COURSE SCHEME

FOR

B. TECH. – BIOTECHNOLOGY

2022

Approved in 107th meeting of the Senate held on June 16, 2022

FIRST SEMESTER

S. NO.	COURSE NO.	COURSE NAME	Cat	L	T	P	Cr
1	UMA005 OR UMA010	INTRODUCTORY MATHEMATICS-I (*for NEET students*) OR MATHEMATICS-I (*for JEE students*)	BSC	3	1	0	3.5
2	UTA003	COMPUTER PROGRAMMING	ESC	3	0	2	4.0
3	UPH004	APPLIED PHYSICS	BSC	3	1	2	4.5
4	UHU003	PROFESSIONAL COMMUNICATION	HS	2	0	2	3.0
5	UTA015	ENGINEERING DRAWING	ESC	2	4	0	4.0
6	UBT008	CELL BIOLOGY AND GENETICS	BSC	3	0	0	3.0
		TOTAL		**16**	**6**	**6**	**22.0**

SECOND SEMESTER

S. NO.	COURSE NO.	COURSE NAME	Cat	L	T	P	Cr
1	UTA027	ARTIFICIAL INTELLIGENCE	ESC	3	0	2	4.0
2	UMA006 OR UMA004	INTRODUCTORY MATHEMATICS-II (*for NEET students*) OR MATHEMATICS-II (*for JEE students*)	BSC	3	1	0	3.5
3	UBT004	BIOCHEMISTRY-I	PCC	3	0	2	4.0
4	UEN002	ENERGY AND ENVIRONMENT	ESC	3	0	0	3.0
5	UCB008	APPLIED CHEMISTRY	BSC	3	1	2	4.5
6	UBT301	MICROBIOLOGY	PCC	3	0	2	4.0
		TOTAL		**18**	**2**	**8**	**23.0**

THIRD SEMESTER

S. NO.	COURSE NO.	COURSE NAME	Cat	L	T	P	Cr
1	UCH301	MATERIAL AND ENERGY BALANCES	PCC	3	1	0	3.5
2	UBT305	FOOD SCIENCE AND NUTRITION	PCC	3	0	2	4.0
3	UBT504	IMMUNOTECHNOLOGY	PCC	3	0	2	4.0
4	UBT303	BIOCHEMISTRY-II	PCC	3	0	2	4.0
5	UBT306	MOLECULAR BIOLOGY	PCC	3	0	2	4.0
6	UPH012	BIOPHYSICS AND BIOMATERIALS	BSC	3	0	0	3.0
		TOTAL		**18**	**1**	**8**	**22.5**

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FOURTH SEMESTER

S. NO.	COURSE NO.	COURSE NAME	Cat	L	T	P	Cr
1	UBT501	BIOANALYTICAL TECHNIQUES	PCC	3	0	2	4.0
2	UBT503	GENETIC & METABOLIC ENGINEERING	PCC	3	0	2	4.0
3	UBT405	BIOSTATISTICS	BSC	2	0	2	3.0
4	UCH407	UNIT OPERATIONS	ESC	3	1	2	4.5
5	UBT508	TRANSDUCERS AND BIOSENSORS	PCC	3	1	2	4.5
		TOTAL		**14**	**2**	**10**	**20.0**

FIFTH SEMESTER

S. NO.	COURSE NO.	COURSE NAME	Cat	L	T	P	Cr
1	UBT601	ANIMAL BIOTECHNOLOGY	PCC	3	0	2	4.0
2	UBT603	BIOPROCESS ENGINEERING	PCC	3	1	2	4.5
3	UBT605	PLANT BIOTECHNOLOGY	PCC	3	0	2	4.0
4	UBT604	PHARMACEUTICAL TECHNOLOGY	PCC	3	0	2	4.0
5	UTA025	INNOVATION AND ENTREPRENEURSHIP	HS	1	0	2#	3.0
6		ELECTIVE I	PEC	3	0	0	3.0
		TOTAL		**16**	**1**	**10**	**22.5**

#Alternate week

SIXTH SEMESTER

S. NO.	COURSE NO.	COURSE NAME	Cat	L	T	P	Cr
1	UHU005	HUMANITIES FOR ENGINEERS	HS	2	0	2	3.0
2	UBT606	DOWNSTREAM PROCESSING	PCC	3	1	2	4.5
3	UBT610	INDUSTRIAL BIOTECHNOLOGY	PCC	3	0	0	3.0
4	UBT613	BIOINFORMATICS	PCC	3	0	2	4.0
5	UBT614	BIOSAFETY, BIOETHICS & IPR	HS	2	0	0	2.0
6	UBT891	CAPSTONE PROJECT (STARTS)	PS	1#	0	2	0.0
7		ELECTIVE II	PEC	3	0	2	4.0
8	UBT615	JOURNAL CLUB	PS	0	0	0	2.0
		TOTAL		**17**	**1**	**10**	**22.5**

Alternate week

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SEVENTH SEMESTER

S. NO.	COURSE NO.	COURSE NAME	Cat	L	T	P	Cr
1	UBT796	PROJECT SEMESTER	PS	0	0	0	15.0
OR							
1	UBT797	PROJECT		0	0	0	8.0
2	UBT705	GENOMICS AND PROTEOMICS		3	1	0	3.5
3	UBT706	ENZYME TECHNOLOGY		3	1	0	3.5
OR							
1	UBT798	START UP SEMESTER*		0	0	0	15.0
		TOTAL		**0**	**0**	**0**	**15.0**

*Based on hands on work on Innovation & Entrepreneurship

EIGHTH SEMESTER

S. NO.	COURSE NO.	COURSE NAME	Cat	L	T	P	Cr
1	UBT802	NANOBIOTECHNOLOGY	PCC	3	1	0	3.5
2	UBT832	CONCEPTS IN BIOMEDICAL INSTRUMENTATION	ESC	3	0	2	4.0
3		ELECTIVE-III	PEC	3	0	0	3.0
4		ELECTIVE-IV	PEC	3	0	2	4.0
5		GENERIC ELECTIVE	OS	2	0	0	2.0
6	UBT891	CAPSTONE PROJECT	PS	1#	0	2	8.0
		TOTAL		**15**	**1**	**6**	**24.5**

Alternate week

Semester	EL Activity**
I	Milk Adulteration detection kit
II	Designing PCR primers
III	Structure analysis of Spike protein in SARS-COV-2 virus
IV	Development of a solid phase denitrification bio-filter
V	Peptide based vaccine design against SARS-COV-2 virus

** Theses EL activities can be changed in subsequent years, if required.

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ELECTIVE-I

S. NO.	COURSE NO.	COURSE NAME	L	T	P	Cr
1	UBT512	STRUCTURAL BIOLOGY	3	0	0	3.0
2	UBT513	CELL AND TISSUE ENGINEERING	3	0	0	3.0
3	UBT514	NATURAL PRODUCTS	3	0	0	3.0

ELECTIVE-II

S. NO.	COURSE NO.	COURSE NAME	L	T	P	Cr
1	UBT608	FOOD PROCESSING	3	0	2	4.0
2	UBT617	MEDICAL BIOTECHNOLOGY	3	0	2	4.0
3	UBT616	PROTEIN ENGINEERING	3	0	2	4.0

ELECTIVE-III

S. NO.	COURSE NO.	COURSE NAME	L	T	P	Cr
1	UBT837	CANCER BIOLOGY	3	0	0	3.0
2	UBT838	STEM CELL TECHNOLOGY	3	0	0	3.0
3	UBT839	DRUG DESIGN AND DEVELOPMENT	3	0	0	3.0

ELECTIVE-IV

S. NO.	COURSE NO.	COURSE NAME	L	T	P	Cr
1	UBT822	ENVIRONMENTAL BIOTECHNOLOGY	3	0	2	4.0
2	UBT841	MOLECULAR DIAGNOSTICS	3	0	2	4.0
3	UBT843	COMPUTATIONAL BIOLOGY	3	0	2	4.0

GENERIC ELECTIVE

S. NO.	COURSE NO.	TITLE	L	T	P	Cr
1	UHU016	INTRODUCTORY COURSE IN FRENCH	2	0	0	2.0
2	UCS002	INTRODUCTION TO CYBER SECURITY	2	0	0	2.0
3.	UTD002	EMPLOYABILITY DEVELOPMENT SKILL	2	0	0	2.0
4.	UHU017	INTRODUCTION TO COGNITIVE SCIENCE	2	0	0	2.0
5.	UHU018	INTRODUCTION TO CORPORATE FINANCE	2	0	0	2.0
6.	UEN006	TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT	2	0	0	2.0
7.	UPH064	NANO SCIENCE AND NANO-MATERIALS	2	0	0	2.0
8.	UMA069	GRAPH THEORY AND APPLICATIONS	2	0	0	2.0
9.	UMA070	ADVANCED NUMERICAL METHODS	2	0	0	2.0
10.	UBT510	BIOLOGY FOR ENGINEERS	2	0	0	2.0

TOTAL NUMBER OF CREDITS: 172 (164 + 8)

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UMA005: INTRODUCTORY MATHEMATICS-I

L	T	P	Cr
3	1	0	3.5

Course objective: The objective is to develop the basics of computing skills and application of quantitative and statistical operations required for biological studies.

Detail contents:

Algebra: Complex numbers, Solution of quadratic equations, Permutations and combinations, Binomial theorem for positive/negative index and its simple applications, Arithmetic and geometric progression

Trigonometry: Review of trigonometric functions, Sum and product formulae for trigonometric functions, Trigonometric equations and sum - to - product formulae for trigonometric functions, Identities related to double angle formulae

Determinants and Matrices: Matrices, Operations on matrices, Determinants and its properties, Singular and non-singular matrices, Adjoint and inverse of a matrix and its properties, Solution of system of linear equations using Cramer's rule and matrix method

Coordinate Geometry: Rectangular coordinate system, Straight lines, Circles (in standard form only)

Statistics: Measure of dispersion: mean deviation, Variance and standard deviation of grouped/ungrouped data. Correlation and regression

Course Learning Outcomes (CLO):

Students will be able to

1) acquire knowledge of basic algebra, trigonometry, matrices, coordinate geometry etc.
2) apply these concepts to solve complex mathematical problems
3) analyse the data of any experiment statistically to extract meaningful result
4) tackle any mathematical challenge that usually occurs during their biological studies.

Text books:

1. *Mathematics, A Text books (Parts I & II), NCERT, New Delhi (2011).*
2. *Kreyszig, Erwin, Advanced Engineering Mathematics, John Wiley, (1999).*

Reference Books:

1. *Krishnamurthy V.K., Mainra V.P. and Arora J.L. An introduction to Linear Algebra, Associated East West Press (2007).*
2. *Loney, S. L., The elements of Coordinate Geometry, Michigan Historical Reprint series, (2012) 3) Meyer, P. L., Introductory Probability and Statistical Applications, Addison Wesley (1970).*

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Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

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UMA010: MATHEMATICS – I

L	T	P	Cr
3	1	0	3.5

Course Objectives: To provide students with skills and knowledge in sequence and series, advanced calculus, calculus of several variables and complex analysis which would enable them to devise solutions for given situations they may encounter in their engineering profession.

Detail contents:

Partial Differentiation: Functions of several variables, Limits and continuity, Chain rule, Change of variables, Partial differentiation of implicit functions, Directional derivatives and its properties, Maxima and minima by using second order derivatives

Multiple Integrals: Double integral (Cartesian), Change of order of integration in double integral, Polar coordinates, graphing of polar curves, Change of variables (Cartesian to polar), Applications of double integrals to areas and volumes, evaluation of triple integral (Cartesian)

Sequences and Series: Introduction to sequences and Infinite series, Tests for convergence/divergence, Limit comparison test, Ratio test, Root test, Cauchy integral test, Alternating series, Absolute convergence and conditional convergence

Series Expansions: Power series, Taylor series, Convergence of Taylor series, Error estimates, Term by term differentiation and integration

Complex analysis: Introduction to complex numbers, geometrical interpretation, functions of complex variables, examples of elementary functions like exponential, trigonometric and hyperbolic functions, elementary calculus on the complex plane (limits, continuity, differentiability), Cauchy-Riemann equations, analytic functions, harmonic functions

Course Learning Outcomes (CLOs) / Course Objectives (COs):

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

1. Examine functions of several variables, define and compute partial derivatives, directional derivatives and their use in finding maxima and minima in some engineering problems.
2. Evaluate multiple integrals in Cartesian and Polar coordinates, and their applications to engineering problems.
3. Determine the convergence/divergence of infinite series, approximation of functions using power and Taylor's series expansion and error estimation.
4. Represent complex numbers in Cartesian and Polar forms and test the analyticity of complex functions by using Cauchy-Riemann equations.

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Text Books:

1. *Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, Pearson Education (2007), 9th ed.*
2. *Stewart James, Essential Calculus; Thomson Publishers (2007), 6th ed.*
3. *Kasana, H.S., Complex Variables: Theory and Applications, Prentice Hall India, 2005 (2nd edition).*

Reference Books:

1. *Wider David V, Advanced Calculus: Early Transcendentals, Cengage Learning (2007).*
2. *Apostol Tom M, Calculus, Vol I and II, John Wiley (2003).*
3. *Brown J.W and Chruchill R.V, Complex variables and applications, McGraw Hill, (7th edition)*

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UTA003: COMPUTER PROGRAMMING

L	T	P	Cr
3	0	2	4

Course Objectives: This course is designed to explore computing and to show students the art of computer programming. Students will learn some of the design principles for writing good programs.

Detail Contents:

Computers Fundamentals: Binary Number System, Computer memory, Computer Software.

Algorithms and Programming Languages: Algorithm, Flowcharts, Generation of Programming Languages.

C Language: Structure of C Program, Life Cycle of Program from Source code to Executable, Compiling and Executing C Code, Keywords, Identifiers, Primitive Data types in C, variables, constants, input/output statements in C, operators, type conversion and type casting. Conditional branching statements, iterative statements, nested loops, break and continue statements

Functions: Declaration, Definition, Call and return, Call by value, Call by reference, showcase stack usage with help of debugger, Scope of variables, Storage classes, Recursive functions, Recursion vs. Iteration

Arrays, Strings and Pointers: One-dimensional, Two-dimensional and Multi-dimensional arrays, operations on array: traversal, insertion, deletion, merging and searching, Inter-function communication via arrays: passing a row, passing the entire array, matrices. Reading, writing and manipulating Strings, understanding computer memory, accessing via pointers, pointers to arrays, dynamic allocation, drawback of pointers

Structures and Union: Defining a Structure, declaring a structure variables, Accessing Structure Elements, and Union

File Handling: Defining and Opening a File, closing a File, reading from a File, Writing into a File

Laboratory Work:
To implement Programs for various kinds of programming constructs in C Language.

Course Learning Outcomes (CLOs) / Course Objectives (COs):
On completion of this course, the students will be able to:

1. comprehend and analyze the concepts of number system, memory, compilation and debugging of the programs in C language.
2. understanding of the fundamental data types, operators and console I/O functions as an aspect of programs.

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3. design and create programs involving control flow statements, arrays, strings and implement the concept of dynamics of memory allocations.
4. evaluate and analyze the programming concepts based on user define data types and file handling using C language.

Text Books:

1. Brian W. Kernighan Dennis M. Ritchie, C Programming Language, 2nd ed, 2012.
2. Balagurusamy G., Programming in ANSI C, 8th ed., 2019

Reference Books:

1. Kanetkar Y., Let Us C, 16th ed.,2017

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UPH004: APPLIED PHYSICS

L	T	P	Cr
3	1	2	4.5

Course Objectives: Introduce the laws of oscillators, acoustics of buildings, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics and demonstrate their applications in technology. Students will learn measurement principles and their applications in investigating physical phenomenon.

Detail Contents:

Oscillations and Waves: Oscillatory motion and damping, Applications - Electromagnetic damping – eddy current; ***Acoustics:*** Reverberation time, absorption coefficient, Sabine's and Eyring's formulae (Qualitative idea), Applications - Designing of hall for speech, concert, and opera; ***Ultrasonics:*** Production and Detection of Ultrasonic waves, Applications-green energy, sound signalling, dispersion of fog, remote sensing, Car's airbag sensor

Electromagnetic Waves: Scalar and vector fields; Gradient, divergence, and curl; Stokes' and Green's theorems; Concept of Displacement current; Maxwell's equations; Electromagnetic wave equations in free space and conducting media, Application - skin depth

Optics: ***Interference:*** Parallel and wedge-shape thin films, Newton rings, Applications as Nonreflecting coatings, Measurement of wavelength and refractive index. ***Diffraction:*** Single and Double slit diffraction, and Diffraction grating, Applications - Dispersive and Resolving Powers. ***Polarization:*** Production, detection, Applications – Anti-glare automobile headlights, Adjustable tint windows. ***Lasers:*** Basic concepts, Laser properties,Ruby, HeNe, and Semiconductor lasers, Applications – Optical communication and Optical alignment

Quantum Mechanics: Wave function, Steady State Schrodinger wave equation, Expectation value, Infinite potential well, Tunnelling effect (Qualitative idea), Application - Quantum computing.

Laboratory Work:

1 Determination of damping effect on oscillatory motion due to various media.
2 Determination of velocity of ultrasonic waves in liquids by stationary wave method.
3 Determination of wavelength of sodium light using Newton's rings method.
4 Determination of dispersive power of Sodium-D lines using diffraction grating.
5 Determination of specific rotation of cane sugar solution.
6 Study and proof of Malus' law in polarization.
7 Determination of beam divergence and beam intensity of a given laser.
8 Determination of displacement and conducting currents through a dielectric.
9 Determination of Planck's constant.

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Micro Project: Students will be asked to solve physics based problems/assignments analytically or using computer simulations, etc.

Course Learning Outcomes (CLO):

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

1. demonstrate a detailed knowledge of oscillations, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics;
2. discuss how the laws of physics have been exploited and applied in the development and design of simple engineering systems;
3. collate, analyse and formulate an experimental report with error analysis and conclusions;

Text books:

1. *Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001).*
2. *Beiser, A., Concept of Modern Physics, Tata McGraw Hill (2007).*
3. *Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999).*

Reference Books:

1. *Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice Hall™ (2008).*
2. *Wehr, M.R, Richards, J.A., Adair, T.W., Physics of The Atom, Narosa Publishing House (1990).*
3. *Verma, N.K., Physics for Engineers, Prentice Hall of India (2014).*

Evaluation Scheme:

Event	**Sub Event**	**Marks**	**Weightage**
Mid Semester Test	-	25	**25**
Sessional Tests	Quiz	6	6
	Tut Test	4	4
	Laboratory Work Evaluation	20	20
	Micro-Project	10	10
End Semester Test	-	100	**35**
Total			**100**

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UHU003: PROFESSIONAL COMMUNICATION

L	T	P	Cr
2	0	2	3.0

Course Objectives: To introduce the students to effective professional communication. The student will be exposed to effective communication strategies and different modes of communication. The student will be able to analyze his/her communication behavior and that of the others. By learning and adopting the right strategies, the student will be able to apply effective communication skills, professionally and socially.

