B. E. SYLLABUS

BIOTECHNOLOGY

III & IV SEMESTER

With
Scheme of Teaching
& Examination
<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Qualification</th>
<th>Position</th>
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<tbody>
<tr>
<td>1</td>
<td>Dr. C. Vaman Rao</td>
<td>Ph.D.</td>
<td>Prof. &amp; Head</td>
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<tr>
<td>2</td>
<td>Dr. Ujwal P.</td>
<td>Ph.D.</td>
<td>Assoc. Prof.</td>
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<td>3</td>
<td>Dr. Vidya S.M.</td>
<td>Ph.D.</td>
<td>Assoc. Prof.</td>
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<td>4</td>
<td>Dr. Shyam Prasad S.</td>
<td>Ph.D.</td>
<td>Assoc. Prof.</td>
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<td>5</td>
<td>Dr. D.M. Chetan</td>
<td>Ph.D.</td>
<td>Assoc. Prof.</td>
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<tr>
<td>6</td>
<td>Mr. Venkatesh Kamath H.</td>
<td>M.Tech., (Ph.D.)</td>
<td>Asst. Prof. Gd II</td>
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<tr>
<td>7</td>
<td>Mr. Vinayaka B. Shet</td>
<td>M.Tech., (Ph.D.)</td>
<td>Asst. Prof. Gd II</td>
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<tr>
<td>8</td>
<td>Mr. Anil Kumar H.S.</td>
<td>M.Sc., (Ph.D.)</td>
<td>Asst. Prof. Gd I</td>
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<tr>
<td>9</td>
<td>Mr. Bharath B.R.</td>
<td>M.Sc., (Ph.D.)</td>
<td>Asst. Prof.</td>
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<tr>
<td>10</td>
<td>Mr. Sandesh K.</td>
<td>M.Tech., (Ph.D.)</td>
<td>Asst. Prof. Gd I</td>
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<tr>
<td>12</td>
<td>Ms. Louella C. Goveas</td>
<td>M.Tech.</td>
<td>Asst. Prof. Gd I</td>
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Vision
To accomplish excellence in Biotechnology research and creating manpower for the benefit of society and human kind with an emphasis on present and future global needs.

Mission
To craft the students of Department of Biotechnology Engineering in to competent professionals by providing academic training, technical achievements and professional leadership in research, academia and industry.

Program: B.E. Biotechnology

Program Educational Objectives (PEO’s)
The program educational objectives are set in line with Institutional and Departmental mission statements. The program educational objectives of B.E. Biotechnology are to produce professionals who later take the role of engineering professionals and researchers with following qualities:

- **PEO-1**: Apply fundamental knowledge of mathematics, principles of physics and chemistry, and biological sciences for the engineering applications.
- **PEO-2**: Demonstrate the application of biotechnological processes and engineering principles through designing of industrial biochemical processes that are of societal and industrial importance.
- **PEO-3**: Exhibit skills of handling microbial processes, biochemical analysis by making use of state of the art instruments.
- **PEO-4**: Exhibit strong, independent learning, analytical and problem solving skills with special emphasis on design, communication, and an ability to work in teams.
- **PEO-5**: To have successful career as engineering professional or a researcher through life-long learning in the field of biotechnology.

Program Outcomes (PO’s)
In addition to PEOs, the B.E. Biotechnology program established a set of Program outcomes (POs), expected to be met by every graduating student from the program at the time of graduation. Program outcomes
listed below, embrace the required outcomes as listed in Graduate Attributes (GAs) of National Board of Accreditation (NBA), India. The graduates of B.E. Biotechnology will have ability to:

(a) Apply knowledge of mathematics, physics, chemistry and biological science and engineering to analyze bioprocesses and related systems.

(b) Identify and formulate and solve bioprocess engineering problems.

(c) Design bioprocess systems involving unit operations, reacting systems, reactors and product purification systems.

(d) Design and conduct experiments, as well as to analyze and interpret data.

(e) An ability to function on multidisciplinary teams.

(f) Understand professional and ethical responsibility.

(g) Communicate effectively, work independently, and practice leadership and teamwork.

(h) Use the techniques, skills, and modern engineering tools necessary for engineering practice.

(i) Design system, components or processes to meet realistic needs of society, environment, health and safety, and sustainability.

(j) Recognize the need for, and an ability to engage in life-long learning.

(k) Acquire knowledge of contemporary issues.

To ensure that we achieve these key outcomes, every B.E. Biotechnology course has a clearly defined set of outcomes that overlap the program objectives (a-k) listed above.
### DEPARTMENT OF BIOTECHNOLOGY ENGINEERING
#### SCHEME OF TEACHING

**III Semester**  
32 Hours/week

<table>
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<tr>
<th>Sl No.</th>
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<th>Hours / week</th>
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### DEPARTMENT OF BIOTECHNOLOGY ENGINEERING

#### SCHEME OF TEACHING

**IV Semester**

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NUMERICAL METHODS

Subject Code: 13BT301  Credits: 04
Hrs/Week: 4  Total Hours: 52

Prerequisites: Differential Equations, Partial Differential Equations, and Calculus

Course Objectives: To differentiate or integrate functions which are represented by tabular values; To apply numerical methods to solve engineering problems where the analytical solutions for some functions are not possible; To solve ordinary and partial differential equations by numerical methods.

