B. E. SYLLABUS

BIOTECHNOLOGY

III & IV SEMESTER

With

Scheme of Teaching

& Examination
**DEPARTMENT: BIOTECHNOLOGY ENGINEERING**

<table>
<thead>
<tr>
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<th>Name</th>
<th>Degree</th>
<th>Position</th>
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<tr>
<td>1</td>
<td>Dr. C. Vaman Rao</td>
<td>M.Sc., Ph.D.</td>
<td>Prof. &amp; Head</td>
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<tr>
<td>2</td>
<td>Dr. Ujwal P.</td>
<td>M.Sc., Ph.D.</td>
<td>Professor</td>
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<td>3</td>
<td>Dr. Vidya S.M.</td>
<td>M.Sc., Ph.D.</td>
<td>Professor</td>
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<td>4</td>
<td>Dr. Shyama Prasad S.</td>
<td>M.Sc., Ph.D.</td>
<td>Associate Professor</td>
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<td>5</td>
<td>Dr. D.M. Chetan</td>
<td>M.Sc., Ph.D.</td>
<td>Associate Professor</td>
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<td>6</td>
<td>Dr. Anil Kumar H.S.</td>
<td>M.Sc., Ph.D.</td>
<td>Associate Professor</td>
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<tr>
<td>7</td>
<td>Dr. Bharath B.R.</td>
<td>M.Sc., Ph.D.</td>
<td>Asst. Prof. Gd III</td>
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<td>8</td>
<td>Mr. Venkatesh Kamath H.</td>
<td>M.Tech., (Ph.D.)</td>
<td>Asst. Prof. Gd II</td>
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<tr>
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<td>M.Tech., (Ph.D.)</td>
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<td>Mr. Sandesh K.</td>
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<td>12</td>
<td>Ms. Louella C. Goveas</td>
<td>M.Tech.</td>
<td>Asst. Prof. Gd I</td>
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DEPARTMENT OF BIOTECHNOLOGY ENGINEERING

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

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

**Programme Outcomes (POs):**
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:

1. Apply knowledge of mathematics, physics, chemistry and biological science and engineering to analyze bioprocesses and related systems.
2. Identify and formulate and solve bioprocess engineering problems.
3. Design bioprocess systems involving unit operations, reacting systems, reactors and product purification systems.
4. Design and conduct experiments, as well as to analyze and interpret data.
5. An ability to function on multidisciplinary teams.
6. Understand professional and ethical responsibility.
7. Communicate effectively, work independently, and practice leadership and teamwork.
8. Use the techniques, skills, and modern engineering tools necessary for engineering practice.
9. Design system, components or processes to meet realistic needs of society, environment, health and safety, and sustainability.
10. Recognize the need for, and an ability to engage in lifelong learning.
11. Acquire knowledge of contemporary issues.
DEPARTMENT OF BIOTECHNOLOGY ENGINEERING
SCHEME OF TEACHING AND EXAMINATION

III Semester

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# DEPARTMENT OF BIOTECHNOLOGY ENGINEERING

## SCHEME OF TEACHING AND EXAMINATION

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NUMERICAL METHODS

Sub code : 14BT301  
Credits : 04  
Hrs/Week : 4+0+0+0  
Total Hours : 52

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.

Course 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 Analysis: Finite differences: forward, backward and central difference operators, Newton-Gregory forward and backward interpolation formulae, Lagrange’s interpolation formula, Lagrange’s Inverse interpolation formula. Newton’s divided difference interpolation formula, Central differences-Stirling’s and Bessel’s interpolation formulae (Without proof).

11 Hours

UNIT - II
Numerical differentiation using Newton’s forward & backward formulae. Numerical integration: General quadrature formula, Trapezoidal rule, Simpson’s one third rule, Simpson,s three eigth rule, Weddle’s rule, errors.

12 Hours
UNIT - III

Numerical solution of algebraic and transcendental equations:
Bisection Method, Ordinary iteration method, Regula– Falsi Method and
Newton–Raphson Method. Numerical solution of simultaneous linear
equations by LU-decomposition method, non-linear equations by
Newton-Raphson method.

10 Hours

UNIT – IV

Numerical solution of first order ordinary differential equations:
Taylor’s series Method, Picard’s method, Euler’s method, Modified
Euler’s Method, 4th order R-K Method. Adam’s Bashforth predictor –
corrector and Milne’s Predictor - Corrector Methods.

9 Hours

UNIT – V

Numerical methods: Finite difference expressions for first and second
order derivatives (ordinary and partial). Classification of second order
partial differential equations. Numerical solutions of Laplace and Poisson
equations by standard five point formulae and heat and wave equations
by explicit method.