Detail Contents:

Effective communication: Meaning, Barriers, Types of communication and Essentials. Interpersonal Communication skills

Effective Spoken Communication: Understanding essentials of spoken communication, Public speaking, Discussion Techniques, Presentation strategies

Effective Professional and Technical writing: Paragraph development, Forms of writing, Abstraction and Summarization of a text; Technicalities of letter writing, internal and external organizational communication. Technical reports and proposals

Effective non verbal communication: Knowledge and adoption of the right non verbal cues of body language, interpretation of the body language in professional context. Understanding Proxemics and other forms of non verbal communication

Communicating for Employment: Designing Effective Job Application letter and resumes.

Communication Networks in organizations: Types, barriers and overcoming the barriers.

Laboratory work:

1. Needs-assessment of spoken and written communication and feedback.
2. Training for Group Discussions through simulations and role plays.
3. Technical report writing on survey based projects.
4. Project based team presentations.

Course learning outcome (CLO) / Course Objectives (COs):

Students will be able to:

1. apply communication concepts for effective interpersonal communication.
2. select the most appropriate media of communication for a given situation.
3. speak assertively and effectively.
4. write objective organizational correspondence.
5. design effective resumes, reports and proposals.

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Text Books:

1. *Lesikar R.V and Flately M.E., Basic Business Communication Skills for the Empowering the Internet Generation. Tata Mc Graw Hill. New Delhi (2006).*
2. *Raman, M & Sharma, S., Technical Communication Principles and Practice, Oxford University Press New Delhi. (2011).*
3. *Mukherjee H.S., Business Communication – Connecting at Work, Oxford University Press New Delhi, (2013).*

Reference Books:

1. *Butterfield, Jeff., Soft Skills for everyone, Cengage Learning New Delhi, (2013).*
2. *Robbins, S.P., & Hunsaker, P.L., Training in Interpersonal Skills, Prentice Hall of India, New Delhi, (2008).*
3. *DiSianza, J.J. & Legge, N.J., Business and Professional Communication, Pearson Education India New Delhi, (2009).*

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UTA015: ENGINEERING DRAWING

L	T	P	Cr
2	4	0	4.0

Course Objectives: This module is dedicated to graphics and includes two sections: manual drawing and AutoCAD. This course is aimed at to make the student understand dimensioned projections, learn how to create two-dimensional images of objects using first and third angle orthographic projection as well as isometric, perspective and auxiliary projection, to interpret the meaning and intent of tolerance dimensions and geometric tolerance symbolism and to create and edit drawings using drafting software AutoCAD

Detail Contents:

Engineering Drawing

1. Introduction
2. Orthographic Projection: First angle and third angle projection system
3. Isometric Projections
4. Auxiliary Projections
5. Perspective Projections
6. Introduction to Mechanical Drawing
7. Sketching engineering objects
8. Sections, dimensions and tolerances

AutoCAD

1. Management of screen menus commands
2. Introduction to drawing entities
3. Co-ordinate systems: Cartesian, polar and relative coordinates
4. Drawing limits, units of measurement and scale
5. Layering: Organizing and maintaining the integrity of drawings 6. Design of prototype drawings as templates.
7. Editing / modifying drawing entities: Selection of objects, object snap modes, editing commands
8. Dimensioning: Use of annotations, dimension types, properties and placement, adding text to drawing

Micro Projects / Assignments:

1. Completing the views – Identification and drawing of missing lines in the projection of objects.
2. Missing views – Using two views to draw the projection of the object in the third view, primarily restricting to Elevation, Plan and Profile views.
3. Projects related to orthographic and isometric projections.
    a. Using wax blocks or soap bars to develop three dimensional object from given orthographic projections.
    b. Using wax blocks or soap bars to develop three dimensional object, section it and color the section.

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c. Use of AUTOCAD as a complementary tool for drawing the projections of the objects created in (1) and (2).

4. Develop the lateral surface of different objects involving individual or a combination of solids like Prism, Cone, Pyramid, Cylinder, Sphere etc.
5. To draw the detailed and assembly drawings of simple engineering objects / systems with due sectioning (wherever required) along with bill of materials e.g. Rivet joints, simple bearing, wooden joints, Two plates connected with nut and bolt etc.

Course Learning Outcomes (CLOs) / Course Objectives (COs):

Upon completion of this module, students will be able to:

1. creatively comprehend geometrical details of common engineering objects.
2. draw dimensioned orthographic and isometric projections of simple engineering objects.
3. draw sectional views of simple engineering objects.
4. interpret the meaning and intent of toleranced dimensions and geometric tolerance symbolism.
5. create and edit dimensioned drawings of simple engineering objects using AutoCAD.
6. organize drawing objects using layers and setting up of templates in AutoCAD.

Text Books:

1. *Jolhe, D.A., Engineering Drawing, Tata McGraw Hill, 2008.*
2. *Davies, B. L., Yarwood, A., Engineering Drawing and Computer Graphics, Van Nostr and Reinhold (UK), 1986.*

Reference Books:

1. *Gill, P.S., Geometrical Drawings, S.K. Kataria & Sons, Delhi (2008).*
2. *Gill, P.S., Machine Drawings, S.K. Kataria & Sons, Delhi (2013).*
3. *Mohan, K.R., Engineering Graphics, Dhanpat Rai Publishing Company (P) Ltd, Delhi (2002).*
4. *French, T.E., Vierck, C.J. and Foster, R.J., Fundamental of Engineering Drawing & Graphics Technology, McGraw Hill Book Company, New-Delhi (1986).*
5. *Rowan, J. and Sidwell, E. H., Graphics for Engineers, Edward Arnold, London (1968).*

UBT008: CELL BIOLOGY AND GENETICS

L	T	P	Cr
3	0	0	3.0

Course objectives: The course is aimed to impart knowledge of structural and functional aspects of cells as unit of living systems. To understand functions of various organelles and transport of information and matter across cell membrane and classical genetics comprising Mendelian laws of inheritance and their significance in genetic diseases.

Detail contents:

Cell structure and function: Cell – structural and functional unit of life, cell morphology, difference between bacterial, plant and animal cells, structure and function of cellular organelles, plasma membrane and cell wall, cytoskeleton, transport across cell membrane.

Cell division: Mitosis and meiosis, cell cycle and its regulation, apoptosis and necrosis.

Genetics: Mendel's laws of inheritance, Intra-allelic and inter-allelic interaction, incomplete dominance, codominance and blood types, Multiple alleles, Lethal genes, Polygenic inheritance, cytoplasmic inheritance, chromosomal structure, nucleosome and chromatin, sex determination and sex-linked inheritance.

Linkage and recombination: Recombination and crossing over, linkage maps, mapping of genes, Hardy-Weinberg distribution.

Course Learning Outcomes (CLO):

Students will be able to

1. acquire knowledge about the organizational and functional aspects of cell and organelles
2. learn about the interactions of the cells with outside environment through exchange of information and transport of molecules.
3. learn about the classical genetics and transmission of characters from one generation to the next which will make foundation for the advanced genetics.
4. develop innovative research ideas for curing genetic disorders in humans

Text Books:

1. *Bruce Alberts et al., Essential cell biology, Garland Science (Taylor & Francis Group)*
2. *Gardner, Simmons and Snustad, Principles of Genetics by John Wiley & Sons*
3. *Veer Bala Rastogi, Cell Biology (MedTech Science Press)*
4. *Eddon John Gardner. Principles of Genetics (Wiley; 8th edition)*

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Reference Books:

1. *H Lodish et al., Molecular Cell Biology (4th edition), WH Freeman*
2. *MW Stickberger, Genetics (3rd edition), PHI Learning Pvt Ltd (2012)*
3. *Geoffrey M. Cooper., The Cell: A Molecular Approach (Sinauer Associates Inc)*
4. *Peter J. Russel. iGenetics: A Molecular Approach (Pearson Education India)*

Evaluation Scheme

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45

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UMA006: INTRODUCTORY MATHEMATICS-II

L	T	P	Cr
3	1	0	3.5

Course objective: The objective is to develop basic computing skills and application of quantitative required for biological studies and rationalization of experimental designs.

Detail contents:

Differentiation: Functions, Domain and range, Properties of standard functions (trigonometric, exponential and logarithmic) and their graphs, Limit, Continuity and Differentiability. Differentiation of standard functions (polynomials, trigonometric, inverse trigonometric exponentials and logarithmic), Product rule, Quotient rule, Chain rule, Applications of derivatives in graphing, Maximum and minimum of single variable function, Functions of several variables, Partial derivatives, Homogeneous functions, Maximum and minimum of several variable functions

Integration: Integral as anti-derivative, Integration: by substitution, by parts and partial fractions, Definite integral and its properties, Double integrals, Areas of bounded regions and rectification

Differential Equations: Order and degree, General and particular solution of differential equation, Techniques for solving first order ordinary differential equation and its applications to biological problems (population growth, radioactive decay)

Course Learning Outcomes (CLO):

Students will be able

1) explain functions, related properties and determine their continuity and differentiability.
2) apply derivatives in graphing and maxima and minima of single variable function.
3) predict integration of function using by parts, by substitution and partial fraction methods and apply these to find areas of bounded regions and rectifications.
4) learn methods to solve first order ordinary differential equations and apply it to biological problems.

Text books:

1. *Mathematics, A Text books (Parts I & II), NCERT, New Delhi, 2011.*
2. *Thomas, G.B. and Finney, R.L. Calculus and Analytical Geometry, Pearson Education, 10th ed., 2007.*

Reference Books:

1. *Kreyszig, Erwin, Advanced Engineering Mathematics, 8th Edition, John Wiley, 1999.*
2. *Shanti Narayan, Differential and Integral Calculus, S. Chand, 2005.*

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Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

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UMA004: MATHEMATICS – II

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce students the theory and concepts of differential equations, linear algebra, Laplace transformations and Fourier series which will equip them with adequate knowledge of mathematics to formulate and solve problems analytically.

Detail Contents:

Linear Algebra: Row reduced echelon form, Solution of system of linear equations, Matrix inversion, Linear spaces, Subspaces, Basis and dimension, Linear transformation and its matrix representation, Eigen-values, Eigen-vectors and Diagonalisation, Inner product spaces and Gram-Schmidt orthogonalisation process

Ordinary Differential Equations: Review of first order differential equations, Exact differential equations, Second and higher order differential equations, Solution techniques using one known solution, Cauchy - Euler equation, Method of undetermined coefficients, Variation of parameters method, Engineering applications of differential equations

Laplace Transform: Definition and existence of Laplace transforms and its inverse, Properties of the Laplace transforms, Unit step function, Impulse function, Applications to solve initial and boundary value problems

Fourier Series: Introduction, Fourier series on arbitrary intervals, Half range expansions, Applications of Fourier series to solve wave equation and heat equation

Course learning outcome (CLO) / Course Objectives (COs):

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

1. solve the differential equations of first and second order and basic application problems described by these equations.
2. find the Laplace transformations and inverse Laplace transformations for various functions. Using the concept of Laplace transform students will be able to solve the initial value and boundary value problems.
3. find the Fourier series expansions of periodic functions and subsequently will be able to solve heat and wave equations.
4. solve systems of linear equations by using elementary row operations.
5. identify the vector spaces/subspaces and to compute their bases / orthonormal bases. Further, students will be able to express linear transformation in terms of matrix and find the Eigen values and Eigen vectors.

Text Books:

1. *Simmons, G.F., Differential Equations (With Applications and Historical Notes), Tata McGraw Hill (2009).*

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2. *Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).*

Reference Books:

1. *Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley (2006), 8th ed.*
2. *Jain, R.K. and Iyenger, S.R.K., Advanced Engineering Mathematics, Narosa Publishing House (2011), 11th ed.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

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UBT004: BIOCHEMISTRY-I

L	T	P	Cr
3	0	2	4.0

Course objective: The Students will know how the collection of thousands inanimate molecules that constitute living organisms interact to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the nonliving thing.

Detail contents:

Biochemistry: Introduction as a discipline-historical perspective, major landmarks in the development of biochemistry.

Chemical Foundations of living systems: Molecular basis of life, Biological chemistry – Biomolecules, Metabolism – Basic concepts and Design, Bioenergetics- Entropy, Biochemical equilibria, Dissociation and association constants, pH and buffers

Interactions in biological systems: Intra and intermolecular forces, Electrostatic and hydrogen bonds, Disulfide bridges, Hydrophobic and hydrophilic molecules and forces, Water and weak interactions, Debye-Huckel Theory

Carbohydrates: Classification, Monosaccharides – structures and function; reactions of monosaccharides- mutarotation, glycoside formation, reduction and oxidation, epimerization and esterification, polarimetry; important monosaccharides and disaccharide; Polysaccharides – overview, structure; important polysaccharide; plant polysaccharide; Glycosaminoglycans, Glycoproteins

Amino acids and Proteins: Amino acids as building blocks of proteins, their structure, classification and chemical properties; non- proteinogenicaminoacids; Structure of peptide bond, organizational levels of protein structure; alpha- helix, beta pleated sheet, Ramachandran Plot

Nucleic Acids and Porphyrins: Structure and properties of nucleic acid bases, nucleosides and nucleotides, biologically important nucleotides, Physical and chemical properties of RNA/DNA. Hydrolysis of nucleic acids. Structure, properties and classification of porphyrins

Lipids: Fatty acids as building blocks of most lipids, their structure and properties, classification of lipids, General structure and function of major lipid subclasses: Acylglycerols, phosphoglycerides, sphingolipids, glycosphingolipids, terpenes, steroids, Prostaglandins

Laboratory Work: Preparation of buffer solutions, Determination of pK values, Estimation of reducing sugars, total carbohydrates, amino acids and proteins, Quantitative analysis of lipids, Enzyme assays from microbes and eukaryotes, Basic strategies for enzyme purification, Enzyme kinetics i.e determination of K_m and V_{max} of enzymes

Course Learning Outcomes (CLO):

Students will be able to

1. know the chemical constituents of cells, the basic units of living organisms.
2. explain various types of weak interactions between the biomolecules.

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3. know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids, nucleic acids.
4. correlate the structure-function relationship in various biomolecules
5. know the role of biomolecules for orderly structures of the cells/tissues.

Text books:

1. *Nelson, DL and Cox MM., Lehninger: Principles of Biochemistry, WH Freeman (2008) 5th ed.*
2. *David E Metzler: Biochemistry, The Chemical reactions of Living Cells Vol. 1. 2nd Edition, Elsevier Academic Press (2003),*
3. *Berg JM, Tymoczko JL and Stryer L: Biochemistry, 5th Edition, WH Freeman and Company, (2005)*

Reference Books:

1. *Koolman J and Roehm K H Color Atlas of Biochemistry, 2nd Edition, Georg Thieme Verlag Publishers (2005)*
2. *Jain, J.L., Jain, S. and Jain, N., Fundamentals of Biochemistry, S. Chand and Company Ltd. (2005).*
3. *Plummer DT An Introduction to Practical Biochemistry, Tata McGraw-Hill Publishing Company Limited (1988)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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UEN002: ENERGY AND ENVIRONMENT

L	T	P	Cr
3	0	0	3.0

Course Objectives: The exposure to this course would facilitate the students in understanding the terms, definitions and scope of environmental and energy issues pertaining to current global scenario; understanding the value of regional and global natural and energy resources; and emphasize on need for conservation of energy and environment.

Detail Contents:

Introduction: Natural Resources & amp; its types, Concept of sustainability and sustainable use of natural resources, Pollution based environmental issues and case-studies

Conventions on Climate Change: Origin of Conference of Parties (COPs), United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC); Kyoto Protocol, instruments of protocol – CDM, JI and IET; Montreal Action Plan; Paris Agreement and post-Paris scenario

Air Pollution: Origin, Sources and effects of air pollution; Primary and secondary meteorological parameters; Wind roses; Atmospheric Stability; Inversion; Plume behavior; Management of air pollution: Source reduction and Air Pollution Control Devices for particulates and gaseous pollutants in stationary and mobile sources

Water Pollution: Origin, Sources of water pollution, Category of water pollutants, Physico-Chemical characteristics, Components of wastewater treatment systems, Advanced treatment technologies

Solid Waste Management: Introduction to solid waste management, Sources, characteristics of municipal and industrial solid waste, Solid waste management methods: Incineration, composting, Biomethanation, landfill, E-waste management, Basal convention

Energy Resources: Classification of Energy Resources; Conventional energy, resources-Coal, petroleum and natural gas, nuclear energy, hydroelectric power; Non-conventional energy resources – Biomass energy, Thermo-chemical conversion and biochemical conversion route; Generation of Biogas and biodiesel as fuels; Solar energy-active and passive solar energy absorption systems; Type of collectors; Thermal and photo conversion applications; Wind energy

Facilitated through Online Platforms:

Ecology and Environment: Concept of an ecosystem; structural and functional units of an ecosystem; Food Chain, Food Web, Trophic Structures and Pyramids; Energy flow; Ecological Succession; Types, Characteristics, Biodiversity, Biopiracy

Human Population and the Environment: Population growth, variation among nations; Population explosion – Family Welfare Programmes; Environment and human health; Human Rights; Value

Education; Women and Child Welfare; Role of Information Technology in Environment and Human Health, Environmental Ethics

Course Learning Outcomes (CLOs) / Course Objectives (COs):

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

1. comprehend the interdisciplinary context with reference to the environmental issues and case studies.
2. assess the impact of anthropogenic activities on the various elements of environment and apply suitable techniques to mitigate their impact.
3. conceptualize and explain the structural and functional features of ecological systems.
4. correlate environmental concerns with the conventional energy sources associated and assess the uses and limitations of non-conventional energy technologies.

