of drug action and drug interactions
3. To analyse various pharmacokinetic & pharmacodynamics parameters, their significance & applications.
4. To compare the Bioavailability and bioequivalence of drug products and their significance.

UNIT I: ABSORPTION AND DISTRIBUTION 10 Hrs.

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

UNIT II: METABOLISM AND EXCRETION 10 Hrs.

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 III: PHARMACODYNAMICS & DRUG INTERACTIONS 10 Hrs.

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 IV: APPLICATION OF PHARMACOKINETICS & DYNAMICS 10 Hrs.

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.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

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

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/REFERENCE BOOKS

1. D. M. Brahmankar and Sunil B.Jaiswal, “Bio pharmaceutics and Pharmacokinetics-A Treatise”, Vallabh Prakashan Pitampura, Delhi .
2. Leon Shargel and Andrew B,” Applied biopharmaceutics and pharmacokinetics,” Mc Graw Hill.
3. Remington,”Remington’s Pharmaceutical Sciences”, Mack Publishing Company,.
4. Abdou H.M, “Dissolution, Bioavailability and Bioequivalence” Mack Publishing Company, Pennsylvania.
5. Malcolm Rowland and Thomas, N. Tozen,”Clinical Pharmacokinetics, Concepts and Applications”, Lippincott Williams and Wilkins.
6. Milo Gibaldi, “Biopharmaceutics and Clinical Pharmacokinetics” Pharma Book Syndicate.

24BT338T					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 emphasize the concept of functional foods and different fermented foods
4. To comprehend the principles behind important analytical techniques employed in biotechnology as well as in genetic modification of foods.

UNIT I: FOOD PROCESSING AND PRESERVATION 10 Hrs.

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 II: FOOD BIOTECHNOLOGY 10 Hrs.

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 III: FERMENTATION FOOD BIOTECHNOLOGY 10 Hrs.

Fermented foods: 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 IV: FOOD SAFETY AND REGULATION 10 Hrs.

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.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

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

CO1 : Demonstrate the propagation of plant cultures
CO2 : Perform the maintenance and culturing of animal cell
CO3 : Understand the principles of gene construct
CO4 : Get acquainted with the ethical issues involved in transgenic organisms
CO5 : Focus professionally on latest technologies like genome editing
CO6 : Apply their knowledge on transgenic plants in day to day life

TEXT/REFERENCE BOOKS

1. B. Lee, “Fundamentals of Food Biotechnology”, 2nd Edition, Wiley-Blackwell Publishers, 2020

2. SC Bhatia, “Food Biotechnology (Woodhead Publishing India in Food Science, Technology and Nutrition)”, CRC Press, 2017
3. HD Belitz, W. Grosch, P Schieberle. “Food Chemistry”, Springer, 2009

24BT339T					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 I: INTRODUCTION 10 Hrs.

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 II: TECHNOLOGIES FOR TRANSCRIPTOMICS AND REGULATORY GENOMICS 10 Hrs.

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

UNIT III: SOFTWARE AND PIPELINES FOR NGS DATA ANALYSIS 10 Hrs.

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

UNIT IV: GENOME SEQUENCING AND APPLICATIONS IN GENETICS STUDIES 10 Hrs.

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.

40 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. Noam Shomrom, "Deep Sequencing Analysis", Springer, 2018
3. Fall, C.P., Marland, E.S., Wagner, J.M., Tyson, J.J, "Computational Cell Biology", Springer, 2018.
4. Megahed Mohammad, "Genomic Data Analysis", LAP Lambert Academic Publishing, 2017
5. Choi Sangdun, "Introduction to System Biology", Humana Press/Trtowa/New Jersey, 2013.

24BT304T					Genetic Engineering Techniques					
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	50	50	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 10 Hrs.

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 II: INTRODUCTION OF DNA INTO CELLS AND SELECTION OF RECOMBINANTS 10 Hrs.

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 III: RECOMBINANT DNA METHODS 10 Hrs.

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 IV: TECHNIQUES IN BIOTECHNOLOGY 10 Hrs.