10 Hours

TEXT BOOKS:
2. S.S. Sastry, Introductory methods of Numerical Analysis, 2nd Ed.,

REFERENCE BOOK:
   Scientific and Engineering computations, 5th Ed., New Age

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UNIT OPERATIONS

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*Self Study to be exercised under the supervision of course instructor
and to be restricted to not more than 10% of the total teaching hours.
Course Objective:
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.

Course Outcomes:
At the end of the course the student will be able to
1. Describe and apply principles of fluid statics and fluid dynamics for bioprocess operations.
2. Understand the concepts of multiphase fluid dynamics.
3. Explain the various fluid metering techniques and fluid pumping.
4. Understand and analyze the concepts of mechanical operation techniques 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.
Fluid statics: Pressure and its measurement using manometers. Hydrostatic equilibrium, barometric equation.

UNIT- II
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.

10 Hours

UNIT -IV

SETTLING AND MIXING OPERATIONS

Settling: Types of settling-sedimentation and centrifugation, Stoke’s law, Newton’s law, Terminal settling velocity. Kynch theory and Thickener design.

Centrifugal Separation: Basic theory of centrifugation, centrifugal pressure, flocculation and sedimentation, simple and ultra centrifugation, density gradient centrifugation, sedimentation in a centrifugal field.

Mixing: Principle, types of agitators (impellers used for cell culture), flow pattern. Dimensionless numbers and dimensional analysis in mixing, Power number calculation and aeration. Rate and time of mixing.

10 Hours

UNIT -V

MECHANICAL OPERATIONS

Filtration: Batch and continuous filtration; constant volume and constant Pressure filtration;

Size reduction: Laws of size reduction, particle size analysis, screen effectiveness.

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

11 Hours

(Self study component amounts to total of 6 hours)

TEXT BOOKS:


REFERENCE BOOKS:

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BIOCHEMISTRY

Sub code : 14BT303
Credits : 04
Hrs/Week : 4+0+0+0
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 multi-cellular process.

Course Outcomes:
At the end of the course the student will be able to
1. Understand fundamental principles of biochemistry.
2. Describe metabolic pathways of carbohydrates, lipids, proteins and nucleic acids.
3. Learn and understand interaction of biochemical pathways.
4. Apply biochemical principles to clinical investigation and therapies.

UNIT -I
BIOMOLECULES I: Introduction to Biochemistry; Nature and scope of biochemistry, biochemical evolution. Chemistry of sugars; stereo and optical isomerism, monosaccharides, disaccharides and polysaccharides; structure, occurrence and biological importance. Lipids; structure and properties of fatty acids, biological properties of lipids.

10 Hours

UNIT -II
BIOMOLECULES II: Proteins – structure and properties of amino acids, peptides, structure of proteins; Primary, secondary, tertiary and quaternary. Nucleic acids – Nitrogen bases and nucleotides; purine and pyrimidines. Structure and molecular models of DNA and RNA.

10 Hours

UNIT- III

11 Hours

UNIT -IV

11 Hours

UNIT -V

10 Hours
TEXT BOOKS:

REFERENCE BOOKS:

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MICROBIOLOGY

Sub code     : 14BT304
Hrs/Week     : 4+0+0+0
Credits      : 04
Total Hours  : 52

Course Objective:
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.

Course Outcomes:
At the end of the course the student will be able to
1. Understand fundamental concepts and techniques involved in microbiology to differentiate microbial flora based on morphological and biochemical characteristics.
2. Understand nutritional aspects and metabolism of microflora.
3. Understand and apply the knowledge of microbiology in healthcare, industries and agriculture.
UNIT-I


12 Hours

UNIT-II

MICROBIAL NUTRITION, GROWTH & METABOLISM:

12 Hours

UNIT-III

MEDICAL MICROBIOLOGY: Host-microbe Interactions: The process of infection—Pathogenicity, virulence and infection, Microbial adherence, penetration of epithelial cell layers, events in infection following penetration, Microbial virulence factors. Aetiology, clinical features, laboratory diagnosis and control of: Bacterial—Tuberculosis, Leprosy, Typhoid, Syphilis; Viral—AIDS, H1N1, Ebola, Poliomyelitis and Rabies; Fungal—Candidacies, Dermatomycoses; Protozoans—Amoebiasis, Malaria.

10 Hours
UNIT-IV

SOIL AND AGRICULTURAL MICROBIOLOGY:
Soil microorganisms, ecological adaptation of soil microbes. Microbial interactions/associations, biogeochemical role of soil microorganisms (C, N, P, S cycles).