Expected Outcomes: At the end of the course the student will be able to
1. Differentiate or integrate tabulated values using appropriate numerical techniques.
2. Apply numerical methods to solve bioprocess engineering problems having no analytical solutions.
3. Apply numerical methods to solve ordinary and partial differential equations.
4. Analyze and Evaluate applicability of numerical solutions to common type ordinary or partial differential equations.

UNIT - I
Numerical integration: General quadrature formula, Trapezoidal rule, Simpson’s one third rule, Simpson’s three eighth rule. 13Hrs

UNIT - II

UNIT - III
UNIT – IV


UNIT – V

Numerical methods: 

TEXT BOOKS:

REFERENCE BOOK:

UNIT OPERATIONS

Subject Code : 13BT302  
Credits : 04  
Hrs/Week : 4  
Total Hours : 52

Course Objectives:

The objective of this course is to study various aspects of fluid flow and mechanical operations. This gives a picture on how the dynamics of fluid flow plays an important role in processes and its implications to industry. Individual operations described in this chapter when combined in different order gives a total process for industrial operations.
Expected Outcomes: At the end of the course the student will be able to
1. Describe principles of fluid static and fluid flow operations.
2. Apply the principles of fluid dynamics to bioprocess operations.
3. Understand the concepts of multiphase fluid dynamics.
4. Explain the various metering techniques of fluid flow and pumping.
5. Analyze and apply the concepts of settling and mixing operations in bioprocess engineering applications.
6. Understand and apply the concepts of filtration, fluidization, size reduction, and conveyor mechanisms to industrial applications.

UNIT - I
BASIC CONCEPTS
Units and Dimensions: Fundamental & Derived Variables, Dimensionless Numbers, Dimensional Analysis by Rayleigh’s method and Buckingham’s pi method.

UNIT - II
FLUID DYNAMICS
Equation of Motion: Energy balance equation, Continuity equation, Euler’s equation, Bernoulli’s equation. Drag, Lift, Drag coefficient.
Energy loss in circular and non-circular pipes, Flow of viscous and turbulent fluid through pipe: Hagen Poiseuille and Darcy-wesbach equation. Energy loss in pipes due to sudden expansion, contraction and pipe fittings. Energy loss in packed bed: Kozney-Karmen equation, Ergun’s equation. Two phase flow (G – L System), Boundary layer theory, boundary layer separation, wake formation. Introduction to unsteady state flow. 12 Hrs

UNIT - III
FLUID PUMPING AND METERING
Pipe and pipe fittings; Fluid pumping: Energy calculations, Centrifugal pump, Positive displacement pump, fans, blowers, compressors. Valves: Types and applications. Metering of fluids: Orifice meter, Venturi meter, Rota meter, Notches and Weirs, Load cells, wheel flow meter, magnetic flow meter. Construction and working of: Plunger pump, peristaltic pump, piston pump, Metering pumps. 10 Hrs
UNIT - IV

SETTLING AND MIXING OPERATIONS


10 Hrs

UNIT - V

MECHANICAL OPERATIONS

Filtration: Batch and Continuous filtration; Constant volume and Constant Pressure filtration; Filtration equipments, types of filters, filter aids.

Size reduction: Laws of size reduction, Equipments of size reduction; Particle size analysis, Screen effectiveness.

Fluidization: Characteristics of fluidized systems, solid-liquid system, gas-solid-liquid system, applications.

Conveyors: Slurry transport, Pneumatic conveyors, Mechanical conveyors, and elevators (Screw conveyor, Belt conveyor, Bucket elevator, continuous flow conveyor elevators).

11 Hrs

TEXT BOOKS:


REFERENCE BOOKS:

1. McCabe, Smith and Harriott, Unit Operations of Chemical Engineering, 7th Ed., 2005, MGH.


**BIOCHEMISTRY**

Subject Code : 13BT303  
Credits : 04  
Hrs/Week : 4  
Total Hours : 52

Course Objectives:
The objective of learning biochemistry course is to understand the physiological processes of living organisms in terms of molecular structure and reactivity. It aims at giving the student the knowledge about the basic processes taking place in the biological systems and the pathological conditions related to biochemical defects. Biological processes are coordinated via complex molecular interactions involving molecules like proteins, carbohydrates, nucleic acids etc. Metabolism is studied and knowledge acquired around the individual pathways is integrated in a multicellular process.

Expected Outcomes: At the end of the course the student will be able to
1. Understand fundamental principles of biochemistry.
3. Learn and Appreciate interaction of biochemical pathways.
4. Understand and Apply biochemistry to clinical samples.