Recommended Books:

1. *Moaveni, S., Energy, Environment and Sustainability, Cengage (2018)*
2. *Down to Earth, Environment Reader for Universities, CSE Publication (2018)*
3. *Chapman, J.L. and Reiss, M.J., Ecology - Principles and Application, Cambridge University Press (LPE) (1999).*
4. *Eastop, T.P. and Croft, D.R., Energy Efficiency for Engineers and Technologists, Longman and Harow (2006).*
5. *O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).*
6. *Peavy H.S. and Rowe D.R. Environmental Engineering, McGraw Hill (2013).*

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UCB008: APPLIED CHEMISTRY

L	T	P	Cr
3	1	2	4.5

Course Objective: The course aims at elucidating principles of applied chemistry in industrial systems, water treatment, engineering materials and analytical techniques.

Detail Contents:

Atomic Structure and Bonding: Chemical change; elements, compounds and mixtures, Atomic structure, dual nature of electron, concept of atomic orbitals, Pauli`s Exclusion principle, Concept of chemical bonding: covalent, ionic, metallic, hydrogen bond, Vander Waal`s, Hybridization and shapes of molecule, electronic structure and periodic table

Chemical Equilibrium: Law of mass action, Factors that influence the position of equilibrium. Ionic equilibria: ionic equilibria in aqueous solutions; strong and weak acids and bases; buffer solution and indicators

Electrochemistry: Migration of ions, Transference number, Specific, equivalent and molar Conductivity of electrolytic solutions, Conductometric titrations, Electrode potential and types of electrodes, Introduction to galvanic and concentration cells, Liquid junction potential

Colligative Properties of Dilute Solutions: Depression of freezing point and elevation of boiling point

Phase Rule: States of matter, Phase, Component and Degree of freedom, Gibbs phase rule, One component and two component systems

Water Treatment and Analysis: Hardness and alkalinity of water: Units and determination, External and internal method of Softening of water: Lime-soda Process, Ion exchange process, Desalination of brackish water

Fuels: Classification of fuels, Calorific value, Cetane and Octane number, fuel quality, Comparison of solid liquid and gaseous fuel, properties of fuel, alternative fuels: biofuels, Power alcohol, synthetic petrol

Application of Atomic and Molecular Spectroscopic Methods: Structure determination of certain model compounds of industrial importance.

Assignments based on working and applications of advanced instruments will be given in the tutorial class.

Laboratory Work:

Electrochemical measurements: Experiments involving use of pH meter, conductivity meter, potentiometer.

Acid and Bases: Determination of mixture of bases

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Spectroscopic techniques: Colorimeter, UV-Vis spectrophotometer.
Kinetics: Kinetics of oxidation of iodine ion by peroxydisulphate ion.

Thermochemistry: Cloud point and pour point determination

Water and its treatment: Determination of hardness, alkalinity, chloride, chromium, iron and copper in aqueous medium.

Course Learning Outcomes (CLO):

The Students will be able to:

1. analyse trends in periodic table with electronic and atomic structure.
2. interpret phase diagrams of pure and binary substances.
3. demonstrate the working of electrodes and their applications.
4. calculate various parameters defining water and fuel quality 5. identify the various functional groups through IR spectra.
6. carry out basic experimental procedure and to emphasize need for safety and safety procedure in laboratory.

Text books:

1. *Ramesh, S. and Vairam S. Engineering Chemistry, Wiley India (2012).*
2. *Jain, P.C. and Jain, M. Engineering Chemistry, Dhanpat Rai Publishing Co. (2005).*
3. *Puri, B.R., Sharma and L.R., Pathania, M.S. Principles of Physical Chemistry, Vishal Publishing Co. (2008).*

Reference Books:

1. *Brown, Holme, Chemistry for engineering Students, Thompson.*
2. *Shulz, M.J. Engineering Chemistry, Cengage Learnings, (2007).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

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UBT301: MICROBIOLOGY

L	T	P	Cr
3	0	2	4.0

Course objective: To provide fundamental understanding of the microbial world, basic structure and functions of microbes, metabolism, nutrition, their diversity, physiology and relationship to environment and human health. To impart practical skills of isolation and manipulating conditions for their propagation.

Detail contents:

History and classification: Brief history on development and scope of microbiology, characterization, classification and identification of microorganisms, numerical taxonomy and molecular approaches, microscopic examination of microorganisms, bacterial staining, simple and differential staining

Morphology and fine structure of microorganisms: Prokaryotes and eukaryotes, bacterial diversity, bacterial cell structures, Gram positive and Gram negative bacteria, morphological features, cell structure and major characteristics of cellular (bacteria, fungi, algae, protozoa) and acellular (viruses) organisms

Cultivation and cultural characterization of microorganisms: Nutritional and physical requirements of autotrophs, heterotrophs, chemotrophs and lithotrophs, types of culture media, enumeration of microbial populations, pure culture and cultural characteristics

Microbial Growth: Modes of cell division, normal growth cycle, and quantitative measurement of growth, growth curve, synchronous growth and continuous culture, factors affecting growth, sporulation, Maintenance and preservation of microbial cultures and its importance, culture banks

Microbial Physiology: Bacterial metabolism, energy production, respiration, intermediate metabolism, fermentation and photosynthesis

Microorganisms and Diseases: Major diseases caused by different microorganism in human, animals and plants

Microbial Control: Physical and chemical agents for control of microbial growth, their mode of action, sterilization, disinfectants and antiseptics, chemotherapeutic agents, antibiotic susceptibility test

Laboratory Work: Microscopic examination of stained cell preparation, Gram staining and staining of spore, capsule, Sterilization techniques, Preparation of culture media, sources of microbial contamination, techniques for isolation of pure cultures, isolation of heterotrophs and autotrophs, isolation and enumeration of microbial population in soil and water, microscopic measurement of cell dimension and growth by cell counting, biochemical activity of bacteria, bacterial growth curve

Course Learning Outcomes (CLO):

Students will be able to

1. define the science of microbiology, its development and importance in human welfare.
2. describe historical concept of spontaneous generation and the experiments performed to disprove.

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3. describe some of the general methods used in the study of microorganisms.
4. recognize and compare structure and function of microbes and factors affecting microbial growth.
5. demonstrate aseptic microbiological techniques in the laboratory and check sources of microbial contamination and their control.

Text books:

1. *Pelczar Jr., M.J., Chan, E.C.S. and Krieg, Noel R., Microbiology, Shree Hari Publications (2021).*
2. *Stanier, R.Y., Ingraham, J.L. and Wheelis, M.L., General Microbiology, MacMillan (2007) 5th ed.*
3. *Madigan, M. T. and Martinko, J. M., Brock Biology of Microorganisms, Pearson Publication (2017) 14th ed.*

Reference Books:

1. *Tortora, G.J., Funke, B.R., and Case, C.L., Microbiology: An Introduction, Pearson Education (2019) 4th ed.*

2. *Willey, J. and Sherwood, L., Prescott's Microbiology, Asia Higher Education Science Microbiology (2017)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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UCH301: MATERIAL AND ENERGY BALANCES

L	T	P	Cr
3	1	0	3.5

Course Objective: To understand and apply the basics of calculations related to material and energy flow in the processes.

Detail contents:

Introduction: Units and dimensions, Stoichiometry of chemical equations, Mole and weight fractions, Unit operations and unit processes with reference to material and energy balance calculations

Behaviour of Gas and Liquid Mixtures: Gas laws, Raoult's law, Henry's law, Duhring's plot, Saturation, Partial saturation, Relative saturation, Real gases, Bubble point and dew point temperatures

Material Balance Calculations: Law of conservation of mass, General material balance equation, Material balance calculations without chemical reactions, Material balance calculations with chemical reactions, Recycling, Bypass, Purge, Analysis of degrees of freedom

Energy Balance Calculations: General energy balance equation, Internal energy, Enthalpy, Heat capacity of gases, liquids, and solids, Latent heats, Heats of formation, combustion, reaction and dissolution, Enthalpy-concentration chart, Fuel heating value, Theoretical flame temperature, Energy balance calculations in unit operations and systems with and without chemical reactions, Humidity and psychrometric chart, Energy balance calculations in humidification and adiabatic cooling

Sample List of Micro-Projects

Students in a group of 4/5 members will be assigned a micro project.

1. Complete material balances on a process flow sheet
2. Energy balances on a complete process flow sheet
3. Analyze the degrees of freedom for a complete process

Course Learning Outcomes (CLO):

Students will be able to:

1. predict the behaviour of gas and liquid mixtures.
2. make material balances on unit operations and processes.
3. perform simultaneous material and energy balances with and without chemical reactions.
4. evaluate the degrees of freedom for a system.
5. solve practical problems related to humidification/dehumidification and saturation.

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Text books:

1. *Himmelblau, D.M. and Riggs, J.B., Basic Principles and Calculations in Chemical Engineering, Prentice Hall of India (2003).*
2. *Bhatt, B.I. and Vora, S.M., Stoichiometry, Tata McGraw Hill (2004).*

Reference Books:

1. *Hougen, O.A., Watson, K.M. and Ragatz, R.A., Chemical Process Principles, Volume-I, C.B.S. Publications (2004).*
2. *Felder, R.M, and Rousseau, R.W., Elementary Principles of Chemical Processes, C.B.S. Publications (2000).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

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UBT305: FOOD SCIENCE AND NUTRITION

L	T	P	Cr
3	0	2	4.0

Course Objective: To impart knowledge about the various areas related to food science as a discipline. To develop an understanding of food composition, food quality, analysis and food laws.

Detail contents:

Food composition: Introduction to food science as a discipline, Constituents of food (macronutrients and micro-nutrients), functional properties, food sources and deficiency diseases. Other food constituents: Bioactive compounds, anti-nutritional factors, pigments

Food and nutrition: Malnutrition, recommended dietary allowances (RDAs) for various age groups, the concept of a balanced diet, diet planning. Special dietary needs of people with different medical conditions. Food groups and their classification

Food microbiology: Food spoilage by micro-organisms: classification of foods on the basis of spoilage, factors affecting the growth of microorganisms in food, chemical changes caused by microorganisms. Foodborne illness (infection and intoxication), pathogenic micro-organisms in food. Desirable relationship of microorganisms with food (fermentation, probiotics)

Food quality and laws and Standards: Food quality & analysis: Quality factors in food physical, chemical and microbiological factors of quality. Sensory evaluation of foods. Sample and sample preparation in foods, proximate analysis of foods. Food laws: voluntary and mandatory food laws in India

Impetus in Food Industry: New Product Development, strategies, planning for marketing, Process designing of food. Foods types available in the market and need of their innovation

Laboratory work: Determining the RDA's and planning diet. Estimating the physico-chemical composition of foods (moisture, fat, protein, ash, TSS). Identifying the microbial flora of different foods. Determining bioactive properties of food. Determine the quality of various foods (dairy, fruit and vegetable, bakery products)

Course Learning Outcomes (CLO):
Students will be able to

1. explain importance of different types of nutrients in balanced diet and diet planning
2. differentiate between different nutrient components in food and their role in processing and consumption.
3. correlate basic food microbiology with food safety laws and standards.
4. determine food quality by food analysis as per food laws and their importance in food industry.
5. apply traditional methods for food preservation in developing a new food product.

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Textbooks:

1. *Vaclavik, Vickie, Christian, Elizabeth W - Essentials of Food Science 4th Ed. (2014)*
2. *Geoffrey Campbell-Platt - Food Science and Technology, Wiley-Blackwell Publisher. 2nd Ed. (2017)*
3. *Sunetra Roday- Food Science and Nutrition, 2nd Edition, Publisher-Oxford (2012)*
4. *B. Srilakshmi Food Science, 5th ed. New Age Publishers (2010)*
5. *L.H. Meyer Food Chemistry, New Age Publishers (2004)*
6. *Frazier C and Westhoff, C. Food Microbiology, TMH, New Delhi. 5th Ed (2017)*

Reference Books:

1. *S. Suzanne Nielsen-Food Analysis:Food Science Texts Series, Springer; 4th Edition (2010)*
2. *Avantina Sharma Textbook of Food Science & Technology (Vol - I & II), International Book Distributing Company, 2nd ed. (2010)*
3. *Fennema's Food Chemistry, 5th Edition (Food Science and Technology, CRC Press; 4 edition (2017)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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UBT504: IMMUNOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: To provide students with detail understanding of basic concepts of immune system, application of immunological techniques, immune dysregulation in health disorder.

Detail Contents:

Basic concept and cells of the Immune System: Hematopoietic stem cells, Lymphocytes, Granulocytes and Monocytes, Cell participation in innate and adaptive Immunity, MHC, Inflammatory response, Complement System

Antigens and Antibodies: Antigenicity and Immunogenicity Epitopes, Adjuvants, Superantigens, Antigen Presentation and processing, Structure and function of antibody, Antibody classes, Passive antibody therapy, Monoclonal antibody, Antibody engineering, Generation of antibody diversity

Immunological Techniques: Cross reactivity, Precipitation and Agglutination reaction, Coomb's test, RIA, ELISA, ELISPOT assay, Western blotting, Immunofluorescence and Flow cytometry

Immunological disorder: Tolerance and Autoimmunity, Types and mechanism of autoimmune diseases, Hypersensitive reactions, Different types of Hypersensitive reactions, Primary and Secondary Immunodeficiency, Tumor immunity and Tumor antigens, Transplantation types, Immunological basis of graft rejection

Vaccine and Immunotherapy: Criteria for effective vaccine, Live and Killed Vaccines, Subunit vaccines, Recombinant Vaccines, DNA vaccines, mRNA vaccines, Peptide vaccines

Laboratory Work:
Immune cells identification, Immuno-diffusion, Hemagglutination, Latex agglutination, Rocket immunoelectrophoresis, ELISA, Epitope prediction using Immunoinformatics tool, Isolation of Peripheral blood mononuclear cells, Demonstration on Flow cytometry

Course Learning Outcomes (CLO):

Students will be able to

1. explain the role of immune cells and their mechanism in body defense mechanism.
2. adopt immunological techniques for industrial uses.
3. demonstrate the association of immune system with different health ailments
4. apply the immunological concept in developing vaccine

Text books:

1. *Punt J, Stranford S, Jones P, Owen J. Kuby- Immunology W.H. Freeman & Company (2019) VIIIth edition*
2. Murphy K., and Weaver C. *Janeway Immunobiology Garland Exclusive (2016) IXth edition*

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Reference Books:

1. *Delves P. J., Martin S. J., Burton D. R., Roitt I. M. Roitt's Essential Immunology Wiley Publisher (2017) 8th Edition*
2. *Khan F.H. The Elements of Immunology, Pearson Education (2009)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Quizes/Lab Evaluations)	35

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UBT303: BIOCHEMISTRY-II

L	T	P	Cr
3	0	2	4.0

Course Objective: To make Students understand interaction of biomolecules in cell, biotransformations and enzyme-catalyzed metabolic pathways obeying physical and chemical laws to maintain and perpetuate life forms.

Detail Contents:

Bioenergetics: Basic principles of thermodynamics, Common biochemical reactions, Concepts of energy and energy change in biochemical processes, Factors affecting free energy changes in biochemical reactions, Group transfer potential, Role of ATP as energy currency, High energy phosphates and thioesters in biological systems, Biological oxidation-reduction reactions

Enzymes: Nomenclature of enzymes, Enzyme kinetics, Mechanism of enzymatic, Catalysis, Active site, Activators and inhibitors, Coenzymes, Isoenzymes, Michaelis-Menten equation, K_m and V_{max} value, Regulation of enzyme activity (single-substrate and multi-substrate reactions)

Intermediary Metabolism: Basic concept and design of metabolism, Regulation of metabolic pathways, Basic carbohydrate metabolism: glycolysis, TCA cycle, pentose phosphate pathway, gluconeogenesis, and glycogen metabolism; Electron transport and oxidative phosphorylation; Photosynthesis; Fatty acid and lipid metabolism; Metabolism of amino acids, purines, pyrimidines and nucleotides

Biosignaling: General features of signal transduction, G protein-coupled receptors, and second messengers, Receptor Tyrosine kinases, Gated ion channels, signaling by steroid hormones, Cell cycle, Regulation of cell cycle by protein kinases, programmed cell death

Integration of Metabolic Pathways: Hormonal control, inter-relationships between carbohydrate, protein, lipid and nucleic acid metabolism

Laboratory Work: Separation and identification of amino acids, polar and non-polar lipids by chromatographic techniques, Iodine number of oil, Estimation of cellular and serum proteins, Estimation of inorganic and organic phosphorus, Quantification of nucleic acids, Estimation of lactic acid and cholesterol in serum, Subcellular fractionation and assay of the marker enzymes, Effects of pH and temperature on the activity of □-galactosidase, Glucose oxidase, Glucose-6-phosphatase, Serum alkaline phosphatase, Glutamate dehydrogenase Lactate dehydrogenase, Isolation of photosynthetic pigments

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Course Learning Outcomes (CLO):

Students will be able to:

1. know the various signals that influence different cellular/metabolic processes.
2. realize that all the cellular/biochemical changes obey the basic thermodynamic principles.
3. explain release of free energy during catabolic breakdown of the substances and its utilization during anabolic pathways.
4. comprehend role of hormones in the integration of metabolic pathways.
5. perform various experiments related to biochemistry.
6. comprehend role of enzymes as biocatalysts and mechanisms of enzyme catalysis.

Text books:

1. *Nelson, D.L. and Cox, M.M., Lehninger Principles of Biochemistry, W.H. Freeman (2008) 5th ed.*
2. *Jain, J.L., Jain, S. and Jain, N., Fundamentals of Biochemistry, S. Chand and Company Ltd. (2005).*
3. *Rao, B.S. and Deshpande, V., Experimental Biochemistry: A Students companion. Anshan Publication (2005).*
4. *Wilson, K. and Walker, J., Practical Biochemistry, Principles and Techniques, Cambridge University Press (1995) 5th ed.*

Reference Books:

1. *Berg, J.M., Tymoczko, J.L. and Stryer, L., Biochemistry, W. H. Freeman (2006) 6th ed.*
2. *Campbell, M.K. and Farrell, S.O., Biochemistry, Brooks Cole (2006) 5th ed.*
3. *Switzer, R.L. and Garrity, L.F., Experimental Biochemistry, W. H. Freeman (1999) 3rd ed.*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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UBT306: MOLECULAR BIOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: To understand storage of genetic information and its translation at molecular level in prokaryotic and eukaryotic systems. The course also aims to make Students understand intricate molecular mechanisms of carcinogenesis and apoptosis and their applications.

