KAMARAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)
S.P.G.Chidambara Nadar - C.Nagammal Campus
S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

B.TECH. BIOTECHNOLOGY
REGULATION – 2021
AUTONOMOUS SYLLABUS
CHOICE BASED CREDIT SYSTEM
III TO IV SEMESTER CURRICULUM AND SYLLABI

VISION:

To make the Department of Biotechnology, unique of its kind in the field of research and development activities pertaining to the field of biotechnology in this part of the world.

MISSION:

To impart highly innovative and technical knowledge in the field of biotechnology to the urban and rural student folks through "Total Quality Education".

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: **Program Specific Academic Excellence:** The student will be able to pursue higher education in India/Abroad in Biotechnology and its related fields by taking up competitive exams like GATE, CSIR, TANCET, GRE, TOEFL etc

PEO 2: **Professional Attitude:** The student will be able to come up with solutions for any scientific or technical problems related to Biotechnological industries/institutes by engaging in independent and life-long learning.

PEO 3: **Core Competence:** The student will be able to plan and conduct experiments in modern biotechnology and allied field laboratories using modern tools including interpreting the significance of resulting data, reporting results and writing technical reports

PEO 4: **Collaboration:** The students will be able to work in multidisciplinary team with confidence and will be able to venture out with entrepreneurial activities.

PROGRAM OUTCOMES:

After going through the four years of study, the Biotechnology graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/Development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1 : **Future ready graduates:** The student will be able to identify, choose and perform to their best ability in the next career step: Higher education/Job/Entrepreneurial initiatives.

PSO2 : **Industry ready graduates:** The student will be able to apply the acquired knowledge to provide cost-effective and sustainable solutions in Biotechnology

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CHOICE BASED CREDIT SYSTEM
B.TECH. BIOTECHNOLOGY
CURRICULUM AND SYLLABI FOR SEMESTER III TO IV

SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA2202	Transforms and Numerical Solution of Equations	BS	4	3	1	0	4
2	BT2201	Biochemistry	PC	3	3	0	0	3
3	BT2202	Cell Biology	PC	3	3	0	0	3
4	BT2203	Stoichiometry	PC	4	3	1	0	4
5	BT2204	Thermodynamics for Biotechnologist	ES	3	3	0	0	3
6	GE2201	Design Thinking	EM	3	3	0	0	3
7		Audit Course	AU	3	3	0	0	0
PRACTICALS								
8	BT2205	Biochemistry Laboratory	PC	4	0	0	4	2
9	BT2206	Cell Biology Laboratory	PC	4	0	0	4	2
10	EM2202	Interpersonal Skills - Listening and Speaking	EM	2	0	0	2	1
			TOTAL	**33**	**21**	**2**	**10**	**25**

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA2254	Probability, Statistics and Numerical Methods	BS	4	3	1	0	4
2	BT2251	Basic Industrial Biotechnology	PC	3	3	0	0	3
3	BT2252	Enzyme Technology and Biotransformations	PC	3	3	0	0	3
4	BT2253	Fluid Mechanics and Heat Transfer Operations	ES	3	3	0	0	3
5	BT2254	Microbiology	PC	3	3	0	0	3
6	BT2255	Molecular Biology	PC	3	3	0	0	3
7	GE2251	Quantitative Aptitude	EM	1	1	0	0	1
8	AUD110	Tamils and Technology	AU	1	1	0	0	0
PRACTICALS								
9	BT2256	Chemical Engineering Laboratory for Biotechnologist	PC	3	0	0	3	1
10	BT2257	Microbiology Laboratory	PC	3	0	0	3	1
11	EM2252	An Introduction to Advanced Reading and Writing	EM	2	0	0	2	1
			TOTAL	**29**	**20**	**1**	**8**	**23**

Course Code	Course Name	L	T	P	C
MA2202	TRANSFORMS AND NUMERICAL SOLUTION OF EQUATIONS	3	1	0	4

Category: Foundation Courses (Basic Science Courses)

a. Preamble

Fourier analysis allows modelling periodic phenomena which appears frequently in engineering, alternating electric currents or the motion of planets. The idea of Fourier analysis is to represent complicated functions in terms of simple periodic functions, namely cosines and sines. This course aims to developing the ability to formulate an engineering problem in a mathematical form by appropriate numerical approach..