**UNIT - I**

**BASIC CONCEPTS**
Nature and scope of biochemistry, biochemical evolution, chemical compounds, water- its role in life, chemical bonding-types and significances, types of chemical reactions. Solution chemistry (Normality, molarity, standard solutions and problems); buffer system and problems.  

8 Hrs
UNIT - II

BIOMOLECULES
Carbohydrates - Monosaccharides, Disaccharides, Oligosaccharides and Polysaccharides. Isomerism of monosaccharides.
Proteins – Structure and properties of amino acids, Peptides, Structure of proteins
Lipids – Structure and properties of fatty acids, biological importance of lipids
Nucleic acids – Structure of Purines and Pyrimidines, Nucleotides, Nucleoprotein complex, Ribonucleic acid: types and its properties

10 Hrs

UNIT - III

METABOLISM OF CARBOHYDRATES AND LIPIDS

UNIT - IV

METABOLISM OF PROTEINS AND NUCLEIC ACIDS

12 Hrs

UNIT - V

CLINICAL BIOCHEMISTRY

10 Hrs

TEXT BOOKS:

REFERENCE BOOKS:

**MICROBIOLOGY**

Subject Code : 13BT304  
Credits : 04  
Hrs/Week : 4  
Total Hours : 52

Course Objectives:  
The objective of learning microbiology course is to learn fundamental aspects of microbes, and their cultivation. This course further deals with microbial growth and metabolism. The course also intends to learn microbiological applications in medical, soil, agriculture and industry.

Expected Outcomes: At the end of the course the student will be able to  
1. Understand fundamental concepts of microbiology and techniques involved.  
2. Differentiate microbial flora and its morphological characteristics.  
3. Learn and Apply microbiological techniques.  
4. Understand nutritional aspects, and metabolism of microflora.  
5. Describe the microbes involved in infectious diseases.  
6. Understand and Apply the microbial processes to agriculture, and industrial requirements.

**UNIT - 1**

INTRODUCTION  
The scope of Microbiology, Discovery of Microbial world, Microbial diversity and taxonomy, Types of microorganisms – Bacteria, Fungi, Virus and Protozoans. Important contributors in microbiology, Prokaryotic and Eukaryotic cell structure and functions. Structure and Reproduction: Morphology – structure and functions, Reproduction of bacteria, fungi and virus.  
13 Hrs
UNIT - II
MICROBIAL NUTRITION, GROWTH & METABOLISM
The Principles of Microbial nutrition, ingredients of culture media, Types of media - (solid and liquid), selective, differential and enrichment media. Microbial growth -The definition of growth, growth curve of bacteria, Factors affecting microbial growth, Microbial growth kinetics, the measurement of growth. Biochemical tests Metabolic pathways and bioenergetics Aerobic and anaerobic growths, Production of secondary metabolites, formation of toxic materials from microbes. 13 Hrs

UNIT - III
MEDICAL MICROBIOLOGY
Host-microbe Interactions, Infectious diseases affecting the various body systems (see below) with reference to their aetiology, clinical features, laboratory diagnosis and control ; Bacterial – Tuberculosis, Leprosy, Typhoid, Syphilis, Viral – AIDS, , Polio myelitis, Rabies, Fungal – Candidacies, Protozoans – Amoebiasis, Malaria. 8 Hrs

UNIT - IV
SOIL AND AGRICULTURAL MICROBIOLOGY
Soil microorganisms and soil microbial processes to optimize, crop productivity (soil biotechnology). Ecological adaptation of soil microbes, Microbial interactions, Biogeochemical cycles. Plant microbe interactions, Microbial disease of crops, Plant disease management. Bioinsecticide -bacillus thuringiensis, Sphaeriotilus, Papilloma, and Baculoviruses. Biofertilizers – Nitrogen fixing microorganisms, Phosphate solubility, 10 Hrs

UNIT - V
APPLIED MICROBIOLOGY
Production of industrial enzymes, Antibiotics, biopolymers (PHB etc.), single cell protein. Role of microbes in waste water treatment. 8 Hrs

TEXT BOOKS:

REFERENCE BOOKS:
2. Prescott & Dunn, Industrial Microbiology, Agrobios (India) 2002
BIOPROCESS CALCULATIONS

Subject Code : 13BT305  Credits : 03
Hrs/Week : 3  Total Hours : 39

Course Objectives:
The basic calculations of energy balance and mass balance of biochemical processes is the primary objective of learning this subject. These calculations are further used for analysis of effluent gases, heat of reaction. The process calculations are more important in industrial aspects where the material balance sheets are to be prepared for design problems and also for process design.

Expected Outcomes: At the end of the course the student will be able to
1. Learn fundamental concepts of process calculations and unit conversions.
3. Apply material balance in steady and unsteady state to unit processes.
4. Apply concepts of material balances to processes involving reactions.
5. Understand and Apply energy balance to processes involving chemical reactions.