Detail contents:

Storage and replication of genetic information: chromosomal structure and organization, nucleic acids, Transfer of genetic material in microorganisms - Molecular mechanisms. DNA replication in phages, prokaryotes and eukaryotes, origin of replication and replication machinery, DNA damage and repair systems, excision repair systems, recombination repair systems, recombination

Transcription: Defining a gene, interrupted genes, structure and function of phage, prokaryotic and eukaryotic promoters, eukaryotic and prokaryotic transcription initiation, RNA polymerases and ancillary factors required for transcription initiation, elongation and termination. Regulation of gene expression in prokaryotes, phages and eukaryotes, epigenetic regulation of genes, regulatory RNA

Post-transcriptional modifications and translation: RNA processing, polyadenylation, 5' capping, splicing, structure and function of rRNAs, tRNAs, prokaryotic and eukaryotic ribosomes. Genetic code, initiation, elongation and termination of translation, post-translational modifications, signal peptides and protein translocation

Applications of molecular biology: Gene silencing by RNA interference, oncogenes, proto-oncogenes and tumour suppressor genes, apoptosis, molecular biology of genetic and metabolic disorders, aging and senescence

Laboratory Work: Genomic DNA isolation from plant and animal cells, RNA isolation, whole cell protein isolation and analysis on SDS-PAGE, DNA, RNA and protein quantification by spectrophotometric analysis, restriction digestion and analysis on native-PAGE, induction of gene

Course Learning Outcomes (CLO):

Students will be able to

1. explain the properties of genetic materials and storage and processing of genetic information.
2. apply mechanisms of DNA replication, damage and repair in applied molecular genetics.
3. apply mechanisms involved in gene expression and regulation in genetic engineering.
4. explain molecular basis of complex metabolic diseases.

Text books:

1. *J. E. Krebs, E. S. Goldstein, S. T. Kilpatrick, Lewin's Genes XI, International Edition, Pearson Education (2014).*

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2. *Malacinsk, G. M., i Freifelders Essentials Of Molecular Biology, 4Th/Ed,* Jones & Bartlett *(2015)*
3. *Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, Garland Science Publishing (2007).*

Reference Books:

1. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006) 7th ed. ISBN 1-4051-3544-1*
2. *Rastogi, S. & Pathak, N., Genetic Engineering, Oxford Higher Education (2009).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

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UPH012: BIOPHYSICS AND BIOMATERIALS

L	T	P	Cr
3	0	0	3.0

Prerequisite(s): None

Course Objective(s): This course introduces the concepts of chemical binding, stability and transport phenomenon to the students. Introduction to various biomaterials for specific biomedical applications is also given.

Chemical binding: Biomolecules, chemical bonding, interatomic potentials for strong and weak bonds, ionization potential, electron affinity, electronegativity, variation in properties with bonding character.

Thermodynamics and diffusion Kinetics: Free energy, internal energy, concept of equilibrium, stability and metastability, basic thermodynamic functions, statistical nature of entropy, kinetics of thermally activated process, Fick's law of diffusion, solution to Fick's second law and its applications, Kirkendall effect, atomic model of diffusion.

Biomaterials: Classification: Metals, Ceramics, polymers, Composites, Hydrogels, Bioresorbable and Biodegradable materials, Properties of biomaterials: Physical, Thermal, Electrical and Optical, Surface properties, Structure-property relationship of biological materials.

Novel Biomaterials: Hydrogels, Self-assembling peptides, Metallic implant materials (stainless steels, Co-based alloys, Ti based alloys), Ceramic implant materials (aluminum oxides, hydroxyapatite glass ceramics), Polymeric implants, polymers for drug delivery, In-vitro and in-vivo applications of biomaterials

Course Outcome:
Students will be able to:
1. Explain various characteristics of materials based on interatomic potential plots
2. Analyse basic kinetic reactions in living systems by applying governing laws of thermodynamics.
3. Analyse the suitability of the material to be used as a biomaterial.
4. Compare the performance of different biomaterials in biomedical applications

Text Books:

1. *Rodney Cotterill, BIOPHYSICS An Introduction, John Wiley and Sons (2002).*
2. *B. D. Ratner, A. S. Hoffman,F. J. Schoen and J. E. Lemons, Biomaterials Science, Second Edition: Wiley Science (2004).*
3. *Temenoff J.S. and Mikos A.G., Biomaterials: The intersection of Biology and Materials Science, Pearson, (2009).*
4. V. Raghavan, *Introduction to Materials Science and Engineering*; PHI, Delhi, 2005.

Reference Books:

1. *J. Breme, R.Thul and C. J. Kirkpatrick, Metallic Biomaterial Interfaces Wiley (2008).*
2. *L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering (Woodhead Publishing in Materials (2002).*

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Evaluation Scheme

Sr. No	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional	25

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UBT501: BIOANALYTICAL TECHNIQUES

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objectives of this course are to provide the students with the understanding of various analytical techniques used in biotechnology based research and industry. The course will acquaint the students with the various instruments, their configuration and principle of working, operating procedures, data generation and its analysis.

Detail contents:

Sampling and sample preparation: Sample fixing for various analytical applications and sample processing

Introduction to chromatographic techniques: Theoretical basis of chromatographic separations. Column, thin layer, Paper, Normal phase and reverse phase chromatography, Ion-exchange, Affinity and Gas Chromatography, High performance liquid chromatography (HPLC)

Electrophoretic techniques: Theory and application of polyacrylamide and agarose gel electrophoresis, electrophoresis of protein and nucleic acids, Capillary electrophoresis

Centrifugation techniques: Introduction, Basic principle of sedimentation, Centrifuges and their uses, safety aspects in the use of centrifuges. Density gradient and analytical centrifugation

Spectroscopic techniques: Theory and application of UV-VIS, IR, NMR, Fluorescence, Atomic absorption spectroscopy; X-ray diffraction. Introduction to mass spectroscopy

Radioisotopic techniques: Introduction to radioisotopes, detection, measurement and uses of radioisotopes, counting efficiency and autoradiography, biotechnological applications

Microscopy: Principles of microscopy, Light, dark field, fluorescent, UV, transmission and Scanning electron microscopy, Confocal microscopy, microtomy and analysis and measurement of images

Laboratory work: Paper chromatography, thin layer chromatography, column chromatography, gas chromatography, centrifugation, UV visible spectroscopy, SDS-PAGE and agarose gel electrophoresis microscopy and micrometery, microtomy, identification of blood group

Course Learning Outcomes (CLO):

Student will be able to

1. apply basic principles of different analytical techniques in analytical work.
2. use spectroscopy and radioactivity in biotechnological applications
3. use microscopy, centrifugation and electrophoretic techniques.
4. demonstrate principle and working of various instruments.

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5. use various techniques for solving industrial and research problems.

Text Books:

1. *Wilson K., Walker J. Principle and Techniques of Biochemistry and Molecular Biology. Cambridge University Press (2010) 7th edition*
2. *Pingoud A., Urbanke C., et al. Biochemical Methods – A concise guide for students and researchers. Wiley (2002)*
3. *Stryer, A.L., Berg J.A. and Tymoczko, J.L., Biochemistry, W.H.Freeman & Co Ltd (2002).*

Reference Books:

1. *Hawes C., Satiat-Jeunemaitre B. Plant Cell Biology. Oxford University Press (2001) 2nd edition*
2. *McHale J.L. Molecular Spectroscopy. Pearson (2008) 1st edition*
3. *Zubey, G.L., Principles of Biochemistry, Pearson-Education (2007).*
4. *Marimuthu R. Microscopy and Microtechniques. MJP Publishers Chennai (2008)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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UBT503: GENETIC & METABOLIC ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objective: This course would familiarize Students with facile molecular techniques involved in isolation and manipulation of genetic material for achieving the desired goal.

Detail Contents:

Introduction: Scope of genetic engineering, Restriction enzymes and other DNA modifying enzymes used in cloning and other DNA manipulations, essential and desired properties of cloning vectors, examples of cloning and expression vectors, recombinant protein expression in bacteria, yeast and higher eukaryotic systems, rDNA technology in purification of overexpressed recombinant proteins

Genomic and cDNA libraries: Construction and screening of Genomic and cDNA libraries, expression and regulation studies of genes, DNA labelling, nucleic acid hybridization

Applications of genetic engineering: DNA and protein sequencing, Polymerase Chain Reactions (PCR), Site-directed mutagenesis and applications, Molecular markers, Detecting protein-protein interactions, High-throughput techniques, Gene therapy, Genome editing, DNA fingerprinting, RFLP and RAPD

Metabolic Engineering: Introduction, Molecular strategies for rerouting of metabolic pathways in microbes, plants and animals, Various case studies, directed production of novel molecules in microbes and other organisms having therapeutic and industrial values, selection of host-vector system, constraints of the process, genetic instability and host cell mutations

Laboratory work: Competent cell preparation, Bacterial transformation, Isolation of plasmid DNA, Restriction digestion of DNA, Analysis of DNA by agarose gel electrophoresis and Native PAGE, Cloning in plasmid vectors, DNA amplification by PCR, Gene expression in bacterial hosts and analysis of gene products, Reporter gene assay

Course Learning Outcomes (CLOs)

Students will be able to

1. design and perform cloning of foreign DNA in an appropriate vector.
2. select the suitable hosts for a given vector and apply it for cloning or expression of recombinant proteins.
3. amplify DNA with a target sequence using polymerase chain reaction.
4. demonstrate application of recombinant DNA technology in various research, industrial, diagnostic and therapeutic applications.
5. design process for enhanced production of secondary metabolites

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Text books :

1. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*
2. *J. E. Krebs, E. S. Goldstein, S. T. Kilpatrick, Lewin's Genes XI, International Edition, Pearson Education (2014).*
3. *Rastogi, S. & Pathak, N., Genetic Engineering, Oxford Higher Education (2009).*

Reference Books:

1. *Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell, 5th Edition, Garland Science Publishing (2008).*
2. *Fritsch, J. and Maniatis, E.F., Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laboratory (1999).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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UBT405: BIOSTATISTICS

L	T	P	Cr
2	0	2	3.0

Course Objective: Students will learn about descriptive and inferential statistics and its application in biological data analysis.

Detail Contents:

Descriptive Statistics: Biology and statistics, Variables and data, Sampling and sampling errors in biological data, Sampling techniques, measures of central tendency, measures of dispersion and variability, Permutations and combinations, Probability, addition and multiplication of probabilities, normal, binomial and Poisson distributions, Binomial and Poisson probabilities, prior probabilities, posterior probabilities and Bayes' theorem

Hypothesis Testing: Test of hypotheses, one and two sample analysis, Paired sample analysis, Nonparametric statistics and limitations. Confidence limits and tests of confidence, Single, Two and Multifactorial analysis, Non-parametric Analysis of Variance (Kruskal-Wallis test), Multiple comparison tests – Tukey, Newman Keul, Dunnett's test, Scheffe's tests, Contingency tables, Chi-square goodness of fit test

Regression and Correlation Analysis: Concept of least squares, Simple linear regression, residual sum of squares, regression coefficients, covariance, Pearson coefficient of correlation, coefficient of determination, hypothesis about correlation coefficient, Rank correlation.

Design of Experiments and Data Presentation: Blocking factors, Latin square design, Factorial experiments, Response Surface Methods, Survivorship curves, Graph plotting and significance of Curves, Data representation.

Laboratory Work:
MS Excel / SPSS software, Data entry and graphical representation, Equation formulation and analysis for sample testing, correlation and regression, ANOVA, Multiple comparisons, Chi-square test, Survivorship curve plotting.

Course Learning Outcome (CLO):

Students will be able to:

1. classify various types of data and apply basic statistical concepts such as measure of central tendencies, measure of dispersion and sampling.
2. apply concepts of probability, probability laws, probability distributions and apply them in solving biological problems and statistical analysis.
3. perform statistical hypothesis testing using tools such as t-test, ANOVA, Chi-square test.
4. design experiments and solve problems based on relationships among multiple variables.

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Text Books:

1. *Zar, J. H., Biostatistical Analysis. Pearson Education (2014) 5th Edition.*
2. *Banerjee, B., Mahajan's Methods in biostatistics for medical students and research workers. Jaypee Brothers Medical Publishers (2018) 9th Edition*
3. *Montgomery, D. C., Design and Analysis of Experiments. John Wiley & Sons, Inc. (2009) 7th Edition*

Reference Books:

1. *Rao, K. V., Biostatistics – A Manual of Statistical Methods for Use in Health, Nutrition and Anthropology. Jaypee Brothers (2009) 2nd Edition.*
2. *Daniel, W. W. & Cross, C. L., Biostatistics: A Foundation for Analysis in the Health Sciences, Wiley Series in Probability and Statistics (2013).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/ Projects/ Tutorials /Quizes /Lab Evaluations)	40

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UCH407: UNIT OPERATIONS

L	T	P	Cr
3	1	2	4.5

Course Objective: To introduce Students with fundamentals concerning the calculations and principles involved in basic unit operations in biotechnology processes.

Detail contents:

Introduction: Physical variables, Units, their dimensions and conversions, dimensional consistency, dimensionless ratios, precision of measurement, unit operation involved in biotechnological processes (general process flow sheet)

Fluid Characteristics and Dynamics: Definition and classification of fluids, types of fluid, types of flow, Flow through pipes: laminar flow, turbulent flow, Hagen Poiseuille equation, Power law, Energy losses, Pipe networking, Flow measuring devices, Pumps

Mass Transfer: Modes of mass transfer, Fick's law of diffusion, diffusion theory, analogy between heat, mass and momentum transfer, interphase mass transfer, overall mass transfer coefficient, mass transfer in equipment, humidification and dehumidification, role of diffusion in mass transfer, oxygen uptake in cell culture, factors affecting cellular oxygen demand, oxygen transfer from gas bubble to cell

Mass Transfer: Heat conduction, heat conduction in composite wall structure, thick-walled tube, sphere, insulation, unsteady sate condition, Natural and forced convection, heat transfer in laminar and turbulent flows inside tubes, condensation, design of heat exchangers, basic equation of radiation

Laboratory work: Stefan boltzman's constant calculations, natural and forced convection, LMTD calculations for parallel and counter flow, determination of thermal conductivity through composite wall, lagged pipe, lagged cylinder, sphere, sedimentation and calculation of terminal velocity, performance of packed bed apparatus, fluidized bed apparatus: pressure drop vs. flow rate, drying rate

Course Learning Outcomes (CLO):

Students will be able to:

1. differentiate between dimensions and units and apply the concepts of unit consistency.
2. describe and explain basic principles of fluid flow for ideal and non-ideal fluids.
3. apply and explain basic principles of heat and mass transfer operations.
4. solve simple cases of fluid flow, heat and mass transfer.
5. perform simple calculations of unit operations involved in a biotechnology industry.

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Text Books:

1. *W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 7th edition, McGraw-Hill (2017).*
2. *Treybal, R.E., Mass Transfer Operations, McGraw Hill (1980) 3rd edition (2017).*
3. *Holman, J.P., Heat Transfer, 10th edition, Tata McGraw-Hill Education (2017).*

Reference Books:

1. *Doran P M, Bioprocess Engineering Principles, 2nd Edition, Academic Press (2012)*
2. *Perry's Chemical Engineers' Handbook, 9th edition, Don Green (2018).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

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UBT508: TRANSDUCERS AND BIOSENSORS

L	T	P	Cr
3	1	2	4.5

Course Objectives: The course aims to impart knowledge on basic concepts of transducers and acquaint the Students with different types of electrodes used in bio-potential recording. The course will also provide understanding of biosensors, optical and ultrasonic sensors.

Detail Contents:

Physiological Transducers: Transducers in general, active and passive transducers, pressure transducers, catheter tip pressure transducers, temperature transducers, pulse sensors, respiration sensors, digital transducers, selection criteria for transducers

Bioelectric potentials/Physiological signals: Action potentials and impulse propagation, origin of bioelectric signals, electrode theory, types of electrodes, selection criteria for electrodes recording electrodes and skin-contact impedances, electrical conductivity and microelectrodes, pulse, temperature, pressure and repression sensors

Biosensors: Benefits of biosensors, Types of biosensors, potentiometry, Bio-chemical sensors, chemical potential and equilibrium - some famous examples - electrochemical cell at equilibrium - Nernst equation - pH electrode - Ion-sensitive electrodes, voltammetry, amperometry, conductimetry

Ultrasonic, Optical & Laser biosensors: Basics of ultrasound, theory, characteristics, design, applications in medical science for diagnostic and therapeutic, Optical fiber sensor, Polarization, Refractive index, Light scattering, micro-opto- electromechanical system [MOEMS], Laser in industry

Signal processing: Introduction to biomedical signal processing and analysis; Wheatstone bridge, Bioelectric amplifiers, instrumentation amplifier, Introduction to active filters, First order, second order and higher order filters, Modulation and demodulation

Laboratory work
Experiments based on strain gauge, LVDT, capacitance, photoelectric, piezoelectric and temperature. Also, experiments for digital sensor, LDR, resistivity measurement

Course Learning Outcomes (CLO):

Students will be able to

1. explain basic concepts of transducers
2. elucidate different types of electrodes used in bio-potential recording
3. differentiate biosensors, optical and ultrasonic sensors
4. analyze, formulate and select suitable sensor/biosensor.

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Text books:

1. *Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd ed.*
2. *Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall (2000) 4th ed.*

Reference Books:

1. *A.K. Sawhney and Puneet Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai, 2014*
2. *Florinel-Gabriel Banica, Chemical Sensors and Biosensors: Fundamentals and Applications, Wiley, 2012*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

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UBT601: ANIMAL BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of this course is to enable Students to develop basic skills for vertebrate cell culture, maintenance of cell lines and *in vitro* application of cell and molecular techniques and also to understand the principles of animal cloning and its applications.

Detail contents:

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation. Layout of animal tissue culture laboratory.

Media: Role of Physicochemical properties, Introduction to the balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media, Advantages, disadvantages and their applications.

Primary Culture and Culture of Specific Cell Types: Isolation of tissue, Steps involved in primary cell culture, Subculture and propagation, Cell lines, Nomenclature, Cell line designations, Routine maintenance, Immortalization of cell lines, Cell transformation. Cell cloning and Cell separation, Cell synchronization. Epithelial, Mesenchymal, Tumor cell culture. Measurement of viability and cytotoxicity

Characterization, Contamination and Cryopreservation of Cell Line: Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time, Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cell banks, Transporting cells.