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Construct the Fourier series for periodic functions and for function with discrete data.	K3
CO2	Classify and solve the initial and boundary value problems such as wave and heat flow equation.	K3
CO3	Compute the Fourier transforms of standard functions and learn its properties.	K3
CO4	Apply the techniques of Z - transform to get the solutions of difference equations.	K3
CO5	Compute numerical solution of algebraic, transcendental equations and system of linear equations.	K3

c. Course Syllabus **Total : 60 Periods**

FOURIER SERIES **12**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range sine and cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **12**

Classification of partial differential equations - Method of separation of variables – Solutions of one-dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation - Fourier series solutions in cartesian coordinates.

FOURIER TRANSFORM **12**

Fourier integral theorem - Fourier transform pair - Sine and cosine transforms - Properties - Transform of elementary functions - Convolution theorem - Parseval's identity.

Z-TRANSFORM **12**

Z-transform - Elementary properties - Initial and final value theorems - Inverse Z–transform - Convolution theorem - Formation of difference equation - Solution of difference equation using Z - transform

NUMERICAL SOLUTION OF EQUATIONS **12**

Solution of Algebraic and Transcendental equations: Bisection Method - Fixed point iteration method - Newton Raphson method - Solution of linear system of equations: Gauss elimination method - pivoting - Gauss Jordan method - Iterative methods: Gauss Jacobi - Gauss Seidel.

d. Activities

Students shall be exposed to MATLAB programming to find the Fourier transform of the given functions.

e. Learning Resources

Text Books

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, Tenth Edition, New Delhi, 2015.
2. Grewal, B. S, *Higher Engineering Mathematics*, Khanna Publishers, Forty Fourth Edition, New Delhi, 2017.
3. Sastry, S. S, *Introductory Methods of Numerical Analysis*, PHI Learning, Fifth Edition, 2015.

Reference Books

1. Bali, N, Goyal, M, & Watkins, C, *Advanced Engineering Mathematics,* Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), Seventh Edition, New Delhi, 2009.
2. Peter, V, O'Neil, *Advanced Engineering Mathematics,* Cengage Learning India Pvt., Ltd., Seventh Edition, New Delhi, 2012.
3. Ramana, B.V, *Higher Engineering Mathematics*, Tata McGraw Hill Co. Ltd., New Delhi, Eleventh Reprint, 2010.

Course Code	Course Name	L	T	P	C
BT2201	BIOCHEMISTRY	3	0	0	3

Category: Professional Core Course

a. Preamble

This course introduces the chemical basis of life and importance of water, biological buffers and biomolecules. It also emphasis the structural properties of biomolecules and the role of enzymes in biochemical reactions.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the structure of the biomolecules	K3
CO2	Understand the structure and function of the lipid, nucleic acid	K2
CO3	Illustrate the basic concepts related to function and activity of enzymes	K3
CO4	Demonstrate the structure and function of the intermediates	K3
CO5	Apply the knowledge in understand the bioenergetics of the cell	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO BIOMOLECULES **9**

Basic principles of organic chemistry - types of functional groups- chemical nature of water- pH and biological buffers.- overview of biomolecules and biochemical reactions. Carbohydrates: Classification of carbohydrates (mono, di - oligo & polysaccharides) - mutarotation, glycosidic bond - reactions of monosaccharides and reducing sugars, polysaccharides : structure of starch, glycogen, Heparin, Chodroitin sulphate. Introduction to glycosaminoglycans..

STRUCTURE AND PROPERTIES OF LIPIDS, PROTEINS AND NUCLEIC ACIDS **9**

Lipids: Classification- structure and properties - fatty acids - phospholipids - glycolipids - sphingolipids - cholesterol - steroids - prostaglandins. Properties : saponification - iodination - hydrogenation. Proteins: Structure and properties of amino acids - biologically significant peptides like glutathione, vasopressin and oxytocin- hierarchy of structural organization of proteins- primary - secondary, tertiary and quaternary structures - glycoproteins and lipoproteins. Nucleic acids: Introduction to nucleic acids - Nucleic acids as genetic material - purines, pyrimidines, nucleoside and nucleotide - difference between DNA and RNA,

Structure of DNA: primary structure, Secondary structure, - Watson & Crick model - Chargaff‘s rule. biological significance of DNA and RNA, nucleoprotein complex

INTRODUCTION TO ENZYMES **9**

Introduction to metabolism - enzymes classification - structure of enzyme (active site, substrate binding site) - factors affecting enzyme activity - pH, temperature, substrate (Michaelis–Menten equation Km, Vmax) and enzyme concentration ; role of coenzymes

INTERMEDIARY METABOLISM AND ITS REGULATION **9**

Glycolysis - gluconeogenesis - pentose phosphate pathway - TCA cycle, fatty acid synthesis, β oxidation of fatty acid- - reactions of amino acids - deamination, transamination and decarboxylation - urea cycle - interconnection of metabolic pathways and their regulation.