10 Hours

UNIT-V

APPLIED MICROBIOLOGY: Production of industrial enzymes, lactic acid, vinegar, citric acid, amino acids; Production of antibiotics, production of biopolymers (PHB etc.), single cell protein. Role of suspended and attached microbes in waste water treatment, microbial films, microbial surfactants; microbial mining.

8 Hours

TEXT BOOKS:

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

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BIOPROCESS CALCULATIONS

Sub code : 14BT305
Hrs/Week : 3+2+0+0
Credits : 04
Total Hours : 39+26

Course Objectives:
The basic calculations of energy balance and mass balance of biochemical processes is the primary objective of learning this Course. 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.

Course Outcomes:
At the end of the course the student will be able to
1. Learn and understand fundamental concepts of process calculations, unit conversions and apply them to express the composition of mixtures.
2. Apply material balance in steady and unsteady state unit operations and unit processes.
3. Apply energy balances in steady and unsteady state unit operations and unit processes

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, chemical equation and stoichiometry; ideal gases and mixtures.

13 Hours

UNIT- II
STEADY STATE MATERIAL BALANCE WITHOUT REACTION: General material balance equation. Material balances in distillation (with and without reflux), liquid-liquid extraction and leaching, crystallization, drying, mixing, evaporation processes, bypass and recycle, material balance for multistage operations. Humidity charts and their uses.

14 Hours
UNIT- III
STEADY STATE MATERIAL BALANCE WITH REACTION

14 Hours

UNIT- IV
ENERGY BALANCE: General energy balance equation.

13 Hours

UNIT- V
UNSTEADY STATE MATERIAL BALANCE AND FLOWSHEETING: Unsteady state material balance and energy balance equations 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.

11 Hours

TEXT BOOKS:

REFERENCE BOOKS:

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**UNIT OPERATIONS LAB**

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<td>Hrs/Week</td>
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**Course Objectives:**
To develop experimental skills in basic fluid flow operations and mechanical separation processes.

**Course 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**
2. Flow characteristics of open orifice
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

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Syllabus of III & IV Semester B.E. / Biotechnology Engg.

BIOCHEMISTRY LAB

Sub code : 14BT307  Credits : 02
Hrs/Week : 0+0+3+0  Total Hours : 39

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

Course Outcomes:
At the end of the course the student will be able to
1. Learn principles and chemical preparations required for biochemical analysis.
2. Apply methods of analysis to carbohydrates, proteins and lipids in biological samples.
3. Learn and apply estimation techniques in biochemical analysis.

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.
9. Estimation of triglyceride by phospho vanillin method
10. Determination of Saponification value of lipids.
11. Determination of Iodine value of lipid.
12. Determination of acetyl value of a lipid.

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INDIVIDUAL EFFECTIVENESS LABS (IEL)

Introduction
Entry Edge ($E^2$) is an industry readiness program designed for technology undergraduates to help them enhance important individual behavior & skills, and become productive from the very beginning of their corporate carrier. The program places a high emphasis on the pedagogy of learning by doing.

As part of the program, students first go through individual behavior & skill labs (Individual Effectiveness Labs) in their II year of engineering curriculum and then participate in “hands on” and “minds on” team activities in a simulated work environment, to accomplish tasks and to solve real-world organizational issues during a week long Immersive Group Workshop (IGW) held in the III year of their engineering course.

This document provides the syllabus and evaluation framework for Individual Effectiveness Labs (IEL).

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INDIVIDUAL EFFECTIVENESS LABS (IEL)

Sub Code: 14BT308 Credits : 02
Hrs / Week: 0+0+4+0 Total Hours : 52

Course Outcome:
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 Hours

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 Hours

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 Hours

Module 4: Presentation Skills
Syllabus of III & IV Semester B.E. / Biotechnology Engg.

- 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 Hours

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

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 Hours

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

BIOSTATISTICS

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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.

**Course Outcomes:**
At the end of the course the student will be able to
1. Understand and use probabilistic models and probability distributions for both discrete and continuous biological data.
2. Apply ANOVA to engineering problems and perform hypothesis testing on experimental samples.
3. Learn sampling methods and statistics based experimental designs.

**UNIT-I**
**Averages and Dispersion:** Data collection, presentation of data, diagrams and graphs, measures of central tendency, measures of dispersion, coefficient of variation.

10 Hours

**UNIT-II**
**Probability:** Definition of probability, axioms, conditional probability, Baye’s theorem, one dimensional random variable, mean and variance. Curve fitting(linear, non-linear and exponential). Correlation and regression.