Gene transfer technology in animals: Gene transfer techniques in mammalian cells, Viral and nonviral methods, Production of transgenic animals, ES and microinjection, retroviral method and molecular pharming, applications of transgenic animal technology

Animal cloning: Animal cloning basic concept, Techniques, relevance and ethical issues, embryo transfer, SCNT, embryo-spliting, embryo sexing, embryos, *in situ* and *ex situ* preservation of germplasm, in utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders. Different methods for characterization of animal genomes, SNP, STR, QTL, RFLP and RAPD

Laboratory work: Laboratory Design & Instrumentation in ATC, Quality Assurance in Animal tissue culture facility, Preparation of animal cell culture media, Isolation and Culturing Peripheral Blood Lymphocytes, Viability assay, Cryopreservation technique, Sub-culturing and maintenance of Cell line, In vitro anticancer assay (MTT Assay), Genomic DNA Isolation from Blood and Tissue

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Course Learning Outcomes (CLO):

Students will be able to

1. explain the fundamental scientific principles that underlie cell culture
2. acquire knowledge for isolation, maintaince and growth of cells.
3. develop proficiency in establishing and maintaining of cell lines.
4. acquire knowledge in animal cloning and its applications

Text Books:

1. *R. Ian Freshney Culture of Animal Cells: A Manual of Basic Technique, 4th Edition" 2000.*
2. *Ranga, M.M., Animal Biotechnology, Agrobios (2007) 2nd ed.*

Reference Books:

1. *Masters, J. R.W., Animal Cell Culture, Oxford (2000) 3rd ed.*
2. *Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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UBT603: BIOPROCESS ENGINEERING

L	T	P	Cr
3	1	2	4.5

Course Objective: The objective of the course is to apply fundamental principles and concepts of chemical engineering to biological systems. This course will provide a comprehensive understanding of media formulations, microbial growth kinetics, bioreactor selection, upstream & fermentation processes, and its role in manufacturing bio-products.

Detail contents:

Introduction: Introduction to bioprocess engineering**,** Interaction of two disciplines: biotechnology and bioprocess engineering, outline of unit operations involved in upstream and downstream processing, steps in bioprocess development, role of bioprocess engineer in the biotechnology industry, historical advancement in bioprocess technology, range of microbial diversity, process and products relating to bioprocess engineering.

Microbial Growth Kinetics: Growth, growth measurement, media formulation, simple and complex media, media sterilization, Del factor, design of batch and continuous sterilization, log penetration theory, scale up of sterilization process, filter design, screening, culturing, culture preservation, strain improvement, inoculum preparation, stoichiometry of cell growth and product formation, elemental balances- degrees of reduction, factors influencing product formation on varying carbon & nitrogen source, batch culture, Monod's kinetics, modeling of batch growth kinetics, environmental factors affecting microbial growth, continuous culture, an ideal chemostat, advantages and limitations of continuous over batch culture, fed-batch culture and its applications.

Bioreactor Selection, Design and Process Control: Overview of reactor, mass balance in bioreactor, design equations of bioreactors, selection criteria for bioreactor, body construction of fermenter and its components i.e., impellers, stirred glands and bearings, seal assemblies, baffles, sparger and valves, solid state and submerged fermentation, design aspects of bubble column bioreactor, air-lift fermenter, plug-flow and packed bed bioreactor, scaling up of bioreactor. Main parameters to be monitored and controlled in fermentation processes, control systems in a bioprocess, methods of measuring process variables i.e., temperature, pressure, flow, dissolved oxygen, pH, role of computers in fermentation process analysis.

Transport phenomenon in Bioreactor: Fick's law, theories of mass transfer, mass transfer between two phases, role of aeration and agitation in a bioprocess, oxygen transfer methodology in a fermentation process, significance of volumetric transfer coefficient (K_La) and its determination, factors affecting K_La values in a bioreactor, power requirements in gassed and ungassed bioreactors.

Laboratory work: Bacterial growth kinetics, effect of varying carbon substrate on specific growth rate, production of citric acid and lactic acid, comparative study on rate of product formation using immobilized and suspension cells, KLa determination using non-fermentative and fermentative methods, effect of mixing and agitation rate on KLa

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Course Learning Outcomes (CLO):

Students will be able to:

1. explain how microorganisms and biochemical processes can be applied in engineered systems.
2. distinguish among batch, continuous and fed-batch culture systems for the production of biochemical products.
3. describe microbial growth & cultivation, various bioreactor components, and types of bioreactors used in biotechnology industries.
4. design media sterilization and design of air filter in a bioprocess.
5. apply various concepts to improve bioreactor performance and evaluate process variables to analyze a bioprocess.

Text Books:

1. *Stanbury PF, Hall SJ, and Whitaker A, Principles of Fermentation Technology, 3rd Edition, Elsevier (2016).*
2. *Shuler ML and Kargi F, Bioprocess Engineering, 2nd Edition Prentice Hall (2015).*
3. *Sivasankar B, Bioseparations: Principles and Techniques, PHI Learning Pvt. Ltd. (2006)*
4. *Belter PA, Cussler E and Hu WS, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience (1988)*

Reference Books:

1. *Doran P M, Bioprocess Engineering Principles, 2nd Edition, Academic Press (2012)*
2. *Ahuja S, Handbook of Bioseparations, Academic Press (2000)*
3. *Harrison RG, Bioseparations: Science and Engineering, Oxford University Press (2015)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/ Projects/ Tutorials/ Quizzes/Lab Evaluations)	40

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UBT605: PLANT BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The course will enable the students to acquire knowledge about various techniques like micropropagation, single cell culture, suspension culture, protoplast culture, hairy root culture and various techniques of recombinant DNA technology to produce genetically modified organisms with novel characters.

Detail contents:

Introduction, Aim and Scope of Plant Biotechnology: Major challenges and prospects of traditional and modern plant biotechnology, Important milestones of plant biotechnology

Plant Tissue Culture and protoplast culture—its history, development and applications, Plant tissue culture media, Plant growth regulators, Types of cultures, Protoplast culture and somatic hybridization.

Micropropagation: Techniques and various steps involved in micropropagation, Production of disease free plants and certification of tissue culture raised plants.

Production of Haploid Plants: Androgenesis and Gynogenesis, Significance and uses of haploids. Embryo culture and embryo rescue and its applications in plant improvement.

Strategies for Producing Novel Plants: Manipulation of Phenotypic Traits: Strategies of molecular cloning of plant genes, direct and indirect gene transfer methods, rDNA approaches for introducing herbicide tolerance, pest resistance, plant disease resistance, Abiotic & biotic stress tolerance, various strategies for the improvement of crop yield and quality, Applications of plant transformations/ transgenics, Molecular farming of commercially/pharmaceutically important products.

Secondary Metabolite Extraction: Primary vs secondary metabolites, Role of plant tissue culture in secondary metabolite production, Hairy root culture, Strategies for the enhancement of secondary metabolite production.

Germplasm Conservation and Somaclonal Variations: Isolation of somaclonal variants, Applications and limitations of somaclonal variations, Gametoclonal variations. Germplasm and methods of its conservation and Cryopreservation

Self-Learning: Transgenics-Issues and Concerns, Biosafety, Societal and ethical concerns on genetically modified foods and crops.

Laboratory Work:
Plant tissue culture media, Explant preparation and culture establishment, Regeneration and rooting of plantlets and accilimatization, Preparation of artificial seeds, Isolation and purification of plant DNA and RNA, Quantification of DNA, restriction analyses, *Agrobacterium*-mediated transformation of plants.

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Course Learning Outcomes (CLO):

Students will be able to:

1. familiarize with organization of PTC Lab., aseptic manipulations and learn techniques of culturing tissues, single cells, protoplast and anther culture, hairy root culture and germplasm conservation
2. undertake large scale in vitro propagation of plants through micropropagation
3. generate plants with desirable/novel traits through genetic manipulations using different methods of gene transfer and marker associated selections.
4. recognize the importance of plant secondary metabolites, their commercial production.

Text Books:

1. *Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Oxford University Press (2008).*
2. *Chawala, HS, Introduction to Plant Biotechnology, Third Edition, Oxford & IBH (2017).*
3. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishing (2006).*

Reference Books:

1. *Satyanarayana, U., Yeast Biotechnology: Diversity and Applications, Springer (2009).*
2. *Razdan, M.K., Introduction to Plant Tissue Culture, Science Publishers (2003).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

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UBT604: PHARMACEUTICAL TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of this course is to make students understand the basic concepts involved in pharmaceutical industry. The course will give knowledge about new drug development and approval process, ADMET of drugs, about the manufacturing and quality control of conventional, new type of dosage forms and biotechnology derived pharmaceuticals.

Detail contents:

Introduction to drugs and pharmacy: An overview and history of pharmaceutical industry. The business and the future of Biopharmaceuticals. Drug regulation and control. Scope and applications of biotechnology in pharmacy. New drug development and approval process: Strategies for new drug discovery, finding a lead compound, combinatorial approaches to new drug discovery, pre-clinical and clinical trials

Drug pharmacokinetics & pharmacodynamics: Routes of drug administration, membrane transport of drugs, absorption, distribution, metabolism and excretion of drugs. Factors modifying drug action, mechanism of drug action on human beings, receptor theory of drug action, pharmacogenomics, adverse effects of drugs and toxicology, Drug interactions

Pharmaceutical manufacturing: Drug dosage forms and their classification. Sterile dosage forms- parenteral and biologics, novel dosage forms and targeted drug delivery systems. Current good manufacturing practices and issues. Quality control of pharmaceutical products as per pharmacopoeia. Stability studies, Method validation

Biotechnology derived pharmaceuticals: Production of pharmaceuticals by genetically engineered cells-hormones and vaccines. Drug regulatory requirement of India, Drug regulatory and accrediting agencies of the world (USFDA, TGA, ICH, WHO, ISO etc.). Overview of registration process of Indian drug product in overseas market

Laboratory work: Quality control of antibiotic and non-antibiotic formulations using titrimetric, spectrophotometric, chromatographic methods as per IP/US Pharmacopoeia. Microbiological assays of vitamins and antibiotics. Sterility testing and stability testing of parenteral formulations

Course Learning Outcomes (CLO):
Student will be able to
1. explain the regulatory aspects and various steps of new drug discovery process.
2. explain the concept of pharmacodynamics and pharmacokinetics.
3. apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins and hormones.
4. carry out the quality control procedures in the production of various biopharmaceuticals.

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Text Books:

1. *Allen, L.V., Popovich, N.G. and Ansel, H.C., Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams and Wilkins (2005).*
2. *Walsh, G., Biopharmaceuticals: Biochemistry and Biotechnology, Wiley (1998).*

Reference Books:

1. *Gennaro, A.R., Remington: The Science and Practice of Pharmacy. Lippincott Williams and Wilkins (2005).*
2. *Tripathi, K.D., Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers (2008).*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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UTA025: INNOVATION AND ENTREPRENEURSHIP
(2 SELF-EFFORTS HOURS)

L	T	P	Cr
1	0	2#	3.0

Course Objectives: This course aims to provide the students with a basic understanding in the field of entrepreneurship, entrepreneurial perspectives, concepts and frameworks useful for analyzing entrepreneurial opportunities, understanding eco-system stakeholders and comprehending entrepreneurial decision making. It also intends to build competence with respect business model canvas and build understanding with respect to the domain of start-up venture finance

Detail contents:

Introduction to Entrepreneurship: Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioural; entrepreneurial challenges

Entrepreneurial Opportunities: Opportunities- discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering

Entrepreneurial Process and Decision Making: Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision making process and approaches, - Effectuation and Causation

Crafting business models and Lean Start-ups: Introduction to business models; Creating value propositions - conventional industry logic, value innovation logic; customer focused innovation; building and analyzing business models; Business model canvas, Introduction to lean startups, Business Pitching

Organizing Business and Entrepreneurial Finance: Forms of business organizations; organizational structures; Evolution of organization, sources and selection of venture finance options and its managerial implications. Policy Initiatives and focus; role of institutions in promoting entrepreneurship

Course Learning Outcomes (CLOs):

Students will be able to

1. Explain the fundamentals behind the entrepreneurial personality and their intentions
2. Discover/create and evaluate opportunities.
3. Identify various stakeholders for the idea and develop value proposition for the same.
4. Describe various Business Models and design a business model canvas.
5. Analyse and select suitable finance and revenue models for start-up venture.

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Text Books:

1. *Ries, Eric (2011), The lean Start-up: How constant innovation creates radically successful businesses, Penguin Books Limited.*
2. *Blank, Steve (2013), The Startup Owner's Manual: The Step by Step Guide for Building a Great Company, K&S Ranch.*
3. *S. Carter and D. Jones-Evans, Enterprise and small business- Principal Practice and Policy, Pearson Education (2006)*

Reference Books:

1. *T. H. Byers, R. C. Dorf, A. Nelson, Technology Ventures: From Idea to Enterprise, McGraw Hill (2013)*
2. *Osterwalder, Alex and Pigneur, Yves (2010) Business Model Generation.*
3. *Kachru, Upendra, India Land of a Billion Entrepreneurs, Pearson*
4. *Bagchi, Subroto, (2008), Go Kiss the World: Life Lessons For the Young Professional, Portfolio Penguin*
5. *Bagchi, Subroto, (2012). MBA At 16: A Teenager's Guide to Business, Penguin Books*
6. *Bansal, Rashmi, Stay Hungry Stay Foolish, CIIE, IIM Ahmedabad*
7. *Bansal, Rashmi, (2013). Follow Every Rainbow, Westland.*
8. *Mitra, Sramana (2008), Entrepreneur Journeys (Volume 1), Booksurge Publishing*
9. *Abrams, R. (2006). Six-week Start-up, Prentice-Hall of India.*
10. *Verstraete, T. and Laffitte, E.J. (2011). A Business Model of Entrepreneurship, Edward Elgar Publishing.*
11. *Johnson, Steven (2011). Where Good Ideas comes from, Penguin Books Limited.*
12. *Gabor, Michael E. (2013), Awakening the Entrepreneur Within, Primento.*
13. *Guillebeau, Chris (2012), The $100 startup: Fire your Boss, Do what you love and work better to live more, Pan Macmillan*
14. *Kelley, Tom (2011), The ten faces of innovation, Currency Doubleday*
15. *Prasad, Rohit (2013), Start-up sutra: what the angels won't tell you about business and life, Hachette India.*

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UHU005: HUMANITIES FOR ENGINEERS

L	T	P	Cr
2	0	2	3.0

Course Objectives: The objective of this course is to introduce values and ethical principles, that will serve as a guide to behavior on a personal level and in professional life. The course is designed to help the students to theorize about how leaders and managers should behave to motivate and manage employees; to help conceptualize conflict management strategies that managers can use to resolve organizational conflict effectively. It also provides background of demand and elasticity of demand to help in devising pricing strategy; to make strategic decisions using game theory and to apply techniques of project evaluation.

Unit 1: Human Values and Ethics

Values: Introduction to Values, Allport-Vernon-Lindzey Study of Values, Rokeach Value Survey, Instrumental and Terminal Values.

Moral and Ethical Values: Types of Morality, Kant's Principles of Morality, Factors for taking ethical decisions, Kohlberg's Theory of Moral Development

Professional Ethics: Profession: Attributes and Ethos, Whistle-blowing.

Unit 2: Organizational Behavior

Introduction to the Field of Organizational Behaviour: Individual Behaviour, Personality, and Values,

Perceiving Ourselves and Others in Organizations, Workplace Emotions, Attitudes, and Stress, Foundations of Employee Motivation and Leadership, Performance Appraisal, Conflict and Negotiation in the Workplace.

Unit 3: Economics

Demand, Supply & Elasticity – Introduction to Economics, Demand & its Determinants, Elasticity and its types

Production & Cost Analysis – Short run & Long Run Production Functions, Short run & Long run cost functions, Economies & Diseconomies of Scale

Competitive Analysis & Profit Maximization – Perfect competition, Monopoly, Monopolistic & Oligopoly Markets

Strategy & Game Theory – Pure Strategy & Mixed Strategy Games, Dominance, Nash Equilibrium, &

Prisoner's Dilemma

Capital Budgeting – Capital Projects, Net Present Value (NPV) & IRR techniques.

Practical:

1. Practical application of these concepts by means of Discussions, Role-plays and Presentations,
2. Analysis of Case Studies on ethics in business and whistle-blowing, leadership, managerial decision-making.
3. Survey Analysis
4. Capital Budgeting assignment

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Course Learning Outcomes (CLOs) / Course Objectives (COs):

The student after completing the course will be able to:

1. Comprehend ethical principles and values and apply them as a guide to behavior in personal and professional life.
2. Apply tools and techniques to manage and motivate employees.
3. Analyse and apply conflict management strategies that managers can use to resolve organizational conflict effectively.
4. Devise pricing strategy for decision-making.
5. Apply techniques for project evaluation.

Text Books:

1. *N. Tripathi, Human Values, New Age International (P) Ltd. (2009).*
2. *Robbins, S. P/ Judge, T. A/ Sanghi, S Organizational Behavior Pearson, New Delhi, (2009).*
3. *Petersen, H.C., Lewis, W.C. and Jain, S.K., Managerial Economics, Pearson (2006).*

Reference Books:

1. *McKenna E. F. Business psychology and organisational behaviour. Psychology Press, New York (2006).*
2. *Furnham A. The Psychology of Behaviour at Work: The Individual in the organization. Psychology Press, UK (2003).*
3. *Salvatore, D and Srivastava, R., Managerial Economics, Oxford University Press (2010).*
4. *Pindyck, R and Rubinfiled, D., Microeconomics, Pearson (2017).*

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UBT606: DOWNSTREAM PROCESSING

L	T	P	Cr
3	1	2	4.5

Course Objective: The course provides fundamental concepts of various downstream purification steps involved in a bioprocess industry.

Detail contents:

Introduction: Basic concepts of separation technology, overview of major upstream and downstream processes, importance of downstream processing in biotechnology, economic evaluation of downstream processing, separation characteristics of biological molecules, generic scheme of bioseparation, modern separation technology in bioprocessing

Primary Isolation and Recovery: Selection of purification methodologies, biomass removal and disruption by physical, chemical and biological methods, Types of Homogenizers, Types of filters (vacuum filter, plate and frame filter, leaf filter) Advanced Centrifugation, Theory of centrifugation, Types of centrifuges (tubular bowl centrifuge, basket centrifuge, ultracentrifuge), Precipitation, Coagulation and flocculation

Membrane based Separation, Extraction and Adsorption: Membrane process, ultrafiltration, nanofiltration, reverse osmosis, dialysis, Extraction, liquid-liquid extraction, Batch extractions, staged extractions, solvent recovery, applications of extraction. Evaporation, Types of evaporation, Adsorption, adsorbents types, their preparation and properties, types of adsorption isotherms and their importance in bioprocessing, adsorption in fixed bed

Chromatography, Drying and Case Studies: General theory, partition coefficient, types of chromatography: Ion exchange, gel permeation, affinity, HPLC, Crystallization: Batch and continuous crystallization, crystallization equipment, Drying, Types of drying (spray drying, vacuum drying, freeze drying, Case studies: downstream processing of baker's yeast and citric acid

Laboratory work: Optimization of flocculating agent concentration, comparative cell disruption methods, Batch settling process, filtration efficiency, protein precipitation by salting-out method, adsorption process in batch mode, Ball milling, Batch drying, Qualitative and quantitative estimation of product using GC, HPLC

Course Learning Outcomes (CLO):

Students will be able to:

1. comprehend the interplay between upstream and downstream processes.
2. describe the main stages of downstream processing operations.
3. explain the principles of major downstream operations used in a bioprocess industry such as filtration, centrifugation, extraction and chromatography.