BIOENERGETICS **9**

General concept of oxidation and reduction - electronegative potential - high energy compounds - ATP/ADP cycle - electron transport chain - oxidative phosphorylation – uncouplers and inhibitors of Electron Transport chain - bioenergetics of glucose and palmitic acid oxidation

d. Activities

Model making activity for clear understanding of structure of biomolecules and various metabolic pathways

e. Learning Resources

Text Books

1. Satyanarayana, U & Chakrapani, U 2019, *Biochemistry*, 5th ed , Elsevier .
2. Hames D, Hooper, N 2011, *BIOS Instant notes – Biochemistry*, 4th ed, Garland Science, Taylor & Francis group, New York and London.
3. Champe,PC & Harvey RA 2005, *Lippincott's illustrated reviews, Biochemistry,* 3rd ed, Lippincott Williams & Wilkins
4. Murray, RK, Granner DK, Mayes, PA & Rodwell, VW & Harpers 2015, *Biochemistry,* 30th ed, McGraw Hill Education.
5. Rama Rao, 2010 *Textbook of Biochemistry,* 4th ed, L.K. and S. Publishers

Reference Books

1. Lehninger AL, Nelson. DL & Cox, MM 2012, *Principles of Biochemistry,* 6th edition, CBS publishers
2. Burtis, CA & Ashwood ER 1999. Tietz *Textbook of Clinical chemistry*, Volume 564, WB Saunders Company,

3. Berg, JM, Tymoczko, JL, Stryer, L & Clarke ND 2002, *Biochemistry*, 5th Revised edition , W H Freeman
4. Voet D, Voet JG & Pratt CW 2018, *Voet's Principles of Biochemistry*, 5th ed, (Global Edition) John Wiley and Sons, Inc

Course Code	Course Name	L	T	P	C
BT2202	CELL BIOLOGY	3	0	0	3

Category: Professional Core Courses

a. Preamble

This course aims to introduce the basic knowledge of the structural and functional properties of cells and to make the student to understand the fundamental of cell signaling and membrane transport mechanism

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Demonstrate the fundamental composition, structure and characteristics of prokaryotic and eukaryotic cell membrane	K3
CO2	llustrate the fundamental composition, structure and characteristics of prokaryotic and eukaryotic cell organelles	K3
CO3	summarize the action of membrane transport proteins in transport of ions and small molecules across the membrane	K3
CO4	Analyze the basic mechanism behind membrane trafficking and intracellular protein transport	K3
CO5	Utilize a microscope and other bioinstrumentation required in cellular or molecular biology investigations	K3

c. Course Syllabus **Total : 45 Periods**

CELL ORGANELLES & CYTOSKELETON **9**

Cell - Fundamental unit of life; Structural organization of prokaryotic and eukaryotic cell; Structure and functions of cell organelles: Nucleus and cytoplasm. Mitochondria and Chloroplast, Endoplasmic reticulum and its types, Golgi complex, Lysosomes, Vacuoles and peroxisomes. Organelle biomarkers; Cytoskeleton: Structure, Composition, Assembly and functions of microtubules, microfilaments and intermediate filaments, Microfilaments: mechanism of myosin-ATPase activity, contraction; Microtubules, microfilaments activity in Organelle movement.

CELL DIVISION AND CONNECTION **9**

Cell cycle - Mitosis, Meiosis ; Molecules controlling cell cycle - Cyclins, CDK, Regulation of cell cycle ; Cell cycle - Check points ; Extra cellular matrix - Basal lamina, Connective

tissue; Cell-Cell and Cell-ECM Junctions and their Adhesion Molecules - Gap junctions, Tight junctions, Desmosomes, Hemidesmosomes.

MEMBRANE TRANSPORT **9**

Basics of membrane transport: Size, solubility and electrochemical gradient of solutes across membrane. Transport proteins: Uniporters, Symporters, Antiporters, Aquaporins, ATP driven pumps and its types, Ion-channels - voltage and ligand gated. Role of ion-channels and ATP pump

CELL SIGNALLING **9**

Cell signaling models: autocrine, endocrine and paracrine; Steps in signal transduction, Signal amplification, Modes of intercellular signaling ; Intracellular receptor pathways - Nitric oxide pathway; Signaling at the cell surface: GPCRs and Second messengers ; Receptors with intrinsic or associated enzymatic activity: Receptor tyrosine kinases - Ras MAP Kinase pathway, cytokine receptor - JAK/STAT pathway, receptors that are ion channels - Ca^{2+} signaling, receptors activating pathways involving proteolysis - Wnt pathway.