10 Hours

**UNIT-III**
**Probability distributions:** Discrete probability distributions-Binomial, poisson, geometric. Continuous probability distributions-normal, exponential, uniform distributions. Moment generating function and Central limit theorem.

10 Hours

**UNIT-IV**
**Estimation & 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.

10 Hours

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

12 Hours
Syllabus of  III & IV Semester B.E. / Biotechnology Engg.

TEXT BOOKS:

REFERENCE BOOKS:

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HEAT & MASS TRANSFER

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<th>Sub code</th>
<th>14BT402</th>
<th>Credits</th>
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<tr>
<td>Hrs/Week</td>
<td>3+2+0+0</td>
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<td>39+26</td>
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Course Objectives:
The objective of this course is to learn the basics of heat transfer, mass transfer and the related equations. This course gives a picture of importance, principle and mass transfer in bioprocess systems and industrial applications. This course is one of the fundamental requirements for industrial application of biotechnology.

Course Outcomes:
At the end of the course the student will be able to
1. Understand and describe various modes of heat and mass transfer and their associated equations.
2. Design equipments used for heat transfer operations.
3. Analyze the effects of heat and mass transfer in industrial applications like adsorption, extraction, oxygen transfer in medium and distillation.
UNIT- I

HEAT TRANSFER: Modes of heat transfer; Conduction:– Fourier’s law, Steady state heat conduction in slab and cylinders, minimum thickness of insulation, steady state heat conduction with internal heat generation (slab, solid cylinder, solid sphere). Unsteady state heat conduction, Boundary conditions and Biot number. convection:– governing equation, convective HTC, overall HTC, natural and forced convection. dimensional analysis for heat transfer, Heat transfer with phase change. Radiation: - governing equations, laws of black body radiation.

13 Hours

UNIT- II


13 Hours

UNIT- III

MASS TRANSFER: Mass transfer flux, steady state diffusion:- Fick’s I law, equimolar counter current diffusion, diffusion with second stationary component, role of diffusion in bioprocess, boundary conditions. Numericals on rate of diffusion. Diffusivity of gases, liquids and their measurement. Quantitative relationship for mass transfer: Volumetric mass transfer coefficient (\(k_{L\alpha}\) and \(k_{G\alpha}\) for Gas-liquid system). Mass transfer in bioreactors: Oxygen transfer in submerged fermentors, oxygen uptake rate and determination of oxygen transfer coefficients (\(k_{L\alpha}\)). Unsteady state diffusion; Fick’s II law. Theories of mass transfer across phase boundaries – two film theory and penetration theory, convective and diffusive mass transfer Biot number. Analogy between heat and mass transfer.

13 Hours

UNIT -IV

MASS TRANSFER OPERATIONS:

Extraction: Principle, equilibrium calculations, ternary equilibrium diagram, single and multistage cross current and counter current operations, equipments (Spray tower, Rotating Disc Contactor), Numericals.

13 Hours

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 (McCabe - Thiele method), sieve plate and packed bed distillation, hydrodynamics in distillation column, Numericals on Mc Cabe - Thiele and Rayleigh’s method.

Drying: Principle of drying, heat transfer in dryer, mass transfer in dryers, drying rate curve, drying equipments – Tray dryer, Numericals on drying time.

13 Hours

TEXT BOOKS:

REFERENCE BOOKS:
Syllabus of III & IV Semester B.E. / Biotechnology Engg.


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THERMODYNAMICS

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Hrs/Week : 2+2+0+0  Total Hours : 26+26

**Course Objectives:**
To learn fundamental laws of thermodynamics and its application to simple biological systems. To understand properties of pure fluids and property changes in fluid mixtures and apply the concepts to phase and reaction equilibria.

**Course Outcomes:**
At the end of the course the student will be able to
1. Study the laws of thermodynamics and apply them to different systems and processes.
2. Describe properties of pure fluids and their mixtures.
3. Learn the concepts of thermodynamic phase equilibria
4. Study biochemical reaction equilibrium and apply the concepts to biological systems

**UNIT- I**


**UNIT -II**

APPLICATION OF LAWS: First law for cyclic, static and flow processes; heat capacity. P-V-T behavior of pure fluids, phase rule for non reacting systems, processes involving Ideal gas law: polytropic process, isochoric, isothermal, isobaric, adiabatic processes. Carnot cycle & principles, calculation of entropy changes, entropy and irreversibility.
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.  

UNIT- IV

UNIT- V
BIOCHEMICAL EQUILIBRIA: Reaction stoichiometry, criteria of bio-chemical reaction equilibrium, equilibrium constant and standard free energy change, calculation of equilibrium concentrations. Effect of temperature on equilibrium constant, other factors affecting equilibrium conversion. Phase rule for reacting systems, liquid phase reactions, heterogeneous bioreaction equilibria. Coupled reactions and free energy change, Oxidation/Reduction reactions, Thermodynamics of oxygen binding to hemoglobin tetramer. Donnan membrane equilibrium. 