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4. apply different techniques such as precipitation, coagulation and flocculation in downstream processing
5. design recovery outline in polishing of a product employing crystallization and drying methods.

Text Books:

1. *Belter PA, Cussler E and Hu WS, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience (1988)*
2. *Harrison RG, Bioseparations: Science and Engineering, Oxford University Press (2015)*
3. *Sivasankar B, Bioseparations: Principles and Techniques, PHI Learning Pvt. Ltd. (2006)*

Reference Books:

1. *Ahuja S, Handbook of Bioseparations, Academic Press (2000)*
2. *G. Subramanian-Bioseparation and Bioprocessing: Biochromatography, membrane separations, modeling, validation, Vol-I, Wiley-VCH Verlag GmbH Germany (1998)*

Evaluation Scheme:

Sl No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

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UBT610: INDUSTRIAL BIOTECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: To understand the use of living cells such as bacteria, yeast, algae or component of cells like enzymes, plants and animals to generate industrial products and processes. To study techniques for genetic improvement of micro-organisms to improve yield of bioproducts.

Detail contents:

Introduction to Industrial Biotechnology: Overview of fermentation and other bioproducts Industries. Industrial Bioproducts and their producer organisms. Characteristic properties of Industrially important strains

Strain improvement in industrial microorganisms: Improvement through mutation and recombination, Integrated Strain improvement program, targets for industrial strain improvement, Increase product concentration, Process improvement, biosynthesis of new metabolites. Precision Engineering Technology, biosynthetic technology

Process technology for the industrial production of cell biomass, primary and secondary metabolites: SCP, Ethanol, Citric acid, Dextran and Amino acids. (Glutamic acid, L-Lysine.) SCP, beer and vinegar; bio preservatives (Nisin), cheese, biopolymers (xanthan gum, PHB, etc.)

Industrial Production: Vitamin (E, K, B_2 and B_{12}), antibiotics, microbial production of Bio pigments and flavours.

Production of enzymes and Biotransformation: Production of industrial enzymes (proteases, amylases, lipases, cellulases), whole cell biocatalysts, Applications of bioconversion, transformation of steroids and sterols; Microbially enhanced oil recovery (MEOR) and Bioleaching

Laboratory work: Isolation of amylolytic microorganisms; Production and partial purification of Amylase in shake flask culture, Production of Citric acid using Aspergillus species, Strain improvement of Aspergillus species using physical mutagenesis process; Strain improvement of Aspergillus species using chemical mutagenesis; Screening and isolation of cellulase producing enzymes; Determination of cellulolytic activity by DNS method; Screening microorganism for antibiotic production, Production and partial purification of Penicillin.

Course Learning Outcomes (CLO):

Students will be able to:

1. comprehend role of industrial biotechnology in improving microbial cells as factories
2. know the production aspects of commodity chemicals, pharmaceuticals and fine chemicals.

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3. apply knowledge of microorganisms in commercial production of flavours, fragrance, and microbial pigment in textile and industry.
4. apply the process for commercial production of enzyme.
5. know the process of Microbial Enhanced Oil Recovery and Microbial Leaching

Text Books:

1. *Lee, S.Y., Nielsen, J. and Stephanopoulos, G., "Industrial Biotechnology: Products and Processes", John Wiley & Sons, 2016.*
2. *Waites, M.J., Morgan,N.L., Rockey,J.S., Higton, G., "Industrial Microbiology: An Introduction" Blackwell, 2001.*
3. *Cruger, W., Cruger, A., "A Textbook of Industrial Microbiology", Panima Publishing Corporation, 2nd Edition, 2005.*

Reference Books:

1. *Pandey, A., Negi, S., Soccol, C.R., "Current Developments in Biotechnology and Bioengineering: Production, isolation and purification of industrial products", Elsevier, 2016.*
2. *Okafor, N., "Modern Industrial Microbiology and Biotechnology", CRC Press, 2007*
3. *Presscott and Dunn's "Industrial Microbiology", CBS Publisher, 1987.*
4. *Casida Jr, L. E., "Industrial Microbiology", Wiley, 1968.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/ Projects/ Tutorials/ Quizzes/Lab Evaluations)	40

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UBT613: BIOINFORMATICS

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of this course is to familiarize Students with basic concepts of sequences, structural alignment, database searching, protein structure prediction and applications.

Detail contents:

Introduction: Goals, applications and limitations of Bioinformatics, Biological sequence and molecule file formats, Biological databases. Types of biological databases, its classification, application and pitfalls. Information retrieval from biological databases

Pairwise sequence alignment and database searching: Evolutionary Basis of sequence alignment, Homologous sequence, Global alignment and local alignment, Gap penalties, Scoring matrices, Methods of sequence alignment e.g., Dynamic programming methods: Needleman-Wunsch and Smith-Waterman algorithm, Database similarity search, Heuristic methods: FASTA and BLAST

Multiple sequence alignment and phylogenetics: Scoring multiple sequence alignments, Progressive alignment method, Iterative alignment method, Block-based alignment, Molecular evolution and phylogenetics, Phylogenetic analysis

Structural Bioinformatics: Protein structure basics, Visualization, Classification. Protein secondary structure prediction**.** Protein tertiary structure prediction: methods, applications, RNA structures, Genomics and proteomics. Machine learning in structure prediction

Laboratory Work*:* Biological database, file formats, Local and global sequence alignment of protein and DNA sequences, Phylogenetic tree construction, Sequence search and annotation

Course Learning Outcomes (CLO):

Students will be able to

1. explore biological databases
2. perform pairwise and multiple sequences alignment
3. construct phylogenetic tree, analyze and make inferences from it.
4. analyze sequence and structure of bio-macromolecule data.

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Textbooks:

1. *Xiong J, Essential Bioinformatics, Cambridge University Press (2013)*
2. *Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001), 2nd ed*
3. *Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2010)*

Reference Books:

1. *Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2000).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments /quizzes)	35

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UBT614: BIOSAFETY, BIOETHICS & IPR

L	T	P	Cr
2	0	0	2.0

Course Objectives: To introduce basic concepts of ethics and safety that are essential for all basic and applied sciences. To understand balanced integration of scientific and social knowledge and its protection in sustainable development.

Detail contents:

Biosafety: Evolution of the concept of biosafety; biohazard, need and application of biosafety in laboratories and industries; biosafety guidelines, regulations and their implementation; Classification and Description of Biosafety levels; Design of clean rooms and types of biosafety cabinets; Risk assessment and containment levels through case studies; bio-medical and hazardous wastes; Good laboratory practice (GLP); bio-terrorism; Convention on biodiversity and Cartagena protocol on biosafety; types of risk and issues associated with GMO's for animal, human, agriculture and environment

Bioethics: Introduction and need of bioethics, its relation with other branches, Ethical Issues involving GMOs; ethics related to human cloning, prenatal diagnosis, agriculture and animal rights through case studies; Socio-economic impact of biotechnology

Intellectual Property Rights (IPR): Introduction to IPR, types of IP (patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs), treaties in IPR, Patent laws, Legislations covering IPR's in India, IPR Protection, patent filing in biotechnology, provisional and complete specification, patentable and non-patentable items

Course Learning Outcomes (CLO):

Students will be able to

1. interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life
2. recognize importance of biosafety practices and guidelines in research
3. comprehend benefits of GM technology and related issues
4. recognize importance of protection of new knowledge and innovations and its role in business

Text books:

1. *Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)*
2. *Singh I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).*
3. *Srinivasan, K. and Awasthi, H.K., Law of Patents, Jain Book Agency (1997)*

Reference Books:

1. *Narayan, P., Patent Law, Eastern Law House (1975).*
2. *Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).*

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3. *Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UBT891: CAPSTONE PROJECT

L	T	P	Cr
1	0	2	8.0

Course Objective: To give a multifaceted assignment that serves as a culminating academic and intellectual experience for Students. To design and implement integrated approach to biological systems using concepts of biological and engineering sciences. To plan the process for the designed product and analyze the prototype manufactured for improvement in design and function

Scope of work: Each Students group led by a team leader will develop a design project involving formulation of problem, requirement, execution of the project and analysis. The Students will prepare a scientific report and powerpoint/ poster presentation. Depending on the type of project, design problem will be executed by simulation/modelling or developing a product

Course Learning Outcomes (CLO):

The Students will be able to:

1. formulate a design based project
2. implement ideas to solve the real time problems
3. work in a group and coordinate each other
4. present and defend the work done in front of the committee

Evaluation Scheme: Evaluation of the project will be based on following components.

Evaluation Elements	**Weightage (%)**
Formulation of the problem and objectives	10
Execution of the project	20
Results and data interpretation	20
Technical report	20
Presentation cum viva	30

UBT615: JOURNAL CLUB

L	T	P	Cr
0	0	0	2.0

Course objective: The Journal club course will provide an opportunity to the students to learn selection of relevant research articles, comprehending it well enough to be able to present it explaining to the audience

Scope of the course: The Students will be asked to select a recent research article related to a given topic. The student will read the paper and read other related or quoted papers for effective understanding. Finally student will present the paper and defend the results. The exercise will enable the students to read and understand the finding of a paper. They will learn how to design experiments to address a scientific problem, note down observations, infer results and present them in an appropriate way and discuss the results defending them. The discussion will also highlight importance of the findings

Course Learning Outcomes (CLO):

The Students will be able to:

1. select a paper related to a given topic
2. design experiments to address a scientific problem
3. analyze the observation to infer results
4. discuss the research finding in reference with the existing knowledge in the field.

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	Presentation of a research paper	100

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UBT796: PROJECT SEMESTER

L	T	P	Cr
0	0	0	15.0

Course objective: The semester project is aimed to impart an in-depth and thorough training on some specific industrial problems. Such exposures would enable the Students to address the various real-time challenges prevalent in biotech based industries. The Students acquire experience and knowledge to work in professional setup. The Students will understand the challenges faced by industries and research laboratories and the possible solutions. During this period, the Students will get training in the diverse areas of biotechnology

Scope of Training: The Students will get opportunity to be a part of ongoing QA, QC, Production, and R&D activities in different industries, commercial enterprises and organization. The Students can also join laboratories in research institutes and reputed universities. The Students will explore and gain experience in different sectors of biotechnology viz agriculture, food, medicine and pharmaceutical. The Students will develop understanding of biosafety, bioethic, regulatory and compliances. The Students will acquire skill to write, analyze and compile data, and present the detailed technical/scientific report. At the end of successful project semester training, potentially the Students become employable in the industries/organizations

Course Learning Outcomes (CLO):

The Students will be able to:

1. work in a team
2. adapt to the varying working environment in industry and research institute
3. identify a problem in biotechnology based industry.
4. formulate a research problem in research laboratory 5. design experiments to solve the industrial/research problem.
5. compile and/or interpret the industrial data.
6. analyze and interpret the experimental data

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	Formulation of the problem and objectives	10
2.	Execution of the project	20
3.	Results and data interpretation	20
4.	Technical report	20
5.	Presentation cum viva	30

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UBT797: PROJECT

L	T	P	Cr
0	0	0	8.0

Course objective: The semester project is aimed to impart an in-house project training on some specific scientific problems. Such exposures would enable the Students to learn identification of a scientific problem, search research literature, plan and execute experiment seeking a solution to the problem

Scope of Training: The Students will get opportunity to perform an in-house research project under the guidance of one of the faculty members. The Students will gain experience in different sectors of biotechnology viz food, medicine and pharmaceutical sciences. The Students will acquire skill to write, analyze and compile data, and present the detailed technical/scientific report. At the end of successful project training, potentially the students become employable in the industries or better prepared for higher education in

Course Learning Outcomes (CLO):

The Students will be able to:

1. formulate a research problem.
2. design experiments based on the relevant research literature.
3. apply biotechnological techniques to perform experiments.
4. analyze data.
5. compile and present results of a research project.

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	Technical report	30
2.	Presentation cum viva	70

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UBT705: GENOMICS AND PROTEOMICS

L	T	P	Cr
3	1	0	3.5

Course Objective: The objective of this course is to familiarize Students with concepts of genomics and proteomics technologies and to understand the steps of high throughput data analysis.

Detail contents:

Introduction: Goals, applications and limitations of Bioinformatics, Biological sequence and molecule file formats, Biological databases. Types of biological databases, its classification, application and pitfalls. Information retrieval from biological databases, pairwise sequence alignment and database searching**:** Evolutionary Basis of sequence alignment, Homologous sequence, Global alignment and local alignment, Gap penalties, Scoring matrices, Methods of sequence alignment e.g., Dynamic programming methods: Needleman-Wunsch and Smith-Waterman algorithm, Database similarity search, Heuristic methods: FASTA and BLAST

Genomics and Transcriptomics: Structure of Gene and genomes of Eukaryotic and prokaryotic, genome databases, Sanger sequencing-principle, methodology and applications, Whole genome - de novo sequencing or resequencing; exome sequencing, RNA sequencing; small RNA sequencing; Next Generation Sequencing (NGS) workflow, Differential expression.

NGS Data Analysis: NGS work flow and pipeline for data analysis. Next generation sequence data analyses, Data format, Quality control-Phred score; FastQC and FastX tool kits, read length, read depth, sequence coverage, Homology (orthology groups), Genome alignment and analysis tools- BWA (BurrowsWheeler Aligner), SAMtools, GATK (The Genome Analysis Toolkit), Cuffcompare, Velvet, Oases, Trinity.

Proteomics: Introduction to quantitative proteomics- Differential proteomics, post-translational modifications, Proteogenomic Concepts and principles of genome annotation, genome search specific peptides, alternative translation initiation, small ORFs, Analysis of transcriptomic and proteomic data for genome annotation; Gene prediction algorithms

Structural Bioinformatics: Protein structure basics, Visualization, Classification. Protein secondary structure prediction**.** Protein tertiary structure prediction: methods, applications, RNA structures, Genomics and proteomics.

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Course Learning Outcomes (CLO):

Students will be able to:

1. explore biological databases
2. perform pre-processing of NGS data
3. analyze the algorithms to handle NGS data
4. comprehend various methods involved in data analysis of genomics and proteomics technology for commercial and industrial applications

Textbooks:

1. *Xiong J, Essential Bioinformatics, Cambridge University Press (2013)*
2. *S B Primrose and R Twyman, Principles of gene manipulation and Genomics (2013) 7th Edition*
3. *Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001), 2nd ed*
4. *Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2010)*

Reference Books:

1. *Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2010).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments /quizzes)	35

Approved in 107th meeting of the Senate held on June 16, 2022

UBT706: ENZYME TECHNOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objective: The objective of the course is to inform the students about isolation of novel enzymes, basic principles for optimization, modeling of the industrial use of the enzymes etc. in which both, free and immobilized enzymes play a role. Students will be able to implement both biochemical and engineering knowledge in order to design new and improve current enzymatic processes

Detail contents:

Introduction to enzymes: Enzymes-historical resume, Nomenclature and Classification, Biological roles, Isozymes, Marker enzymes, Overview of enzyme 3D-structure, active site, catalytic site, Specific activity, Enzyme activity and kinetics of free enzymes, K_m, V_{max}, and turn over number of enzymes and their significance, Modifiers of enzyme activity, enzyme activators, enzyme inhibitors, Overview of enzyme inhibition kinetics: competitive, non-competitive, and un-competitive, Kinetics of enzyme degradation, Enzyme stability: pH, temperature

Production of enzymes: Sources of industrial enzymes (natural & recombinant), Screening for new and improved enzymes, different methods of extraction, isolation and purification of commercially important enzymes, retailoring of enzyme, large-scale industrial enzyme production and downstream processing: Case studies (from literature), improvement of enzymes

Techniques of enzyme immobilization: Immobilization- definition, Immobilization techniques: physical and chemical adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding with examples, Advantages and disadvantages of different immobilization techniques, Overview of applications of immobilized enzyme systems, Enzymes in electrodes

Kinetics of immobilized enzymes: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors, Analysis of mass transfer effects of kinetics of immobilized enzyme reactions, Packed bed reactors, Film and pore diffusion effects on kinetics of immobilized enzyme reactions, Effectiveness factors of immobilized enzyme systems

Application of enzymes: Industrial uses of enzymes, proteolytic enzymes in meat and leather industry, Clinical enzymology, Therapeutic enzymes, Diagnostic enzymes

Course Learning Outcomes (CLO):

Students will be able to:

1. explain mechanism and function of enzymes and assay enzyme reaction kinetics.
2. produce, isolate and purify enzymes at lab/industry scale.
3. design enzyme immobilization techniques based on the types of enzymes.

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4. comprehend and calculations involved in immobilized enzyme kinetics.
5. explain the industrial applications of enzymes.

Text Books:

1. Arora NK, Mishra J, Mishra V, Microbial Enzymes: Roles and Applications in Industries, Springer Singapore (2020).
2. Vogel A and May O (Ed.) Industrial Enzyme Applications, Wiley (2019).
3. Aehle, Enzyme in Industry: Production and Applications, Wiley-VCH (2007).

Reference Books:

1. Bisswanger H, Enzyme Kinetics: Principles and Methods, Wiley-VCH (2017).
2. Dixon M and Webb MC, Enzymes, Longmans (1980).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include Assignments /Projects /Tutorials /Quizzes/ Lab Evaluations)	35

UBT802: NANOBIOTECHNOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course introduces the concepts of quantum confinement, synthesis routes and characterization tools for nanomaterials to the students. It also provides preliminary ideas about choice of materials for biomedical, therapeutic and environmental applications.

Introduction to Nanoscience: Features of nanosystems, ccharacteristic length scales of materials and their influence on properties, quantum size effect: electron confinement in 2D, 1D and 0D, quantum nanostructures.