TECHNIQUES IN CELL BIOLOGY **9**

Cell fractionation: Extraction, Homogenization and Centrifugation techniques. Microscopy and cell architecture; Cell isolation: Fluorescence Activated Cell Sorter (FACS) and Magnetic-activated cell sorting (MACS); Primary Cell culture – Isolation and separation of cells, viable cell count, maintenance of cell culture ; Types of cell cultures – Monolayer, Suspension, Clone culture, Mass culture-microcarrier culture ; Cell viability studies: Using tetrazolium salts, LDH release and Tryphan blue exclusion.

d. Activities

Students will be exposed to model making for understanding the concepts related to cell communication and signal transduction

e. Learning Resources

Text Books

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P., 2015. *Analyzing cells, molecules, and systems. Molecular Biology of the Cell* (6th Edition). Richter LM (Ed.). Garland Science, NY and Abingdon, UK.
2. Lodish, H., Berk, A., Kaiser, C.A., Kaiser, C., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P., 2008. *Molecular cell biology*. Macmillan.
3. Karp, G., 2009. *Cell and molecular biology: concepts and experiments*. John Wiley & Sons.

Reference Books

1. Cooper, G.M. and Hausman, R.E., 2004. *The cell: a molecular approach.*
2. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P., 2006. *The world of the cell*. Pearson Education, Inc. San Francisco
3. Simon, E.J., Dickey, J.L., Hogan, K.A. and Reece, J.B., 2016. *Essential Biology*. Pearson Education, Inc. United States of America.

Course Code	Course Name	L	T	P	C
BT2203	STOICHIOMETRY	3	1	0	4

Category: Professional Core Courses

a. Preamble

This course introduces the various units and dimensions of physical quantities. It focuses to develop skills of the students in the area of Chemical Engineering with emphasis in material and energy balance calculations without chemical reactions.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Solve the various unit conversion problems and problems related to basic chemical calculations in chemical engineering and biotechnology practice.	K3
CO2	Solve the problems related to ideal, actual gas, air-water vapour system and humidity.	K3
CO3	Apply the concept of material balance without chemical reaction and analysis of data for steady and unsteady state operations in chemical and biochemical engineering.	K3
CO4	Apply the concept of energy balance for open and closed systems and the concept of thermochemistry in chemical engineering and biotechnology application.	K3
CO5	Apply the concepts of material and energy balance with chemical reactions.	K3

c. Course Syllabus **Total : 60 Periods**

BASIC CHEMICAL CALCULATIONS **12**

Dimension – Systems of units esp. engineering FPS, Engineering MKS & SI systems – Conversion from one system to the other; Composition of mixtures and solutions – mass fraction, mass %, mole fraction, mole %, mass ratios, molarity, molality, normality, ppm, composition by density; Chemical Reaction - limiting reactant, excess reactant, fractional conversion, percent conversion, yield, selectivity, extent of reaction.

IDEAL AND ACTUAL GAS EQUATIONS **12**

Ideal and actual gas equations – Vander Walls, compressibility factor equations; Application to pure gas & gas mixtures – partial pressures, partial volumes; Air-water vapour systems –

Humidity, Molar Humidity, Relative Humidity, % Saturation, humid Volume, Humidity chart, Wet and Dry bulb temperatures, Dew point; pH of solutions; Vapour pressure

MATERIAL BALANCE **12**

Material balance concept – overall & component; material balance applications – Evaporator, Gas absorber, Distillation (Binary system), Liquid extraction, Solid-liquid extraction, Drying, Crystallization, Humidification, Mixing, Recycle and Bypass illustration

ENERGY BALANCE **12**

Thermo physics - general energy balance equation for open systems, closed systems; sensible heat calculation; heat required for phase change; Thermo chemistry – heat of formation, heat of reaction, heat of combustion; Application of steam tables - saturated and superheated steam.