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

40 Hrs.

COURSE OUTCOMES

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

CO1 : Memorize the Principles and importance of gene cloning
CO2 : Explain various methods for screening of recombinants and identification of cloned gene
CO3 : Apply the methods of Polymerase chain reaction and DNA sequencing.
CO4 : Analyze the application of recombinant technology
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. S. B. Primrose, R. Twyman, R.W. Old, "Principles of Gene Manipulation", Wiley-Blackwell; 7th Edition. 2013
4. Bruce Alberts, "Molecular Biology of the cell", 6th edition. New York: Garland Science; 2014
5. Jane K. Setlow, "Genetic Engineering: Principles and Methods", Alexander Hollaender. Volume 6. 2006

24BT304P					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 : Memorize the Principles and importance of gene cloning
CO2 : Paraphrase various methods to transfer foreign genes
CO3 : Apply concepts of gene cloning principles
CO4 : Analyze experimental data obtained from molecular biology experiments
CO5 : Assess innovative approaches for gene manipulation, recombinant DNA technology
CO6 : Design construct the recombinant vector and develop genetically modified organisms

TEXT/REFERENCE BOOKS

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)

<24BT305T					Tissue Engineering & Regenerative Medicine					
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	50	50	100

COURSE OBJECTIVES

1. Learn the Basics of Tissue Engineering: Understand tissue structure, repair mechanisms, and cell-matrix interactions essential for tissue engineering.
2. Understand Biomaterials and Their Use: Explore biomaterials' properties, types, and applications in scaffold design and nanotechnology.
3. Gain Knowledge of Stem Cells: Learn about stem cell biology, differentiation, and their therapeutic potential in regenerative medicine.
4. Explore Advances in Tissue Engineering: Study innovative techniques like 3D bioprinting and address safety, ethical, and regulatory aspects.

UNIT I: TISSUE ARCHITECTURE 10 Hrs.

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 Hrs.

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 Hrs.

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 10 Hrs.

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.

TOTAL HOURS: 40 Hrs.

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 and Regenerative 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.

24BT305P					Tissue Engineering and Regenerative Medicine 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 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

LIST OF EXPERIMENTS

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

24BT306T					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 get 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 I: 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 II: DRUGS ACTING ON PERIPHERAL NERVOUS SYSTEM AND AUTOCOIDS 10 Hrs.

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

UNIT III: 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 IV: 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.

42 Hrs.

COURSE OUTCOMES

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

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", Lippincott Williams and Wilkins.
2. Rang H. P., Dale M. M., Ritter J. M., Flower R. J."Rang and Dale's Pharmacology" ,.Churchil Livingstone Elsevier.
3. Kulkarni SK. "Handbook of experimental pharmacology", Vallabh Prakashan Publisher.
4. Katzung B. G., Masters S. B., Trevor A. J." Basic and clinical pharmacology", Tata Mc Graw-Hill.
5. Bjorn Knollmann, "Goodman and Gilman's The Pharmacological Basis of Therapeutics", McGraw-Hill Education.
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. "Applied Therapeutics, The Clinical use of Drugs," The Lippincott Williams &Wilkins.
8. K.D.Tripathi. "Essentials of Medical Pharmacology", Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.
9. Charles R.Craig & Robert ,"Modern Pharmacology with clinical Applications", Lippincott Williams and Wilkins.

24BT306P					Pharmacology of Drug Action 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 familiarize students with the principles and methodologies of experimental pharmacology using simulation software and in vitro techniques.
2. To develop hands-on skills for evaluating pharmacological effects through ethical alternatives to animal experiments.
3. To provide an understanding of the pharmacological actions of drugs on various physiological systems using computational and in vitro approaches.
4. To enhance critical thinking and problem-solving abilities through the analysis and interpretation of pharmacological data from virtual and in vitro experiments.

List of Experiments

1. Introduction to experimental pharmacology
2. To study analgesic activity by writhing test (Software Based)
3. Study of Analgesic activity with the help of "Tail Flick Apparatus" (Analgesiometer) (Software Based)
4. Study of Muscle Relaxant activity with the help of "Rota-Rod Apparatus"(Software Based)
5. Study of CNS Depressants & Stimulants Using "Actophotometer"(Software Based)
6. Study of Drugs acting on CNS (Including Anxiolytic Activity) using following modules- Elevated Plus Maze Method (Software Based)
7. The effect of insulin (hypoglycemic activity) and alloxan on blood glucose (Software Based lab)
8. To study PTZ induced convulsions in mice (Software Based)
9. Prediction of Drug toxicity using ADMET analysis (Software Based)
10. Brime Shrim Lethality Assay – *In vitro*
11. Alpha Amylase enzyme inhibition assay- *In vitro*
12. Protein albumin denaturation assay- *In vitro*

COURSE OUTCOMES

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

CO1 : Demonstrate proficiency in using software tools and in vitro techniques for pharmacological experiments.

CO2 : Evaluate drug activity, toxicity, and efficacy through simulations and laboratory-based assays.

CO3 : Correlate pharmacological principles with experimental outcomes obtained via ethical alternatives.

CO4 : Interpret pharmacokinetic and pharmacodynamic data using *in silico* and *in vitro* methodologies.