Synthesis and Characterization of Nanomaterials: Bottom-up and top-down approaches, thin film deposition techniques, biosynthesis of nanoparticles and self-assembly, **Characterization of nanomaterials:** X-ray diffraction, electron microscopy (SEM and TEM), atomic force microscopy and spectroscopy techniques (UV-visible, fluorescence, FTIR and RAMAN spectroscopy), Thermal characterization techniques (TGA, DTA, DSC)

Biomedical Applications: Concepts and working principles of Targeted drug delivery systems, photodynamic therapy, magnetic hyperthermia, nano-antimicrobials, nanobiosensors, etc.

Nanotoxicology: Cytotoxic and genotoxic effects of nanomaterials, toxic effects on environment (plants and microbes), impact of nanotechnology on society and industry

Course Learning Outcomes (CLO):

Students will be able to:

1) explain the effects of quantum confinement on physical, chemical and biological properties of materials at nanoscale
2) choose an appropriate synthesis technique to synthesize nanostructures of desired size, shape and surface properties
3) choose appropriate nanostructures for biomedical applications
4) evaluate the potential toxic effects of nanotechnology on living organisms

Text Books:

1. *"Introduction to Nanotechnology" Poole,C.P., Owens,F.J., John Wiley &Sons (2003)*
2. *"Nanostructures and Nanomaterials: Synthesis, Properties and Applications", G. Cao, Imperial College Press (2004)*
3. *Nanobiotechnology; Concepts, Applications and Perspectives", C. M. Niemeyer, C. A. Mirkin, Wiley-VCH (2004)*
4. *" Bionanotechnology: In Nanoscale Science and Technology", G. J. Leggett, R. A. L. Jones, John Wiley & Sons, (2005)*
5. *"Nano: The Essentials", T. Pradeep, Tata McGraw-Hill Publishing Company Ltd. (2007)*

Reference Books:

1. *"Bionanotechnology", D. S. Goodsell, John Wiley & Sons (2004)*
2. *"Springer Handbook of Nanotechnology", Eds: Bhushan, 2nd edition.*

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3. *"Encyclopedia of Nanoscience and Nanotechnology", Eds: H. S. Nalwa, American Scientific Publishers (2004)*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessional (May include assignments/quizzes)	25

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UBT832: CONCEPTS IN BIOMEDICAL INSTRUMENTATION

L	T	P	Cr
3	0	2	4.0

Course Objectives: The course aims to develop an in-depth understanding of human body subsystems and to impart knowledge about cardiovascular and respiratory system measurements. In addition, the course will also provide understanding of measurement of biomedical processes and medical imaging.

Detail contents:

Human Body Subsystems: Brief description of neuronal, Muscular, Cardiovascular and respiratory systems; Their electrical, Mechanical and Chemical activities.

Cardiovascular System Measurements: Electrocardiograph, ECG machines, vector cardiography (VCG), ballisto-cardiography (BCG), measurement of blood pressure, blood flow, cardiac output, cardiac rate, plethysmograph, pacemakers, defibrillators, Heart sounds, Phonocardiograph, Echocardiograph.

Respiratory System Measurements: Measurement of gas volume, respiratory transducers and instruments, respiratory therapy equipment, intermittent positive pressure breathing (IPPB) therapy, artificial mechanical ventilation, accessory devices used in respiratory therapy apparatus

Measurement of Electrical Activity in Neuromuscular System and Brain: Neuron potential, muscle potential, electromyograph, brain potentials, electroencephalograph.

Analytical Instruments: pH measurement, measurement of pCO_2 & pO_2, calorimeter, blood cell counter, automation of chemical tests, oximeters

Patient Care, Monitoring and Safety Measures: Elements of intensive care monitoring; Basic hospital systems and components Thermography, ultrasound imaging system, Physiological effect of electric currents, Safety measures; Standards, Codes and practices

Prosthetics and Orthotics: Introduction to artificial kidney, Artificial heart, Heart lung machine, Limb prosthetics and Orthotics elements of audio and visual aids

Computer Applications and Biotelemetry: Real time computer applications, Data acquisition and processing; Remote data recording and management

Laboratory work: Study of various physiological parameters using multichannel recorder, experiments based on stethoscope, sphygmomanometer, pulse oximeter, ECG, EMG. Respiratory parameters study using spirometer for lungs capacity, Ultrasonic characterization study of biological samples

Course learning outcomes (CLO):

Students will be able to:

1. comprehend the physiology of the heart, lung, blood circulation and respiration.

2. apply different transducers and various sensing and measurement devices of electrical origin in biomedical applications.
3. comprehend electrical safety in medical equipment's.
4. explain different medical imaging techniques.

Text books:

1. *Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall (2000) 4th ed.*
2. *Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd ed.*

Reference Books:

1. *Geddes, L.A., and Baker, L.E., Principles of Applied Biomedical Instrumentation, Wiley InterScience (1989) 3rd ed.*
2. *Khandpur, R.S., Handbook of Biomedical Instrumentation, McGraw Hill (2003) 2nd ed.*
3. *Webster, J.G., Medical Instrumentation Application and Design, John Wiley (2007) 3rd ed.*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

UBT512: STRUCTURAL BIOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: Aiming to provide basic knowledge of structural components in biological systems, this course will make students aware of the lower to higher-order biological organizations, including the molecular to macromolecular structures and biological assemblies that drive the living systems.

Detail contents:

Structural components of biological system: Levels of molecular organization, Brief discussions on: Amino acids (R groups and conformations, D- L- isomers), Nucleic acids (general characteristics of nucleic acid structures, forces and stabilizing geometries, glycosidic bond, rotational isomers), Carbohydrates, Lipids, Cofactors, Vitamins, and Hormones; Basic forces and interaction holding biological structure (ionic, polar, hydrogen bonding; hydrophobic, etc.); symmetry in biological molecules: translation, rotation, reflection, and glide; organization of molecules in lattice

Protein and DNA structures: Protein structure and hierarchy; secondary structure: α-helix, β sheet, loop; ϕ/ψ/χ angles: Ramachandran Plot; Super-secondary and tertiary structure: motifs, domain, and fold; Quaternary structure: oligomer assembly- protomer and oligomer: homo-oligomer and heterooligomer; biological implications of higher order protein structure - cooperative interactions, allosteric effects; structural families and classes; Structure of IgG, fibrous proteins (structure of collagen, keratin); Stabilizing ordered forms of DNA (A, B and Z), base-pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA); Concept of DNA lattice; Ribose puckering and tertiary structure of tRNA

Biological membrane and higher order structural organization: Biological membrane components-lipids and membrane proteins; properties of biological membranes; Singer Nicolson model; Membrane protein structures, function, and assemblies; lipid rafts and micro-domains; Present understanding of the structure of biological membrane and cytoskeleton; Actin; Plant plasmodesmata structure; virus structures; SNARE complexes

Tools for determination of biological structures: Overview of the major tools to study the molecular structures, X-ray diffraction; NMR and Electron microscopy; Atomic force microscopy (AFM)

Course Learning Outcomes (CLO):

Students will be able to

1. explain the structural components of biological system.
2. understand the aspects of protein and DNA structure and its importance in living system
3. comprehend the concept of lower to higher order structural organization of life.
4. apply the basic methods of determining and studying biological structures

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Text Books:

1. Alberts B, et al., *Molecular Biology of The Cell* 7th edition, Garland Science (2022)
2. Lodish et al., *Molecular Cell Biology* 8th edition, Freeman Macmillan (2016)

Reference Books:

1. *Branden CI, Tooze J: Introduction to Protein Structure, Garland Science (1998)*
2. *Williamson M: How Proteins Work, Garland Science (2012)*
3. *Miller and Tanner, Essentials of Chemical Biology: Structure and Dynamics of Biological Macromolecules, Wiley, (2008)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

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UBT513: CELL AND TISSUE ENGINEERING

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course will enable Students to understand thoroughly the key concepts of tissue organization, remodeling and strategies for restoration of tissue function. This will enable them to design tissue regeneration and tissue injury repair strategies.

Detail contents:

Introduction: Basic definition, Introduction to tissue engineering, Cells as therapeutic agents with examples. Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.

Structural and organization of tissues: Tissue organization, Tissue Components, Tissue types, Functional subunits. Tissue Dynamics, Homeostasis in highly prolific tissues and Tissue repair. Angiogenesis. Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing

Molecular and cellular aspects: Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers

Biomaterials and scaffold: Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver, Bioreactors for Tissue Engineering

Case study and regulatory issues: Case study of multiple approaches: cell transplantation and engineering for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering

Course learning outcome (CLO):

The Students will be able to:

1. comprehend the structural organization of cells and tissues
2. understand the role of cell interaction, cell migration, wound healing and cellular processes
3. describe the different biomaterials and its properties, design, fabrication and biomaterials selection criteria for tissue engineering scaffolds
4. comprehend applications of tissue engineering

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Text books:

1. *Principles of tissue engineering, Robert. P.Lanza, Robert Langer & William L. Chick, Academic press, 4th edition (2014).*
2. *The Biomedical Engineering –Handbook, Joseph D. Bronzino, CRC press, 4th edition (2015).*
3. *Introduction to Biomedical Engineering, Endarle, Blanchard & Bronzino, Academic press, 3rd edition (2012).*

Reference books:

1. *Tissue Engineering, B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino, CRC-Taylor & Francis, 1st edition (2016)*
2. *Nanotechnology and Tissue engineering - The Scaffold", Cato T. Laurencin, Lakshmi S. Nair, CRC Press, 1st edition (2008)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments /quizzes)	25

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UBT514: NATURAL PRODUCTS

L	T	P	Cr
3	0	0	3.0

Course Objective: To study the drugs from a natural source, their specific method of isolation, stereochemistry, biological activity, and biogenesis/biosynthesis.

Detail Contents:

The general aspect of sources of medicinal plant products: Introduction to primary and secondary metabolites, types of secondary metabolites, production under stress, isolation of active constituent from plant material

Alkaloids Definition, general properties, Classification, methods of isolation, stereochemistry, biological activity, general theory of biogenesis. Role of alkaloids in plants and their pharmaceutical importance

Glycosides and saponins: Definition, Classification, general properties, medicinal importance, separation and isolation, structure determination, biological activity, the study of examples such as cardiac glycosides from Digitalis

Steroids and triterpenoids: Definition, general properties, Classification, methods of isolation, biological activity, general theory of biogenesis, steroids from *Withania somnifera*, *Holarrhena* and *Solanum*

Pigments: Occurrence, classification, introduction, and applications of carotenoids, xanthophylls, anthocyanins, flavones, flavonols. Acetate pathway and Shikimic acid pathway. Natural products of therapeutic importance from animals. Isolation, qualitative and quantitative analysis of secondary metabolite, Edible dyes, plant sweeteners, perfumery, and cosmetic agents

Course Learning Outcomes (CLO):

Students will be able to:

1. apply the acquire knowledge about the secondary metabolites, natural products in various therapies.
2. design experiments for enhanced phytochemical production.
3. design the process of natural products isolation and purification.
4. will have a good understanding of biosynthetic pathways of natural products.

Text Books:

1. *Harborne, J. B. (2013) Phytochemical Methods, Second Edition, Springer publication.*
2. *K. G. Ramawat and J. M. Merillon (Eds.), 2010, Biotechnology – secondary metabolites, Oxford & IBH publishing Co. Pvt. Ltd.*

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Reference Books:

1. *S. V. Bhat, B. A. Nagasampagi and M. Sivakumar 2008. Chemistry of Natural Products, First Edition, Narosa Publishing House, New Delhi*
2. *V. P. Agrawal and V. P. Khamboj, (Eds.) Chemistry and biology of herbal medicine:*
3. *G. E. Trease and W. C. Evans, 2002, Pharmacognosy and Phytochemistry, 15th Edition, W.B. Saunders Edinburgh, New York.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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UBT608: FOOD PROCESSING

L	T	P	Cr
3	0	2	4.0

Course Objective: To provide basic knowledge about food processing. To acquaint the students with the effects of processing and preservation techniques on physical, chemical and microbiological properties of food.

Detail contents:

Thermal and cold processing: Thermal processing: classification of thermal processing methods, factors affecting thermal resistance of microorganisms and their spores, thermal death time, lethality concept. Refrigeration and cold storage, changes in food during refrigerated storage. Freezing and frozen storage, changes during freezing, freezing methods

Food dehydration and concentration: Dehydration of foods**:** normal drying curve, change in food due to drying, drying methods and equipment. Food concentration, methods of concentration, changes in food due to concentration, intermediate moisture foods

Food irradiation and microwave heating: Irradiation: mechanism of the killing of micro-organisms, factors affecting irradiation of foods, effect on the nutritional content of the foods. Microwave heating**:** working principle, components, food applications, effect on micro-organisms

Other processing techniques: Smoking, preservatives (natural and artificial), antibiotics usage and side effects. Recent methods in food processing and preservation: pulse electric field, high pressure, ultrasound, ohmic and infrared heating

Packaging and labelling of foods: Packaging material and their selection, types and levels of packaging, novel packaging techniques. MAP; applications for fresh-prepared produce oxygen, ethylene and CO_2 scavenging technology, zero energy chamber, hypobaric storage

Laboratory work: Designing of a thermal process on the basis of the killing of the microorganism on a particular food. Preserving food using thermal processing: blanching, pasteurization and sterilization. Dehydrating foods using different methods and determining drying characteristics. Microwave processing. Concentration of food products. Study the design and working of different processors, equipments and analytical instruments used in Food Industry. Quality testing of different packaging materials

Course Learning Outcomes (CLO):

Students will be able to:

1. comprehend the working principle and mechanism of action of individual food processing methods on microorganisms and enzyme activity to the increase shelf life.
2. apply various food processing and preservative techniques for shelf life extension of foods

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3. explain the principle and mechanism of processing food using ionic radiations and microwave radiations.
4. compare the efficiency of different food processing and preservation techniques and know their pros and cons
5. identify different packaging materials used for food packaging and understand their importance

Textbooks:

1. *Norman N. Potter and Joseph H. Hotchkiss - Food Science, 5th ed. (2012)*
2. *M. Shafiur Rahman Handbook of Food Processing, 3rd Edition, CRC Press Taylor and Francis group (2020)*
3. *Frazier William C and Westhoff, Dennis C.)- Food Microbiology, TMH, New Delhi. (2017)*
4. *Mc Elhatton, Anna, do Amaral Sobral, Paulo José (Eds.) - Novel Technologies in Food Science, Vol.7, 2nd Edition, CRC Press Taylor and Francis group. (2012)*

Reference Books:

1. *Avantina Sharma Textbook of Food Science & Technology (Vol-I & II), International Book Distributing Company, 3rd Ed. (2021)*
2. *Cheung, Peter C. K., Mehta, Bhavbhuti M. Handbook of Food Chemistry, Springer-Verlag Berlin Heidelberg, Ist Edition. (2015)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

UBT617: MEDICAL BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objectives: To enlighten the knowledge of the Students on different areas of Medical Biotechnology. To train the Students in a hospital based setup and familiarize them with the clinical diagnostics of diseases.

Detail contents:

Introduction: History and scope of medical biotechnology, current status and future prospects.

Classification of genetic diseases: Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders

Molecular basis of human diseases: Pathogenic mutations Gain of function mutations: Oncogenes,
Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor. Genomic. Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Mitochondrial diseases

Gene therapy: *Ex-vivo*, *In vivo*, *In situ* gene therapy, Strategies of gene therapy: gene augmentation Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer. Gene therapy trials – Familial Hypercholesterolemia, ADA, AIDS, Cystic Fibrosis, Solid tumors

Nucleic acid based Therapy: Gene silencing technology, siRNA, Aptamers, antisense oligodeoxynucleotides (AS-ODN), Ribozymes, Peptide Nucleic Acids

Recombinant & Immunotherapy: Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors, Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosupressors in organ transplants; Role of cytokine therapy in cancers

Clinical management and Metabolic syndrome: PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism

Laboratory work: Chromosome preparations-PHA-stimulated short-term blood cultures, air-dried chromosome preparations. G-banding of chromosomes. Blood urea analysis by diacetyl monoxyme method. Analysis of acid and alkaline phosphatase from serum samples Estimation of serum cholesterol, Assay of SGOT enzyme activity, Assay of SGPT enzyme activity, Blood sugar analysis by Folin -Wu method, Estimation of Creatine and Creatinine from urine samples

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Course Learning Outcomes (CLO):

Students will be able to

1. explain insights about genetic diseases and also about the molecular aspects related to human disease
2. gain new insights into molecular mechanisms of nucleic acid and gene therapy
3. gain knowledge about therapeutic recombinant proteins and immunotherapy for the treatment of different diseases

Text books:

1. *Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine by Andrew J.T. George (Editor), Catherine E. Urch (Editor) Publisher: Humana Press; edition (2000)*

2. *Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) by Jochen Decker, U. Reischl Amazon*

Reference Books:

1. Human Molecular Genetics by T. Strachan, Andrew Read Amazon Sales Rank:

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

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UBT616: PROTEIN ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objective: Aiming to provide basic knowledge of engineering and design of the protein for its application, this course will make students learn structural and functional relationships in proteins and enabling students to improvise protein structure and function.

Detail contents:

Elements of protein structure: Introduction to protein engineering; Primary structure: amino acids and their –R groups; Secondary structure: α helix, β strand, β sheet, loops, Ramachandran plot; Supersecondary and tertiary structure: motifs, domain, and fold; Quaternary structure: oligomer assembly; Relationship between structure and function: protein active site, catalytic site, crypto sites and druggability, cooperativity and allosteric effect.

Experimental and computational tools used in protein structural Biology: Protein structure determination by X ray diffraction (XRD) and NMR, Prediction of protein structure and conformation from sequence data (Homology Modeling, Threading and *de novo* prediction); Computational tools for prediction of protein active sites; Spectroscopy methods (CD and fluorescence) of determination of protein structural conformation; Protein activity and stability measurement (k_{cat}/K_m; T_m) using spectroscopy

Protein Engineering: Mutagenesis methods: site directed mutagenesis–insertion, deletion, substitution, modular protein domain, random mutagenesis- directed evolution, gene shuffling; Kunkle mutagenesis; Phage display technology; Overview of CRISPR/Cas method (*in vivo*); Insertion of unnatural amino acids in protein using orthogonal system; Chemical modifications of proteins

Protein expression and purification systems: Expression of proteins in bacteria, yeast, insect and mammalian cells; Protein purification overview; Different chromatography methods in protein purification (Affinity, ion exchange, gel exclusion, hydrophobic)

Application of Protein Engineering: Case study – protein engineering in lysozyme; Overview of protein design and considerations; Applications in drug delivery, biosensors, immunotherapy; antibody engineering

Laboratory work: Computational prediction of protein function and structure from arbitrary protein sequence; Retrieving protein structure from the database (PDB); Visualization and Analysis of protein structure; Design DNA primers for cloning and mutagenesis; Quantification of protein using spectroscopy (Bradford or Lowry); Protein denaturation study using UREA; Protein denaturation study using heat; SDS-PAGE analysis of the protein; Protein crosslinking assay using glutaraldehyde; Measuring protein kinetic constants (enzymatic reaction or binding kinetics); Chromatography method of protein purification.