CHEMICAL REACTION **12**

Combustion reactions – solid, liquid and gaseous fuels; applications - oxidation of sulphur compounds and related processes, carbon dioxide from limestone, phosphorous compounds, nitrogen, ammonia, nitric acid, metallurgical applications; processes in biological systems - yield and yield coefficient, elemental balance, respiratory quotient, degree of reduction, oxygen requirement

d. Activities

Students seminar on applications of chemical engineering concepts in biological domain

e. Learning Resources

Text Books

1. Bhatt, B.I. and Thakore, S.B., 2010. *Stoichiometry*. Tata McGraw-Hill Education.
2. Narayanan, K.V. and Lakshmikutty, B., 2016. *Stoichiometry and process calculations*. PHI Learning Pvt. Ltd.
3. Himmelblau, D.M. and Riggs, J.B., 2012. *Basic principles and calculations in chemical engineering*. FT press.

Reference Books

1. McCabe, W.L., Smith, J.C. and Harriott, P., 1993. *Unit operations of chemical engineering*. New York: McGraw-hill.
2. Sikdar, D.C., 2013. *Chemical Process Calculations*. PHI Learning Pvt. Ltd.
3. Hicks, T.G. and Chopey, N.P., 2012. *Handbook of chemical engineering calculations*. McGraw-Hill Education.

Course Code	Course Name	L	T	P	C
BT2204	THERMODYNAMICS FOR BIOTECHNOLOGIST	3	0	0	3

Category: Foundation Courses (Engineering Science Course)

a. Preamble

This course introduces the basic principles of work and energy and thermodynamics laws and principles of entropy and entropy driven processes in biochemical systems along with free energy and phase equilibria.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the concepts of equilibrium conditions, internal energy, enthalpy, free energy and chemical potential	K3
CO2	Outline the basic concepts in solution thermodynamics and relative energies of different liquid and solid solution	K3
CO3	Understand the basic concepts of different phases (multiple) and its equilibria	K3
CO4	Identify and apply appropriate thermodynamic relations in chemical reaction system	K3
CO5	Analyse the biochemical reaction to the knowledge of basic thermodynamics of chemical reactions in biological systems	K3

c. Course Syllabus **Total : 45 Periods**

THERMODYNAMIC LAWS AND PROPERTIES OF FLUIDS **9**

Concept of heat, work and energy; Forms – work and energy; First Law of thermodynamics- a generalized balance equation and conserved quantities; internal energy and enthalpy changes; Second law of thermodynamics - volumetric properties of fluids exhibiting non-ideal behaviour; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property changes; Maxwell's relations and applications.

SOLUTION THERMODYNAMICS **9**

Partial molar properties; concept of chemical potential and fugacity; ideal and non-ideal solutions; concept and application of excess properties of mixtures; activity coefficient;

composition models; Gibbs-Duhem equation; Gibbs energy dissipation for aerobic, fermentative and autotrophic cell growth; Thermodynamic properties of ions in solutions; Entropy – Calculations of entropy changes, Clausius inequality, Irreversibility

PHASE EQUILIBRIA **9**

Criteria for phase equilibria; Phase equilibrium in single and multi-component system; Phase rule for non-reacting systems; Duhem's theorem; Vapour-Liquid Equilibria (VLE) calculations for binary and multi-component systems; Azeotropes; Consistency Test for VLE Data; Liquid-Liquid equilibria.

CHEMICAL REACTION EQUILIBRIA **9**

Equilibrium criteria for homogeneous chemical reactions and biochemical reaction; evaluation of equilibrium constant; phase rule for reacting biosystems equilibrium constants; effect of temperature and pressure on equilibrium constant; other factors affecting the equilibrium conversion; calculation of equilibrium conversion and yields for single and multiple reactions; free energy changes for biochemical reaction

THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION **9**

Thermodynamics of microbial growth stoichiometry; thermodynamics of maintenance; calculation of the operational stoichiometry - at different growth rates; ATP synthesis for growth, thermodynamic feasibility analysis of metabolic pathways; Herbert-Pirt relation for electron donor; thermodynamics and stoichiometry of product formation

d. Activities

Students seminar

e. Learning Resources

Text Books

1. Smith, J.M., Van Ness, H.C. and Abbott, M.M., 2009. *Introduction to Chemical Engineering Thermodynamics,* ', Mc Grawhill Book Company. International Edition.
2. Narayanan, K.V., 2004. *A textbook of chemical engineering thermodynamics*. PHI Learning Pvt. Ltd..
3. Smolke, C. ed., 2009. *The metabolic pathway engineering handbook: fundamentals (Vol. 1).* CRC press.
4. Von Stockar, U., 2013. *Biothermodynamics: The role of thermodynamics in biochemical engineering*. PPUR Presses polytechniques