TEXT BOOKS:  

REFERENCE BOOKS:  
Syllabus of III & IV Semester B.E. / Biotechnology Engg.


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**STRUCTURAL BIOLOGY**

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**Course Objectives:**

Structural biology is concerned with biological macromolecules and complexes of macromolecules. The Course 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.

**Course Outcomes:**

At the end of the course the student will be able to

1. Describe structural complexities of proteins and nucleic acids.
2. Illustrate the role of membrane proteins as transporters in association with glyco-conjugates as information carriers.
3. Understand interaction between macromolecules for cellular functioning.

**UNIT- I**

**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 Hours

UNIT- II

11 Hours

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). Clinical relevance to membrane transporters.

10 Hours

UNIT -IV

9 Hours

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 Hours

TEXT / REFERENCE BOOKS:
Syllabus of III & IV Semester B.E. / Biotechnology Engg.


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GENETICS & MOLECULAR BIOLOGY

Sub code : 14BT405  Credits : 04  
Hrs/Week : 4+0+0+S*  Total Hours : 52

*Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.

**Course Objectives:**
This fundamental course 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.

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

1. Understand and describe the concept of central dogma, various types of chromosomes and gene organization.
2. Learn and understand the complexity of DNA in information coding, and role of DNA in replication, transcription and translation.
3. Understand the concept of gene regulation and expression, genetic recombination in eukaryotes and prokaryotes.

UNIT- I

8 Hours
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 Hours

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.

6 Hours

6 Hours
Syllabus of III & IV Semester B.E. / Biotechnology Engg.

UNIT- III
REGULATION OF GENE EXPRESSION IN PROKAROTES AND EUKARYOTES: Gene regulation, Operon model, gal, lac, trp; positive versus negative regulation of gene expression, regulation of eukaryotic gene expression, transcriptional control.

8 Hours

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

3 Hours

UNIT- IV

8 Hours

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.

8 Hours

TEXT BOOKS:

REFERENCE BOOKS:
Syllabus of III & IV Semester B.E. / Biotechnology Engg.


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**CELL AND DEVELOPMENTAL BIOLOGY**

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**Course Objectives:**
This course 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.

**Course Outcomes:**
At the end of the course the student will be able to
1. Remember various components of cell structure and their role.
2. Describe the mechanisms of cellular communications.
3. Understand and explain various stages of embryonic development.

**UNIT-I**

35
CELL STRUCTURE AND FUNCTION: Cell Theory; Comparison between plant and animal cells; Cell wall; Plasma membrane; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, Ribosome; Centrioles; Nucleus; Chemical components of a cell; Catalysis and use of energy by cells. Cell division: mitosis & meiosis, cell cycle, molecules that control cell cycle.

7 Hours

UNIT-II

7 Hours

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

9 Hours

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. Position effect.

9 Hours

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,

7 Hours

TEXT / REFERENCE BOOKS:

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HEAT & MASS TRANSFER LAB

Sub code : 14BT407  Credits : 02
Hrs/Week : 0+0+3+0  Total Hours : 39

Course Objectives:
To develop experimental skills in various techniques and operations related to heat and mass transfer applicable to bioprocess industry.

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

1. Perform experiments to understand concepts of heat transfer operations and apply them to biochemical operations.
2. Perform experiments to understand concepts of mass transfer operations and apply them to biochemical operations.
3. Perform experiments to learn and apply concepts of simultaneous heat and mass 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 measurement
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

MICROBIOLOGY LAB
Sub code : 14BT408 Credits : 02
Hrs/Week : 0+0+3+0 Total Hours : 39

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

Course Outcomes:
At the end of the course the student will be able to
1. Learn the importance of preparations required for performing microbiological experiments and perform microbial culture techniques.
2. Identify suitable test for identification of microbes.
3. Learn analysis of food and water for microbiological examination.
EXPERIMENTS
1. Aseptic techniques, Media preparation.
2. Pure culture techniques: serial dilution, pour plate, spread plate and streak plate, CFU.
4. Stains and staining techniques: simple staining-positive and negative, endospore staining, motility test.
5. Stains and staining techniques: Gram staining technique
6. Biochemical tests for the identification of bacteria: fermentation of carbohydrates
7. Biochemical tests for the identification of bacteria: oxidase test, IMVIC test
8. Microbial analysis of food products
10. Antimicrobial activity (MIC).

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