CO5 : Design and conduct experiments ethically, adhering to the principles of 3Rs (Replacement, Reduction, Refinement).

CO6 : Critically analyze experimental data to derive conclusions relevant to drug action and safety.

TEXT/REFERENCE BOOKS

1. Kulkarni, S. K. (2019). Handbook of Experimental Pharmacology. Vallabh Prakashan. A comprehensive resource for experimental methods in pharmacology, including simulation techniques.
2. Rang, H. P., Dale, M. M., Ritter, J. M., & Flower, R. J. (2020). Rang and Dale's Pharmacology. Elsevier. Focuses on pharmacological concepts and experimental methods.
3. OECD Guidelines for Testing Chemicals (2021). Details ethical alternatives for toxicity and pharmacological testing.
4. ADMET Predictor® User Guide. (2022). Simulations Plus. Reference guide for ADMET analysis and predictive modeling.
5. Russell, W. M. S., & Burch, R. L. (1959). The Principles of Humane Experimental Technique. Foundational text on the 3Rs for ethical experimentation.

Department of Biotechnology, School of Energy Technology

B.Tech Biotechnology

Course Matrix for Semester – VII (Batch 2024-2028)

Semester	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 7	PRO	24INT451	Summer Internship	0	0	0	0	2
	OE	24BT421T	Biosimilars Technology	3	0	0	3	3
	PE	24BT431T	Pharmaceutical Biotechnology	3	0	0	3	3
		24BT432T	Synthetic and systems biology					
		24BT433T	Metabolic engineering					
	PE	24BT434T	Biomass conversion and Utilisation	3	0	0	3	3
		24BT435T	Stem Cell Technology					
		24BT436T	Molecular Data Analysis and Simulations					
	PC	24BT401T	Bioethics, IPR and Biosafety	4	0	0	4	4
	PC	24BT402T	Nanotechnology	3	0	0	3	3
	PC	24BT402P	Nanotechnology Laboratory	0	0	2	2	1
	PC	24BT403T	Downstream Processing	3	0	0	3	3
	PC	24BT403P	Downstream Processing Laboratory	0	0	2	2	1
	PRO	24PRBT451	Seminar					1

24INT451					Summer Internship					
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.

24BT421T					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

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.

24BT431T					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

1. To understanding the importance pharmaceutical products.
2. To develop the skills necessary for employing pharmaceutical biotechnology principles.
3. To learn the significance of pharmaceutical preparation and method of production of Vaccines and protein based drugs
4. 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.
2. Rang H. P., Dale M. M., Ritter J. M., Flower R. J, "Rang and Dale's Pharmacology",Churchil Livingstone Elsevier.
3. Katzung B. G., Masters S. B., Trevor A. J,"Basic and clinical pharmacology", Tata Mc Graw-Hill.

4. K.D.Tripathi, “Essentials of Medical Pharmacology”, JAYPEE Brothers Medical Publishers (P) Ltd, New Delhi.
5. Ashok Mulchandani and Kim Rogers, “Enzyme and Microbial Biosensors: Techniques and Protocols”,Springer.
6. Bjorn Knollmann, “Goodman and Gilman’s, The Pharmacological Basis of Therapeutics”, McGraw-Hill Education.
7. Sharma H. L., Sharma K. K., “Principles of Pharmacology”, Paras medical publisher.
8. Lachman Liebermans., “The Theory and Practice of Industrial Pharmacy”, 4th Edition, CBS publisher.
9. Loyd.V.Allen., “ Ansel’s Pharmaceutical Dosage Form and Drug Delivery System”, 11th Edition, Wolters Kluwer India Pvt. Ltd publisher.
10. Parthasarathi G, Karin Nyfort-Hansen, Milap C Nahata, “A textbook of Clinical Pharmacy Practice-essential concepts and skills, Orient Longman Private Limited publisher.

24BT432T					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 I: INTRODUCTION 10 Hrs.

Transcriptional and Post-transcriptional regulation: Biology & engineering systems, modeling foundation: Chemical kinetics (M-M equation and Hill function), Deterministic models, And Stochastic models Spatiotemporal models. Noise in gene expression: Origin, propagation, consequences, and control, Robustness and evaluability of genetic networks, Bacterial circuits.

UNIT II: SYNTHETIC CIRCUITS 10 Hrs.

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 III: NETWORK BIOLOGY AND APPLICATIONS 10 Hrs.

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 IV: 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.

TOTAL HOURS: 40 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.