Reference Books

1. Sandler, S.I., 2017. *Chemical, biochemical, and engineering thermodynamics.* John Wiley & Sons..
2. Atkins, P.W. and De Paula, J., 2013. *Physical chemistry*. John Wiley & Sons.
3. Haynie, D.T., 2013. *Biological thermodynamics*. Cambridge University Press.
4. Peter Atkins, P. and De Paula, J., 2014. *Atkins' Physical Chemistry*. OUP Oxford

Course Code	Course Name	L	T	P	C
GE2201	DESIGN THINKING	3	0	0	3

Category: Employability Enhancement Course

a. Preamble

This course introduces the various principles of design thinking to achieve an effective design and to examine the implementation of the model or process for its successful operation.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the basic principles of design and various stages of design thinking for better conceiving of idea and refinement	K2
CO2	Elucidate the concepts of idea generation and refinement	K3
CO3	Apply various prototype models for solving complex problems	K3
CO4	Analyze real-time problems for effective design, implementation and operation	K3
CO5	Device idea/solution towards development of a prototype for a chosen problem of interest	K4

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO DESIGN THINKING **9**

Introduction - Product life cycle – Design Ethics – Design Process – Stages in design thinking: Immersion, Analysis and synthesis, Ideation, Prototyping.

IDEA GENERATION AND REFINEMENT **9**

Basic design - directions - Themes of thinking - Inspiration and references - Brainstorming - Value - Inclusion – Sketching - Presenting ideas - Thinking in images - Thinking in signs - Appropriation - Personification - Visual metaphors - Modification - Thinking in words – Words and language - Thinking in shapes - Thinking in proportions - Thinking in color - Outside the Box

PROTOTYPING **9**

Developing designs - Types of prototype - Prototyping for Designing Complex Systems – The Efficacy of Prototyping under Time Constraints

IMPLEMENTATION **9**

Format - Materials - Finishing - Media - Scale - Series/Continuity - Emerging Landscapes of Design - Real-Time Design Interaction Capture and Analysis - Enabling Efficient Collaboration in Digital Design - Spaces Across Time and Distance - Software used in Developing in Virtual Environments

DESIGN THINKING IN VARIOUS SECTORS **9**

Design & Development of Prototypes for Wall Plastering, Rubber shredding, Separation of Corn seeds, Electric vehicles, Smart gates, Burglar alarm, Tyre pressure monitor, Development of Online Voting System, Online Proctoring System, Online Health Monitoring System, IoT based Home Automation and any other problem of interest in your domain.

d. Activities

e. Learning Resources

Text Books

1. Binder, T., De Michelis, G., Ehn, P., Jacucci, G., Linde, P., and Wagner, I., 2011. *Design things*, MIT press
2. Ambrose, G., and Harris, P., 2009. *Basics Design: Design thinking*, Bloomsbury

Reference Books

1. Meinel, C., and Leifer, L. (Eds.)., 2011. *Understanding Innovation*, Springer.
2. Plattner, H., Meinel, C., and Leifer, L. (Eds.)., 2010. *Design thinking: understand–improve–apply*, Springer Science & Business Media
3. Moran, T. P., and Carroll, J. M., 1996. *Design Rationale: Concepts, Techniques, and Use*, L. Erlbaum Associates Inc
4. Cross, N., 1984. *Developments in Design Methodology*, Chichester: Wiley.

Web Resources

1. https://www.designsociety.org/download-publication/39626/ Design+prototyping+of+systems
2. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process

Video lectures: (NPTEL or any other video lectures)

1. https://nptel.ac.in/courses/110/106/110106124/#

Course Code	Course Name	L	T	P	C
BT2205	BIOCHEMISTRY LABORATORY	0	0	4	2

Category: Professional Core Course

a. Preamble

This course introduces the basic units of measurements, standardization of various buffer solutions, principles behind the qualitative and quantitative estimation of biomolecules (carbohydrates, proteins, lipids) and determination of enzyme kinetic parameters.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Infer the principle on various solvents & buffers and demonstrate the suitable method of analysis for different carbohydrates.	K3
CO2	Determine the quantity of protein in different methods	K3
CO3	Estimate the nucleic acids and lipids in different sample preparations	K3
CO4	Apply proper method for plant pigment extraction, separation and antioxidant activity analysis	K3
CO5	Demonstrate the enzyme reaction and able to determine the enzyme kinetic parameters	K3