UNIT - I
INTRODUCTION
Fundamental and derived quantities, Systems of units and their inter conversion: FPS, CGS, MKS, and SI. Concept of Mole and Molecule; Composition of mixtures: Solids, Liquids and Gases; Weight – Mole – Volume percentage calculations; Normality, Molality, Molarity and ppm; pH and pK of buffer. Techniques of problem solving, choosing basis, chemical equation and stoichiometry; ideal and real gases. 7 Hrs

UNIT - II
STEADY STATE MATERIAL BALANCE WITHOUT REACTION
General Material balance equation, Bypass Recycle and Purging. Material balances in Distillation (with and without reflux), Extraction, Crystallization, Drying, Mixing, Evaporation processes. Material balance for multistage operations (Counter current and cocurrent Extraction). Humidity charts and their uses. 8 Hrs
UNIT - III
STEADY STATE MATERIAL BALANCE WITH REACTION
Principles of Stoichiometry: Limiting and Excess reactants, Fraction and Percentage conversion, Yield, Selectivity. Combustion Analysis of Fuels: Ultimate and proximate analysis, Excess air and air-fuel ratio calculations. Stoichiometry of microbial growth and product formation, elemental balance and degrees of reduction. 8 Hrs

UNIT - IV
ENERGY BALANCE

UNIT - V
UNSTEADY STATE MATERIAL BALANCE AND FLOWSHEETING
Unsteady state material balance and energy balance equation for batch operations – batch distillation, cell growth and product formation in batch cultures, dissolution of salt, heating system. Solution strategies to solve differential equations and boundary conditions.
Flow sheets: Block flowsheets, Process flowsheets, Mechanical flowsheets (P&ID), Utility flowsheets, drawing of flowsheets, Manual and computerized flow-sheeting. 8 Hrs

Self Study: Industrial problems related to various unit operations and their process calculations will be discussed. Student is expected to learn use of computers for solving problems pertaining to process calculations and flow sheeeting.

TEXT BOOKS:

REFERENCE BOOKS:
1. David Himmelblau, Basic principles and Calculations in Chemical Engineering, 8th Ed. 2012, Prentice Hall.


**UNIT OPERATIONS LAB**

Subject Code: 13BT306

Credits: 02

Hrs/Week: 3

**Corequisites:** 13BT302 Unit Operations

**Course Objectives:**
To learn the basic fluid flow operations and mechanical separation processes.

**Expected Outcomes:** At the end of the course the student will be able to

1. Apply the concepts of fluid flow operations, metering, and pumping.

2. Learn and Apply concepts of filtration process and sedimentation process.

3. Apply principles of sieve analysis for particle size determination.

**EXPERIMENTS**

   c. V-Notch d. Rotameter

2. Flow characteristics of open orifice

3. Characteristics of Pump:
   a. Centrifugal Pump b. Reciprocating Pump

4. Pressure drop calculations
   a. Packed bed b. Fluidized bed

5. Leaf Filter

6. Plate and Frame filter press

7. Batch sedimentation

8. Power calculation in Mixing

9. Sieve Analysis

10. Two phase flow studies
BIOCHEMISTRY LAB

Subject Code : 13BT 307
Credits : 02
Hrs/Week : 3

Corequisites: 13BT303 Biochemistry

Course Objectives:
To learn the basic techniques and tests to identify biomolecules and also to learn the properties associated with these biomolecules.

Expected Outcomes: At the end of the course the student will be able to
1. Learn chemical preparations required for biochemical analysis.
2. Apply methods of carbohydrate, protein, lipid analysis to real world samples.
3. Learn and Understand importance of estimation techniques in biochemical tests.

EXPERIMENTS
1. Preparation of buffers of constant strength using strong acid-strong base and weak acid-weak base.
3. Qualitative tests for carbohydrate and lipids.
4. Qualitative tests for amino acids and proteins.
5. Estimation of blood sugar by Folin-Wu method.
10. Determination of Saponification value of lipids.
11. Determination of Iodine value of lipid.
12. Determination of acetyl value of a lipid.
INDIVIDUAL EFFECTIVENESS LABS (IEL)

Subject Code: 13BT308  Credits: 02  Hrs/Week: 4

Objectives
1. To help the students understand themselves. Identify and analyze personality/behavioral attributes of personal effectiveness – exploratory orientation, self-disclosure, receptivity to feedback and sensitivity to others.
2. To help the students identify their primary and secondary motivators – what drives them for achievement?
   a. Understanding the student’s need for achievement
   b. Understanding how positive expectations lead to positive results.
3. To help the students to develop a goal driven mindset and to take the first steps into individual personal planning, controlling and measuring results.
4. To make the students aware of importance of communication and typical barriers to communication.
5. To help the students develop effective oral communication skills.
6. To help the students develop effective written communication skills.
7. To help the students develop listening skills.
8. To help the students participate in group discussions.
9. To help the students develop effective business presentation skills.
10. To help the students receive feedback with an open mind, respond to feedback and take the action on them.
11. To help the students develop time management and organization skills.