24BT433T	Metabolic 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 analyze mechanisms of Metabolic Control
2. To evaluate strategies for enhancing Primary Metabolite Production
3. To understand the regulation of Secondary Metabolite Biosynthesis
4. To design and analyze bioconversion Strategies

UNIT I: INTRODUCTION 12 Hrs.

Induction-Jacob Monod Model, catabolite regulation, glucose effect, camp deficiency, feedback regulation, regulation in branched pathways, differential regulation by isoenzymes, concerted feedback regulation, cumulative feedback 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 Hrs.

Alteration of feedback regulation, limiting accumulation of end products, feedback, resistant mutants, alteration of permeability.

UNIT III: BIOSYNTHESIS OF SECONDARY METABOLITES 10 Hrs.

Precursor effects, prophophase, idiophase relationships, enzyme induction, feedback regulation, catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites.

UNIT IV: BIOCONVERSIONS 10 Hrs.

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.

OTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student 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. Jens Nielsen, Gregory Stephanopoulos, Sang Yup Lee, “Metabolic Engineering: Concepts and Applications”, Wiley , 2021
2. Wang D. I. C., Cooney C. L., Demain A. L., Dunnil P., Humphrey A. E., Lilly M. D., “Microbial Fermentation and Enzyme Technology”, John Wiles and Sons., 2020.
3. Stanbury P. F. and Whitaker A., “Principles of Fermentation Technology”, Pergamon Press, 2016.
4. Palmer T., “Enzymes”, Horwood Publishers, 2001

.

24BT434T					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. To understand the pigmentary property, chemistry behind the colorants.
2. To differentiate the various biomass conversions procedures
3. To familiarize the properties of biomass and its energy products
4. To apply the concepts in the production and utilisation of biodiesel

UNIT I: BIOMASS – ENERGY SOURCE 10 Hrs.

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 II: THERMAL AND CHEMICAL CONVERSION 10 Hrs.

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 III: BIOLOGICAL CONVERSION 10 Hrs.

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 IV: BIODIESEL AND BIOMASS GASIFICATION 10 Hrs.

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

40 Hrs.

COURSE OUTCOMES

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

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 : Apply the biomass assessment techniques.

TEXT/REFERENCE BOOKS

1. P. Wankat. “Separation Process Engineering”. Fifth Edition. 2022
2. DB Pal, P. Singh “Utilization of Waste Biomass in Energy”, Environment and Catalysis, CRC Press, 2022
3. NP Nghiem, TH Kim, CG Yoo. “Biomass utilization Conversion Strategies”, Springer, 2023.

4. Erik Dahlquist, “Biomass as Energy Source: Resources, systems and applications”, Sustainable Energy Developments series, 2013, CRC Press, Taylor and Francis Group.
5. D.P.Kothari, K.C Singal and Rakesh Ranjan “Renewable Energy Sources And Emerging Technologies”, 2011, PHI Learning Private Ltd, New Delhi.

24BT435T					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 I: INTRODUCTION TO STEM CELLS AND STEM CELL NICHE 10 Hrs.

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 II: CELL CYCLE AND DEVELOPMENT & EPIGENETIC CONTROL 10 Hrs.

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.

UNIT III: TYPES AND REGENERATION 10 Hrs.

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 IV: THERAPEUTIC APPLICATIONS OF STEM CELLS AND ETHICAL ISSUES 10 Hrs.

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.

TOTAL HOURS: 40 Hrs.

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 : Design construct the recombinant vector and develop genetically modified organisms

TEXT/REFERENCE BOOKS

1. Treleaven, J," Hematopoietic Stem Cell Transplantation", first edition 2009.
2. Lanza, R," Essentials of Stem Cell Biology" second Edition, 2009 Academic Press.
3. Lodish et al, Molecular Cell Biology by sixth Ed., W.H. Freeman & Co. 2021.
4. Alexander Battler, Jonathan Leo, "Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine", Springer. 2006.

24BT436T					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

1. Learn the critical relationship among bimolecular structure, function and force field models.
2. Gain the fundamental on drug/receptor interactions using in silico techniques.
3. Create interest in learning molecular mechanics, molecular dynamics simulations and homology modeling.
4. Understand the basic modeling techniques to explore biological phenomena at the molecular level.
5. Learn the concepts of energy minimisation and force fields.

UNIT I: INTRODUCTION 10 Hrs.

Useful Concepts in Molecular Modelling, Coordinate Systems, Internal Coordinates, Potential Energy Surfaces, Molecular Graphics, Surfaces, Computer Hardware and Software, The Molecular Modelling Literature.

UNIT II: FORCE FIELDS 10 Hrs.