c. Course Syllabus **Total : 60 Periods**

1. Demonstration for proper use of volume and weight measurement devices, accuracy, precision, sensitivity and specificity
2. Preparation of buffer –titration of a weak acid and a weak base.
3. Qualitative tests for carbohydrates –distinguishing reducing from non-reducing sugars and aldo from keto sugars.
4. Determination of absorption maxima (λmax) of a given solution
5. Protein estimation by Biuret and Lowry's methods.
6. Protein estimation by Bradford methods and UV-Visible Spectroscopy.
7. Qualitative analysis of nucleic acids in spectrophotometric method and hyperchromic effect.
8. Extraction of lipids from oil seeds and analysis by Thin layer chromatography.
9. Extraction of polyphenol compound from different plant sources and determination of antioxidant activity using DPPH method.

10. Separation of plant pigments using Column chromatography
11. Determination of kinetic parameters (Km and Vmax) for a given enzyme solution.
12. Use of Excel and Origin Pro (Trial version) software to plot the data and statistical analysis.

d. Activities

Demonstration of sample analysis- for given food/clinical sample

e. Learning Resources

Reference Books

1. R.C. Gupta and S. Bhargavan, *Practical Biochemistry* Fifth Edition, CBS Publishers, 2020.
2. David T. Phummer, *Introduction of Practical Biochemistry* Third Edition, McGraw Hill Publisher.
3. V.W.Rodwell, David A Bender, Kathleen M Botham, Peter J Kennely, P Antony Weil, *Harper's Illustrated Biochemistry* Thirty First Edition, McGraw-Hill Education Publisher.
4. Thomas M. Devlin, *Textbook of Biochemistry with clinical correlations*, Sixth Edition, Wiley Liss Publishers

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	UV-Vis Spectrophotometer	1
2.	Hot Air Oven	1
3.	Light Microscopes	4

Course Code	Course Name	L	T	P	C
BT2206	CELL BIOLOGY LABORATORY	0	0	4	2

Category: Professional Core Course

a. Preamble

This course introduces the principles of microscopy and sterilisation techniques and different cell staining and viability methods

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Demonstrate the working principles of Microscopy	K3
CO2	Develop the ability to examine the sub cellular structures	K3
CO3	Carry out differential staining in order to understand the internal components / complexities of a cell.	K3
CO4	Evaluate the integrity and lysis of cells in culture for downstream experiments	K3
CO5	Identify the viability of cells	K3

c. Course Syllabus **Total : 60 Periods**

1. Identification of plant cells – root, stem and leaf.
2. Identification of animal cells – blood cells, squamous epithelial cells.
3. Plant -sub-cellular staining
4. Hemocytometer – enumeration of Red Blood Cells and White Blood Cells.
5. Bacterial cell viability studies - Tryphan blue dye exclusion, Tetrazolium salts
6. Cell/tissue lysis - Homogenization
7. Cell fractionation – Sub-Cellular fractionation
8. Cell division - mitosis in onion root
9. Cell division - meiosis (pre-stained slides)
10. Histopathology - Hematoxylin and Eosin staining (pre-prepared paraffin sections fixed on slide)
11. Membrane transport – Osmosis, Dialysis, Diffusion Tonicity -(hyper, hypo and iso) osmolality condition.

d. Activities

Students shall visit clinical setup / laboratories to witness different staining procedures hands on

e. Learning Resources

Reference Books

1. Rickwood, D. and J.R. Harris 1996, *Cell Biology : Essential Techniques*, John Wiley,
2. Davis, J.M. 1994, *Basic Cell Culture : A Practical Approach*, IRL,.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Refrigerated centrifuge	2
2.	Temperature controlled Incubator shaker	2
3.	Temperature controlled water bath	2
4.	Ice flake machine	1
5.	Tissue homogenizer	1
6.	Microplate reader	1
7.	Laminar air flow.	`1

Course Code	Course Name	L	T	P	C
EM2202	INTERPERSONAL SKILLS – LISTENING AND SPEAKING	0	0	2	1

Category: Employability Enhancement Course

a. Preamble

This course introduces students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Develop their communicative competence in English with specific reference to listening	K3
CO2	Prepare conversation with reasonable accuracy	K3
CO3	Apply lexical Chunking for accuracy in speaking	K3
CO4	Demonstrate their ability to communicate effectively in GDs	K3
CO5	Explain directions and instructions in academic and business contexts	K3

c. Course Syllabus **Total : 30 Periods**

LISTENING AS A KEY SKILL **6**

Listening as a key skill- its importance- speaking - give personal information - ask for personal information - express ability - enquire about ability - ask for clarification - Improving pronunciation - pronunciation basics - stressing syllables and speaking clearly - intonation patterns - conversation starters: small talk