Contents
Module 1: Know Yourself
Self assessment profilers to identify and assess the following – Identify and analyze personality/behavioral attributes of personal effectiveness – exploratory orientation, self disclosure, receptivity to feedback, sensitivity to others. 8 Hrs
Module 2: Achievement Motivation & Goal Setting
- Identifying primary and secondary motivators using a motivational profiler.
- Understanding need for achievement.
- Developing goal driven mindset.
- First steps into career planning. 8 Hrs

Module 3: Communication Skills
- Effective oral communication
- Effective written communication
- Constructing effective messages (memo, letters, e-mails)
- Writing persuasively
- Correspondence etiquettes – letters & email
- Importance of listening responsively
- Handling conversations
- Effective group discussions 15 Hrs

Module 4: Presentation Skills
- Understanding audience, presentation objectives, best practices & tools in preparation of presentation.
- Improving quality of presentation through better use of voice, eyes, gestures, visual aids.
- Presenting to groups
- Presenting one-on-one. 13 Hrs

Module 5: Handling Feedback
- Seeking feedback
- Accepting feedback with an open mind
- Responding to feedback
- Actionizing feedback 6 Hrs

Module 6: Time Management
- Introduction to Time Management and importance of managing self
- Beating procrastination
- Action plans-starting to achieve in a small way
- Scheduling skills 6 Hrs

REFERENCE BOOKS:
2. Online reference materials provided as part of the Entry Edge program.
BIOSTATISTICS

Subject Code :  13BT401  Credits :  04  
Hrs/Week :  4  Total Hours :  52

Prerequisites: Set Theory
Course Objectives:
Objective of this course in statistics is to understand various probabilistic models for situations involving chance effect. To learn and understand some probability distributions both discrete and continuous and its applications in biological systems. To learn and apply ANOVA to problems of biological nature.
Expected Outcomes: At the end of the course the student will be able to
1. Understand and appreciate probabilistic models for situations involving chance effect.
2. Learn some probability distributions both discrete and continuous and its applications in bioprocess systems.
3. Apply ANOVA to bioprocess engineering problems.

UNIT - I
Statistics: Data collection, presentation of data, diagrams and graphs, measures of central tendency, measures of dispersion, coefficient of variation. Curve fitting (linear, non-linear and exponential). Correlation and regression. 10 Hrs

UNIT - II
Probability
Definition of probability, axioms, conditional probability, Baye’s theorem, one dimensional random variable, mean and variance. 10 Hrs

UNIT - III
Probability distributions
Discrete probability distributions-Binomial, poisson, geometric. Continuous probability distributions-normal, exponential, uniform distributions. Estimation, sample size determination, Central limit theorem. 9 Hrs

UNIT - IV
Testing of hypothesis: confidence interval-large and small samples, Tests of significance—large and small sample z-test, t-test, F-test, chi-square tests. 11 Hrs

UNIT - V
Sampling and Design of experiments
Sampling- random sampling, experimental designs, Analysis of variance- one way and two-way classifications. 12 Hrs
TEXT BOOKS:

REFERENCE BOOKS:

HEAT & MASS TRANSFER

Subject Code : 13BT402  
Credits : 04  
Hrs/Week : 4  
Total Hours : 52

Course Objectives:
The objective of this course is to learn the basics of heat transfer, mass transfer and the equation related to it. This course gives a picture of importance, principle and equipments of heat and mass transfer in bioprocess systems and industrial applications. This course is one of the fundamental requirements for industrial application of biotechnology.

Expected Outcomes: At the end of the course the student will be able to
1. Learn and Appreciate concepts of heat transfer and mass transfer.
2. Understand and Describe various modes of heat and mass transfer and their associated equations.
3. Describe equipments used for heat transfer operations and their specific applications.
4. Analyze the effects of heat and mass transfer in biological systems.
5. Evaluate the application of heat and mass transfer in industrial applications like adsorption, extraction, oxygen transfer in medium and distillation.
UNIT - I
HEAT TRANSFER

UNIT - II
HEAT TRANSFER EQUIPMENTS

UNIT - III
MASS TRANSFER
Theories of mass transfer across phase boundaries – two film theory and penetration theory, convective and diffusive mass transfer Biot number. Analogy between heat, mass and momentum transfer.  

UNIT - IV
MASS TRANSFER OPERATIONS
Extraction: Principle, equilibrium calculations, ternary equilibrium diagram, single and multistage cross current and counter current operations, equipments.

UNIT - V
SIMULTANEOUS HEAT AND MASS TRANSFER
Distillation: Principle, VLE, types of distillation: simple distillation, steam distillation, azeotropic distillation, extractive distillation. Governing equations: Rayleigh’s equation, HETP, no. of theoretical stages (Mc Cabe - Thiele method), sieve plate and packed bed distillation, hydrodynamics in distillation column.
Drying: Principle of drying, heat transfer in dryer, mass transfer in dryers, drying rate curve, drying equipments – Tray dryer, rotary dryer.