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Self-learning: Study the scientific literature and understand the cutting edge research in protein engineering; presentation, discussions

Course Learning Outcomes (CLO):

Students will be able to:
1. understand the protein structure and function relationship.
2. know the methods for determination of protein structure and studying protein structure, function and stability.
3. apply the methods involved in protein engineering.
4. design strategy of protein expression and purification
5. comprehend the scope of protein engineering application

Text Books:

1. Primrose SB and Twyman RM: Principles of Gene Manipulation and Genomics Blackwell Publishing (2006).
2. Cleland JL and Craik CS: Protein Engineering: Principles and Practice, Wiley-Liss. (1996).
3. Lutz S and Bornscheuer U T: Protein Engineering Handbook, Wiley-VCH (2009)
4. Zhao H(Editor), Lee SY(Series Editor), Nielsen J(Series Editor), Stephanopoulos G (Series Editor): Protein Engineering: Tools and Applications, Wiley-VCH (2021)
5. Park SJ(Editor), Cochran JR(Editor), Protein Engineering and Design, CRC Press (2009).

Reference Books:

1. Branden CI, Tooze J: Introduction to Protein Structure, Garland Science (1998)
2. Williamson M: How Proteins Work, Garland Science (2012)

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UBT837: CANCER BIOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to introduce current concepts and advances in the area of cancer biology. The students will understand the role of oncogenes and suppressor genes and get knowledge on cancer related mutagens and pathways and cancer therapy

Detail contents:

Fundamentals of cancer biology: Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumor suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer, cancer and chronic diseases.

Principles of carcinogenesis: Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis**.**

Principles of molecular cell biology of cancer: Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto-oncogene activity. Growth factors related to transformation. Telomerases.

Principles of cancer metastasis: Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumor cell invasion.

Cancer diagnostic and therapy: Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer. Different forms of therapy, chemotherapy, radiation therapy, chemotherapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection.

Course Learning Outcomes (CLO):

Students will be able to:

1. comprehend pathogenesis, molecular mechanisms,
2. identify cancer related risk factors
3. explain cancer metastasis microenvironment and cancer therapy
4. understand cancer diagnostic and therapeutic

Text books:

1. *Robert A. Weinberg. The Biology of Cancer. 2nd edition, 2006.*
2. *Robin Hesketh. Introduction to Cancer Biology Cambridge, University Press 2013.*
3. *David J. Kerr, Daniel G. Haller, Cornelis J.H. van de Velde, Michael Baumann. The Oxford Textbook of Oncology. 3rd edition, 2016.*

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Reference Books:

1. *An Introduction Top Cellular and Molecular Biology of Cancer", Oxford Medical Publications, 1991.*
2. *Stella Pelengaris and Michael Khan. The Molecular Biology of Cancer, 2nd edition. Wiley Blackwell, 2013*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

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UBT838: STEM CELL TECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to enable Students to understand the principles of stem cells. Students will acquire knowledge in the areas of tissue engineering

Detail contents:

Concept of Stem Cells: Stem cells: Basic concepts and properties, Totipotency, Pluripotency, Embryonic stem cells, Germinal stem cells, Adult stem cells, Tumor stem cells, Stem cell plasticity, General methods of characterization of stem cells

Stem cell self-renewal and pluripotency: molecular mechanisms Cell cycle regulation in stem cells. Stem cell niches, Stem cell lineage tracing

Embryonic stem (ES) cells: Isolation of ES cells, Salient features and application of ES cells, ES cells. Human and Mouse embryonic stem cells, Differentiation of ES cell, Maintenance of ES in undifferentiated state

Hematopoietic Stem Cells (HSC): Identification and Characterization of HSCs, Sources of HSC Mouse Assay of HSC, HSC in leukemia and lymphoma, Clinical use of HSC

Mesenchymal and Neural Stem Cell: Embryonic origin of MSC's, Harvesting, Isolation and Characterization, Differentiation studies of MSC's, Neural stem cell and Neural crest stem cell

Stem Cells and Cloning: Therapeutic and reproductive cloning, Nuclear Transfer method, Application of NT ES cells, Safety of NT ES cells

Application of stem Cells: Overview of embryonic and adult stem cells for therapy Neurodegenerative diseases; Parkinson's, Alzheimer, Spinal Code Injuries and other brain Syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia etc. Applications of stem cells in medicine and different disease models, Biosafety and Stem cell research, Regulatory considerations and FDA requirements for stem cell therapy

Course learning outcomes (CLO):

The Students will be able to:

1. comprehend the concept of stem cells, different types of stem cells
2. describe the concept of stem cell cloning and its applications
3. recognize treatment of human diseases connected to stem cell therapy.

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Text books:

1. *Twyman RM, Developmental Biology Viva Books Pvt. Ltd. (2001) Marshak L,*
2. *Stem Cell Biology, Cold Spring Harbor Publication, (2001).*
3. *Lanza RP, Robert Langer R and Chick WL, Principles of Tissue Engineering, Academic Press (1997).*

Reference Books:

1. *Palsson B and Bhatia S. Tissue Engineering, Pearson-Prentice Hall, (2003).*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UBT839: DRUG DESIGN AND DEVELOPMENT

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to provide comprehensive knowledge of the basics of the drug discovery and development in the area of pharmacognosy and natural products; traditional and complementary medicine, synthetic medicinal chemistry and development of modern and innovative therapeutic substances.

Detail contents

Introduction: Definition of drugs, Overview of drug discovery process, Economics of drug discovery process, Trends in drug discovery process

Rationale of Drug Discovery: Medical needs, Target identification, Target validation, Receptors and assay development

Bio-resources for Small Molecule Discovery: Bioprospecting, Plant natural products, Microbial secondary metabolites, Marine natural products

Screening Strategies for Drug Leads: Bioassay guided isolation, High throughput assays for antimicrobial, anticancer, anti-diabetic and anti-hypercholesterolemia, combinatorial chemogenomics, combinatorial chemistry. Characterization of drug molecules using integrated technology (TLC, HPLC, MS, IR, NMR)

Complementary and Alternative Medicine: Ayurveda and Herbal Drugs, Definition, Trade scenario, Pharmacopoeial status of herbal drugs

Biosimilars: Introduction to biologics, defining biosimilars, differences between biosimilars and generics, selected examples of approved biosimilars, technical challenges associated with production of biosimilar molecules, regulatory aspects of biosimilar molecules. Current status of biosimilars in different countries (Europe, USA)

Drug Development and Pre-Clinical Studies: Introduction to structure–activity relationships (SAR), Drug receptor interactions; enzyme inhibition and inactivation, *In vitro* and *in vivo* pharmacodynamic models, Therapeutic index, Pharmacokinetics - Microbial and animal models, Lipinski's rule, *In vitro* and *in silico* toxicological models, Drug formulations

Drug Regulatory Operations and Drug Manufacturing: Role of Regulatory Authorities, US FDA, Regulatory applications viz. investigational new drug (IND), new drug application (NDA), Abbreviated New Drug Application (ANDA).

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Course Learning Outcomes (CLO):

Students will be able to:

1. demonstrate current approaches and steps of global drug discovery, their advantages and limitations.
2. demonstrate awareness of different disciplines which play an integral role in drug discovery and development process.
3. comprehend the key role played by natural products and pharmacognosy in shaping the pharmaceutical industry
4. develop understanding of drug targets, their role in drug discovery process and their interaction with natural and synthetic ligands.
5. demonstrate the importance of quality control and regulatory aspects of drug development processes and good manufacturing of medicines

Text books:

1. *Benjamin B Basic Principles of Drug Discovery and Development, Academic Press, Ist Edition, ISBN : 9780124115088 (2015)*
2. *Larsen PK, Leljifore T and Medsan U, Text books of Drug Design and Discovery, CRC Press (2009) 4th ed.*
3. *Hillisch A and Hilgenfeld R, Modern Methods of Drug Discovery, Birkhauser (2003)*

Reference Books:

1. *Patwardhan B, Drug Discovery and Development - Traditional Medicine and Ethnopharmacology, New India Publishing (2007)*
2. *Rick NG, Drugs from Discovery to Approval, 2nd Edition, Wiley- Blackwell (2009)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

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UBT822: ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The course content aims to make the Students understand how biotechnology can help in monitoring or removing the pollutants and developing an understanding of new trends such as biofuels, renewable energy sources, or microbial technologies which can minimize the harmful impact of pollutants in the environment.

Detail contents:

Introduction to environmental pollutants and scope of environmental biotechnology: Water, soil and waste water their sources and effects. Application of biotechnology in environment protection

Biological waste water treatment: Principles and Microbiology of waste water treatment, unit operations: Aerobic process (Activated sludge, Oxidation ditches, Trickling filters, towers, rotating discs, rotating drums, oxidation ponds). Anaerobic processes and digester dynamics (Anaerobic filters, Up flow anaerobic sludge blanket reactors), and other emerging biotechnological processes in waste water treatment for municipal, industrial waste waters

Solid waste management: landfills, recycling and processing of organic residues, minimal national standards for waste disposal, composting technologies. Biofuel production: biogas, bioethanol, biohydrogen and biodiesel

Bioremediation and Biodegradation: Introduction and types of bioremediation, bioremediation of surface soil and sludge, Microbial Systems for Heavy Metal Accumulation, Biosorption & detoxification mechanisms., metal Bioleaching and bio-oxidation *In situ* and *Exsitu* technologies, effect of chemical structure on biodegradation, recalcitrance, co metabolism and biotransformation. Factors affecting biodegradation, microbial degradation of xenobiotic compounds and hydrocarbons: long chain aliphatic, aromatic, halogenated, sulfonated compounds, surfactants, pesticides and oil spills

Environmental Genetics: Plasmid borne metabolic activities, bioaugmentation, degradative plasmids, release of genetically engineered organisms in environment, Biosensor Technology for monitoring pollutants

Laboratory work: Determination of organic carbon, nitrogen, phosphorus in soil, Determination of MPN, Fecal Coliform, BOD; COD; DO; TSS; TDS in different water and wastewater samples, Selective enrichment methods for isolation of contaminant tolerant microorganisms, Analysis of metals and pesticides, Toxicity Assessment, Biosensors

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Course Learning Outcomes (CLO):

Students will be able to:

1. comprehend environmental issues and role of biotechnology in the cleanup of contaminated environments.
2. comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals.
3. apply biotechnological processes in waste water and solid waste management.
4. comprehend biofuels/bioenergy systems; attributes for biofuel / bioenergy production.
5. demonstrate innovative biotechnological interventions to combat environmental challenges.

Text Books:

1. *Rittmann, B. and McCarty, P., Environmental Biotechnology: Principles and Applications, McGraw-Hill (2006)*
2. *Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press, 2007.*

Reference Books:

1. *Scargg, A., Environmental Biotechnology, Longman (1999).*
2. *Wainwright, M., An Introduction to Environmental Biotechnology, Kluwer Academic Press (1999).*
3. *Environmental Microbiology & Biotechnology, D.P. Singh, S.K. Dwivedi, New Age International Publishers, 2004.*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

UBT841: MOLECULAR DIAGNOSTICS

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of the course is to make Students aware of the various medical diagnostic techniques and their use in diagnosing various disorders in humans.

Detail contents:

Historical introduction: 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. Normal microbial flora of the human body. Nosocomial infections. Host- Parasite relationships

Microbial Pathogenicity: Pathogenicity and diagnosis of infection caused by *Streptococcus, Coliforms, Salmonella, Shigella, Vibrio,* and *Mycobacterium.* Diagnosis of fungal infections. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis

Pathogen Diagnostic techniques: Diagnosis of DNA and RNA viruses. Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Study ofhelminthic diseases- *Fasciola hepatica* and *Ascaris lumbricoides*. Filariasis and Schistosomiasis

Medical Genetics: Human Genome Project, Identifying human disease genes. Human disorders Biochemical disorders, Immune disorders, chromosomal disorders, single cell disorders and complex traits. 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

Prenatal diagnosis: Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS), Non-invasive techniques -Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood. Diagnosis using protein and enzyme markers, monoclonal antibodies. DNA/RNA based diagnosis Hepatitis, CML-bcr/abl, HIV - CD 4 receptor. Microarray technology- genomic and cDNA arrays, application to diseases

Genetic disorders: Sickle cell anaemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex –linked inherited disorders. Neonatal and Prenatal disease diagnostics. Gender identification using amelogenin gene locus. Amplification of Y chromosome specific Short Tandem Repeats (Y-STR). Analysis of mitochondrial DNA for maternal inheritance

Biochemical diagnostics: inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, and glycogen storage disorders

Laboratory: Identification of human bacterial pathogens by Polymerase chain reaction, Detection of viral infections in shrimp by PCR, Genotypic characterization of fungal pathogen, Molecular diagnosis of parasitic disease, Amplification of Short Tandem Repeats

(STR)/Microsatellites, Multiplex STR PCR Single strand conformation polymorphism (SSCP) analysis

Course Learning Outcomes (CLO):

The Students will be able to:

1. receive insights about microbial diseases and its detection
2. gain new insights into medical genetics and pre-natal diagnosis
3. gain knowledge about different diagnostic procedures.

Text books:

1. *Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications, Maribeth L. Flaws Ph.d , Lela Buckingham Publisher: F A Davis Co*
2. *Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory Wayne W. Grody, Robert M. Nakamura, Frederick L. Kiechle, Charles Strom, Publisher: Academic Press; ASIN: B003FQM2OI*

Reference books:

1. *Medical Microbiology (1997), Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.*
2. *Parasitology (1997), Chatterjee K.D, Chatterjee Medical Publishers.*
3. *Bailey & Scott's Diagnostic Microbiology (2002), Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfel Ernest A. Trevino, Published by C.V. Mosby*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

UBT843: COMPUTATIONAL BIOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: To understand the basics of computational science and apply it to solve biological problems. To familiarize students with basic concepts of algorithms used in sequences, structural alignment, database searching, protein structure prediction, computer-based drug designing and machine learning classifiers for biological systems.

Detail contents:

Introduction: Definition, Goals, applications of Computational Biology, Biological molecules such as DNA and Protein sequence, their structure and function. DNA and protein sequence databases. Structural databases

Basics of Computer Programming Problem solving Technique: Pseudocode, Algorithm, Flowchart, Data structures – Array, Stack, Queue, Linked, List concepts. Shell commands and scripting

Algorithms: Classification of algorithms, HMM profile searches, Algorithms to analyze system biology problems such as high throughput genomics and proteomics data, Machine-learning approaches, binary classification model development with examples in biological systems

Molecular computational biology: Gene prediction, sequencing genomes Protein structure determination by computational methods such as molecular modeling and molecular threading. Impact of the change of single amino acid (SNP) on the structure and function of the proteins, Protein-protein interactions, Functional insight by molecular dynamic simulations

Tutorials: Shell programming, Multiple sequence alignment, DNA binding motif finding by sequence alignment

Course Learning Outcomes (CLO):
Students will be able to:

1. perform programming Linux shell.
2. explain various types of algorithms with their possible application in solving biological problems
3. explain the computational aspects of complex data analyses.
4. develop binary classifier by using machine learning approaches.

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Text books:

1. *Pevzner, P. A., Computational Molecular Biology, PHI Learning Pvt. Ltd, ISBN-978-81-203-2550-0.*
2. *Ghosh, Z. and Mallick, B., Bioinformatics Principles and Applications (2008) Oxford University Press ISBN 9780195692303*

Reference Books:

1. *Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001), 2nd ed*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/ quizzes)	25

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UBT510: BIOLOGY FOR ENGINEERS

L	T	P	Cr
2	0	0	2.0

Course Objective: To learn about living world and basic functioning of biological systems. The course encompasses understanding of origin of life and some of its central characteristics. It also aims to familiarize engineering students to some of the intricate biological phenomena and mechanisms.

Detailed Contents:

Introduction to the living world: Origin of life and chemical evolution, Properties of Life, levels of biological organization, Cells as unit of life, structure and functions of cell organelles.

Biomolecules and their applications: Brief introduction to the molecular constituents (Protein, carbohydrates, Lipids and nucleic acids) of living cells and their salient structural & functional attributes. DNA as information storage devices, DNA computing, DNA origami in synthesizing 2D and 3D structures, DNA fingerprinting, molecular scissors.

Energy and life: Law of energy transformation, free energy and metabolism, ATP generation, role of enzymes in metabolic reactions.

Nature inspired Biomaterial: Biomechanics, Biomimetics, Nanostructures in living world and their extraordinary properties, gecko foot, lotus leaf, turkey egg shell, mother of pearl, special properties of spider web and silk fibers, biosensors, smart implants, bionics, biosensors, medical diagnostics based on molecular recognition.

Computational aspects of bioinformatics: Sequence alignment, scoring matrices, algorithms used in sequence alignment, multiple sequence alignment and its applications.

Course Learning Outcomes (CLOs):

After completion of this course the students will be able to:

1. Explain the characteristic features of living-systems and differentiate them from non-living systems
2. Broaden the application of engineering knowledge of their branch by applying concepts of living systems.
3. Demonstrate familiarity with special properties of biological macromolecules
4. Upgrade their understanding about biological systems by drawing parallel with thermodynamics system and develop interface between an engineering specialization and living systems.
5. Design engineering products inspired by living creatures.
6. Plan application of computational tools in bioinformatics.

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Text Books:

1. *Nelson, DL and Cox MM., Lehninger: Principles of Biochemistry, WH Freeman (2008) 5th ed.*
2. *Campbell, NA, Reece, JB, Urry LA, Cain, ML, Wasserman, SA, Minorsky, PV and Jackson, RB, Biology – A global approach, Pearson Education Limited (10th edition.)*
3. *Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2008).*

Reference Books:

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1. *Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001).*
2. *Bruce Alberts et al., Essential cell biology, Garland Science (Taylor & Francis Group)*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	50
3.	Sessionals (May include assignments/quizzes)	20

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