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 III: MOLECULAR DYNAMICS AND MONTE CARLO SIMULATION 10 Hrs.

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 IV: ENERGY MINIMISATION AND COMPUTER SIMULATION 10 Hrs.

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.

TOTAL HOURS: 40 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.

24BT401T					Bioethics, IPR and Biosafety					
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 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

UNIT I: INTELLECTUAL PROPERTY RIGHTS 10 Hrs.

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 II: PATENT RIGHTS 10 Hrs.

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

UNIT III: BIOETHICS 10 Hrs.

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 IV: BIOSAFETY 10 Hrs.

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

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

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.

24BT402T					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	50	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 applicationof the principles of nano chemistry in real world problems.

UNIT I: INTRODUCTION 10 Hrs.

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

UNIT II: SYNTHESIS OF NANO-MATERIALS 10 Hrs.

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 OF NANO-MATERIALS 10 Hrs.

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 tunnelling 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 NANO-MATERIALS 10 Hrs.

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.

42 Hrs.

COURSE OUTCOMES

On completion of the course, student 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. Cao G ,"**Nanostructures and Nanomaterials: Synthesis, Properties and Applications**" 2011, Imperial College Press.
2. Reich S and Maultzsch J, "**Carbon Nanotubes – Basic Concepts and Physical Properties**" 2008, Wiley.
3. Chattopadhyay K K ,"**Introduction to Nanoscience and Nanotechnology**", 2009, Prentice Hall India Learning Private Limited.
4. Sulabha K Kulkarni ,"**Nanotechnology: Principles and Practices**", 2014, Springer International Publishing

24BT402P	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, student 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. Guozhong Cao and Ying Wang," Nanostructures and Nanomaterials: Synthesis, Properties and Applications" 2011, Imperial College Press.
2. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore," Introduction to Nanoscience and Nanotechnology" by, 2008, Wiley.

24BT403T	Downstream Processing

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 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.
4. To integrate Advanced Bio-separation Techniques: Explore cutting-edge methods and technologies in downstream processing for efficient and sustainable recovery of bio-products at an industrial scale.

UNIT I: INTRODUCTION TO SCHEMATICS OF DOWNSTREAM PROCESSING 10 Hrs.

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 10 Hrs.

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 10 Hrs.

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 10 Hrs.

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

TOTAL HOURS: 40 Hrs.

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).

24BT403P	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	--	--	--	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 Partial purification of intracellular/ extracellular products from microbial /plant sources—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 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: Demonstrate the ability to extract and partially purify biomolecules from microbial or plant sources.
CO2: Apply membrane filtration and salt precipitation techniques for protein concentration and separation.
CO3: Perform dialysis for effective salt removal and buffer exchange in protein solutions.
CO4: Isolate carbohydrate-digesting enzymes from cereal kernels using solid-liquid extraction methods.
CO5: Employ advanced liquid-liquid extraction methods, including aqueous two-phase and reverse micellar processes.
CO6: Utilize gel filtration, organic solvent extraction, and adsorption techniques for metabolite separation and enrichment.

TEXT/REFERENCE BOOKS

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

24PRBT451					Seminars					
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	-	-	-	-	-	-

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.

Department of Biotechnology, School of Energy Technology

B.Tech Biotechnology

Course Matrix for Semester – VIII (Batch 2024-2028)

Semester	Category code as per NEP	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
Semester 8	Project	PRO	24PRBT452	Major Project	0	0	24	24	12
			24PRBT453	Comprehensive Project					

Major Project

24PRBT452					Major Project					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	24	12	24	-	-	-	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.
   - Biopharmaceutical Development: Scale-up production of biologics such as vaccines, monoclonal antibodies, and biosimilars using recombinant DNA technology. Explore fermentation and cell culture techniques for high-yield production.
   - Nanomedicine: Develop nanotechnology-based drug delivery systems for targeted therapies. Design nanoparticles for imaging, diagnosis, and treatment of diseases like cancer and cardiovascular disorders.
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.

6. 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.

COURSE OUTCOMES

CO1: Design and execute independent biotechnology research projects addressing challenges in healthcare, agriculture, and industry.

CO2: Demonstrate proficiency in laboratory techniques and computational tools for advanced biotechnology research.

CO3: Apply bioinformatics approaches such as molecular modeling, multi-omics integration, and systems biology to solve biological problems.

CO4: Develop innovative solutions in medical biotechnology, including drug discovery, diagnostics, and personalized medicine.

CO5: Utilize biotechnology tools to improve agricultural productivity, environmental sustainability, and industrial processes.

CO6: Communicate scientific findings effectively through written reports, oral presentations, and collaborative discussions.