TEXT BOOKS:
1. Treybal R.E., Mass transfer operations, 3rd Ed. 2012, MGH.

REFERENCE BOOKS:
THERMODYNAMICS

Subject Code : 13BT403
Credits : 04
Hrs/Week : 4
Total Hours : 52

Prerequisites: 13BT303 Biochemistry
Corequisites: 13BT402 Heat & Mass Transfer

Course Objectives:
To learn fundamental laws of thermodynamics and its application to simple biological systems. To understand properties and their changes for pure fluids and their mixtures. To apply the concepts of thermodynamics for phase equilibrium and reaction equilibrium.

Expected Outcomes: At the end of the course the student will be able to
1. Explain laws of thermodynamics.
2. Apply laws of thermodynamics to biological processes.
3. Describe properties of pure fluids and their mixtures.
4. Learn and Evaluate thermodynamic laws applied to phase equilibria.
5. Apply thermodynamic laws to biological reaction equilibrium.

UNIT - I
LAWS OF THERMODYNAMICS

UNIT - II
APPLICATION OF LAWS
UNIT - III
THERMODYNAMICS OF PURE FLUIDS AND SOLUTIONS
Thermodynamic properties, Work function, Gibbs free energy, Relationships among thermodynamic properties: Fundamental property relations, Maxwell’s equation, Clapeyron equations, Gibbs – Helmholtz equation. Concept of Fugacity, Fugacity coefficient, Activity and Activity coefficient - for pure components and mixtures. Partial molar properties, Chemical potential, Lewis Randall rule, Raolt’s law, Henry’s law, Gibbs-Duhem equations. 12 Hrs

UNIT - IV
PHASE EQUILIBRIA

UNIT - V
BIOCHEMICAL EQUILIBRIA
Reaction stoichiometry, Criteria of bio-chemical reaction equilibrium, Equilibrium constant and standard free energy change, Coupled reactions and free energy change, Calculation of equilibrium concentrations. Effect of temperature and pressure on Equilibrium constant, Other factors affecting equilibrium conversion. Phase rule for reacting systems, Liquid phase reactions, Heterogeneous bioreaction equilibria. Oxidation/Reduction reactions, metabolism and ATP yield. Thermodynamics of oxygen binding to hemoglobin tetramer. Donnan membrane equilibrium. 12 Hrs

TEXT BOOKS:

REFERENCE BOOKS:
1. Narayanan K.V., A Textbook of Chemical Engineering Thermodynamics, 2nd Ed. 2013, PHI.

**STRUCTURAL BIOLOGY**

**Subject Code:** 13BT404  **Credits:**  4  **Hrs/Week:**  4  **Total Hours:**  52

**Prerequisites:** 13BT303 Biochemistry  
**Corequisites:** 13BT405 Genetics & Molecular Biology

**Course Objectives:**  
Structural biology is concerned with biological macromolecules and complexes of macromolecules. The subject aims to make the student understand conformation, shape, structure, conformational changes, dynamics and interaction of such systems. Our goal is to convey the major principles and concepts that are at the heart of the field. These principles and concepts are drawn from physics, chemistry, and biology.

**Expected Outcomes:** At the end of the course the student will be able to  
1. Understand and Describe structural complexities of protein as a macromolecule.  
2. Understand and Describe structural complexities of DNA and RNA as a macromolecule.  
3. Describe membrane proteins and their structural conformations.  
4. Explain glycol conjugates and their role as information carrier.  
5. Understand interaction of macromolecules for cellular functioning.

**UNIT - 1**

**PROTEIN STRUCTURES**  
Composition and primary structures of proteins, Conformational analysis and forces that determine protein structures, geometries, potential energy calculations, phi, psi, omega angles, Ramachandran or steric contour diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, hydrophobic
interactions, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions, Scatchard plot, cooperative interactions, allosteric effects, Hill constant; Relationship between the primary, secondary, and tertiary structure of proteins. Fibrous proteins (structure of collagen and keratin). Quaternary structures - dimers, homo & hetero dimers, trimers, tetramers; Protein folds, structural families and classes, multifunctional domains (qualitative examples)

12 Hrs

UNIT - II
STRUCTURE OF NUCLEIC ACIDS

11 Hrs

UNIT - III
STRUCTURE OF BIOMEMBRANES
Structure and conformational properties of cell membranes, Singer and Nicholson model, integral proteins in membranes, permeability, properties, passive transport and active transport, facilitated transport, energy requirement. conformational variations during ion transport, mechanism of Na⁺ / K⁺, glucose and amino acid transport, monitoring membrane potentials, and molecular reception (qualitative).

10 Hrs

UNIT - IV
GLYCOBIOLOGY

UNIT - V
BIOMOLECULAR INTERACTIONS
Association of macromolecules, supramolecular interactions, protein-protein interactions, protein-nucleic acid interactions, specific and non-specific DNA-protein complexes, lipid/membrane-protein interactions, introduction to molecular dynamics and its implication to biological function.

10 Hrs
TEXT / REFERENCE BOOKS:


GENETICS & MOLECULAR BIOLOGY

**Subject Code :** 13BT405  **Credits :** 03  **Hrs/Week :** 3  **Total Hours :** 39

**Course Objectives:**
A very important subject of biotechnology that deals with the molecular aspects of information flow in cellular system. The various aspects of information flow like Replication, Transcription and Translation are dealt in detail. The structures, mechanism of information flow and its regulation also dealt.

**Expected Outcomes:** At the end of the course the student will be able to
1. Explain the concept of central dogma and flow of information in cells.
2. Describe various types of chromosomes, their function.
3. Learn and Appreciate the complexity of DNA in information coding.
4. Learn and Describe processes of replication, transcription and translation.
5. Analyze the regulation of gene expression and recombination in eukaryotes and prokaryotes.
6. Explain and Apply Mendelian laws of genetics to gene interactions.
7. Understand sex chromosomes and Learn their importance.

UNIT - I

INTRODUCTION
Information flow in biological systems: the central dogma.
Identification of genetic material, classical experiments- Hershey & Chase, Avery, McLeod etc., Chromosome, classification of chromosomes, centromere, telomere, chemical composition of chromatin, structural organization of nucleosomes, heterochromatin. Chromosomes as the carriers of genetic information. Polytenene and lamp - brush chromosomes, human chromosomes - karyotypy. DNA denaturation and renaturation, complexity of viral and bacterial genome, complexity of eukaryotic genome, Highly repeated DNA sequences: satellite DNA, minisatellite DNA, microsatellite DNA. Moderately repeated DNA sequences: repeated DNA sequence-with coding function, without coding function. Non repeated DNA sequences. 5 Hrs

REPLICATION
Replication of DNA, structure and function of DNA polymerases of prokaryotes and eukaryotes, models of replications in prokaryotes and eukaryotes. Mechanism of DNA replication, DNA damage and repair. RNA-dependent synthesis of RNA and DNA: Reverse transcription (reverse transcriptase), telomerase as specialized reverse transcriptase, RNA-dependent RNA polymerase (RNA replicase) 5 Hrs

UNIT - II

TRANSCRIPTION
Bacterial RNA polymerase, its structure and function, sigma factor cycle, eukaryotic RNA polymerases. Mechanism of transcription in prokaryotes and eukaryotes. Transcription factors, posttranscriptional processing, Genetic codon and its usage. 5 Hrs

TRANSLATION
Mechanism of translation, activation of amino acids, initiation, elongation and termination of protein synthesis. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of transcription and translation. Post translational modification. 5 Hrs
UNIT - III
REGULATION OF GENE EXPRESSION IN PROKARYOTES AND EUKARYOTES
Gene regulation, Operon model, gal, lac, trp; positive versus negative regulation of gene expression, regulation of eukaryotic gene expression, transcriptional control. 6 Hrs

GENETIC RECOMBINATION
Genetic recombination in bacteria and viruses, site specific recombination, role of recombination and transposons. 3 Hrs

UNIT- IV
MENDELIAN LAWS & GENE INTERACTIONS
Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions: intermediate inheritance and co-dominance, Supplementary and Complementary genes - Comb patterns in fowls, Flower colour in sweet pea, Epistasis - Inhibitory and feather colour gene in fowls, deaf mutism in humans, recessive epistasis, dominant epistasis, duplicate recessive and dominant epistasis. Multiple alleles: blood group antigens, Rh factor, coat colour in rabbits, Drosophila eye colour. Simple problems on the above topics. 5 Hrs

UNIT -V
SEX CHROMOSOMES AND INHERITED DISEASES, LINKAGE AND CROSSING OVER
Sex determination in plants and animals- haplodiploidy, XX – X0, XX-XY, ZZ – ZW, types. Sex Chromosomal disorders. Sex linked and X – linked inheritance, Examples of sex linked inheritance, X-linked inheritance-colour blindness, hemophilia. Sex influenced and Sex limited inheritance. Linkage, crossing over, chromosomal maps, gene mapping in bacteria and higher organisms. 5 Hrs

SELF STUDY: Students will learn problems related to genetics from real world and pedigree analysis.

TEXT BOOKS:

**REFERENCE BOOKS:**

**CELL AND DEVELOPMENTAL BIOLOGY**

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**Course Objectives:**
This is an introductory course that deals with the various cellular systems, its properties and functions. Also deals with the developmental aspects of an embryo. The topics on developmental biology will form the foundation for further studies on animal tissue engineering.

**Expected Outcomes:** At the end of the course the student will be able to
1. Remember various components of cell structure and their role.
2. Understand and Explain the role of cytoskeletal system.
3. Describe the mechanisms of cellular communications.
4. Understand and Remember various stages of embryonic development.
5. Explain post embryonic developments.

UNIT - I

CELL STRUCTURE AND FUNCTION
Cell Theory; Comparison between plant and animal cells; Cell wall; Plasma membrane; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Ribosome; Centriole; Nucleus; Chemical components of a cell; Catalysis and use of energy by cells. Cell division: mitosis & meiosis, cell cycle, molecules that control cell cycle. 10 Hrs

UNIT - II

CYTOSKELETON AND CELL JUNCTIONS
Introduction to Cytoskeleton, Nature of Cytoskeleton, Microtubules, Actin filaments and Intermediate filaments, Celia and Centrioles Introduction to Cell Junctions. Types of cell junctions, cell-cell adhesion, Integrins, Extracellular matrix of animals. 10 Hrs

UNIT - III

CELL COMMUNICATION
Introduction, General principles of cell communication, Signaling molecules and cell receptors. Signal trasnsduction pathways Signal through G-Protein linked receptor, Signal through Enzyme linked receptor Intracellular signaling: computer based “Neural Networks” 10 Hrs

UNIT - IV

BASIC CONCEPTS OF DEVELOPMENT
Cell fate and commitment, Mosaic and regulative development, Maintenance of differentiation, Pattern formation and compartments, Morphogenesis.

Fertilization: Structure of gametes and its recognition, Gamete fusion and prevention of polyspermy, activation of egg and fusion of genetic material.

Cleavage: Radial holoblastic cleavage, Spiral holoblastic cleavage, Rotational holoblastic cleavage, Meroblastic cleavage.

Gastrulation: in Sea urchin, Amphibia, birds, mammals.

Cell fate and commitment, Mosaic and regulative development, Maintenance of differentiation, Pattern formation and compartments, Morphogenesis. 11 Hrs
UNIT - V
LATER EMBRYONIC DEVELOPMENT
Fate of the ectoderm – neural induction and the epidermis, Patterning the anteroposterior neuraxis, Patterning the dorsoventral neuraxis, Neural tube, Neural crest, Mesoderm and endoderm – Mesoderm induction and patterning, Somitogenesis and patterning, Somite differentiation, Mammalian organ development (ex: Heart and Kidney), Endoderm development. Metamorphosis, Regeneration and Aging. 11 Hrs

TEXT / REFERENCE BOOKS:
1. S.C. Rastogi, *Cell Biology*, New Age International
4. Cooper, *Molecular Cell Biology*
5. Gerald Karp, *Molecular Cell*
7. Markert and Ursprung, *Developmental Biology*, PHI.

HEAT & MASS TRANSFER LAB
Subject Code : 13BT407  Credits : 02
Hrs/Week : 3

Corequisites: 13BT402 Heat & Mass Transfer

Course Objectives:
To learn the various techniques and operations related to heat and mass transfer applicable to bioprocess industry.

Expected Outcomes: At the end of the course the student will be able to
1. Perform experiments to understand concepts of heat transfer operations.
2. Perform experiments to understand concepts of mass transfer operations.
3. Perform experiments to learn concepts of simultaneous mass and heat transfer operations.

EXPERIMENTS
1. Measurement of Thermal conductivity of a liquid
2. Effectiveness of counter flow DPHE
3. Heat transfer in packed bed
4. Humidity measurement using psychrometry
5. Solubility of inorganic salt
6. Diffusivity measurements
7. Binodal Curve for Ternary system
8. Ternary Liquid-Liquid Equilibrium
9. Liquid – Liquid Extraction: Single stage and multi stage (cross current)
10. Single stage Batch adsorption
11. Batch Distillation
12. Packed bed distillation
13. Leaching: Single stage and multi stage (cross current)

MICROBIOLOGY LAB
Subject Code : 13BT408 Credits : 02
Hrs/Week : 3

Prerequisites: 13BT304 Microbiology
Course Objectives:
To learn the basic techniques of microbiology and molecular biology. These techniques form the basic requirement for any biological/biotechnological experiments/projects.

Expected Outcomes: At the end of the course the student will be able to
1. Learn preparatory measures required for performing microbiological experiments.
2. Perform various microbial culture techniques.
3. Identify suitable test for identification of microbes.
4. Learn analysis of food and water for microbiological examination.

EXPERIMENTS
1. Aseptic techniques, Media preparation.
2. Pure culture techniques: serial dilution, pour plate
3. Pure culture techniques: spread plate and streak plate
4. Stains and staining techniques: simple staining-positive and negative
5. Stains and staining techniques: Gram staining technique
6. Biochemical tests for the identification of bacteria: fermentation of carbohydrates, motility test
7. Biochemical tests for the identification of bacteria: oxidase test, endospore test, IMVIC test
8. Microbial analysis of food products
9. Microbial analysis of water.