LISTEN TO A PROCESS INFORMATION **6**

Listen to a process information- give information, as part of a simple explanation - taking lecture notes - preparing to listen to a lecture - articulate a complete idea as opposed to producing fragmented utterances - compare and contrast information and ideas from multiple sources- converse with reasonable accuracy over a wide range of everyday topics.

LEXICAL CHUNKING **6**

Lexical chunking for accuracy and fluency- factors influence fluency, deliver a five-minute informal talk - greet - respond to greetings - describe health and symptoms - invite and offer - accept - decline - take leave - listen for and follow the gist- listen for detail

GROUP DISCUSSION **6**

Being an active listener: giving verbal and non-verbal feedback - participating in a group discussion - summarizing academic readings and lectures conversational speech listening to and participating in conversations - persuade- negotiate disagreement in group work

GROUP & PAIR PRESENTATIONS **6**

Formal and informal talk - listen to follow and respond to explanations, directions and instructions in academic and business contexts - strategies for presentations and interactive communication - group/pair presentations

d. Activities

Students shall be taken to the Language lab for enhancing their listening and speaking skills.

e. Learning Resources

Text Books

1. Brooks,Margret,2011, *Skills for Success. Listening and Speaking. Level 4*, Oxford University Press, Oxford.
2. Richards, C, Jack and David Bholke,2010, *Speak Now Level 3*,Oxford University Press, Oxford

Reference Books

1. Bhatnagar, Nitin and MamtaBhatnagar,2010, *Communicative English for Engineers and Professionals*, Pearson, New Delhi.
2. Hughes, Glyn and Josephine Moate,2014, *Practical English Classroom*, Oxford University Press, Oxford.
3. Vargo, Mari,2013, *Speak Now Level 4*, Oxford University Press, Oxford.
4. Richards, C, Jack,2006, *Person to Person (Starter)*, Oxford University Press, Oxford.
5. Ladousse, Gillian Porter,2014, *Role Play*. Oxford University Press, Oxford

Web Resources:

1. https://www.cambridge.org/elt/blog/wp-content/uploads/2019/10/Learning-Language-in-Chunks.pdf
2. https://english.eagetutor.com/english/628-how-to-greet-your-boss-people-in-office.html
3. https://www.groupdiscussionideas.com/group-discussion-topics-with-answers/

Course Code	Course Name	L	T	P	C
MA2254	PROBABILITY, STATISTICS AND NUMERICAL METHODS	3	1	0	4

Category: Foundation Course (Basic Science Course)

a. Preamble

This course introduces the basic concepts and techniques of Random variables, Probability distributions, Testing of Hypothesis, Design of Experiments and Numerical Methods and highlights their applications in various fields such as Engineering and Technology.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Apply the concepts of probability distributions to solve engineering problems.	K3
CO2	Apply the concept of testing of hypothesis for small and large samples in real life problems.	K3
CO3	Apply the basic concepts of classifications of design of experiments in Engineering.	K3
CO4	Compute intermediate values of unknown function using interpolation.	K3
CO5	Apply the numerical techniques of integration for engineering problems.	K3

c. Course Syllabus **Total : 60 Periods**

PROBABILITY AND RANDOM VARIABLES **12**

Probability – Conditional Probability – Baye's Theorem – Random variables – Mathematical Expectations – Moments – Moment generating functions – Distributions: Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

TESTING OF HYPOTHESIS **12**

Sampling distributions – Statistical Hypothesis – Type I and Type II errors – Tests for single mean and difference of means of large samples (Z – test) and small samples (t – test) – F – test for variance – Chi-square test for goodness of fit – Independence of attributes.

DESIGN OF EXPERIMENTS **12**

Basic Principles of Experimental Design – Completely randomized design – Randomized block design – Latin square design – 2^2 factorial design.

INTERPOLATION AND APPROXIMATION **12**

Difference operators and relations – Interpolation with equal intervals: Newton's forward and backward difference formulae – Cubic Splines – Interpolation with unequal intervals: Lagrange's interpolation – Newton's divided difference interpolation

NUMERICAL INTEGRATION AND INITIAL VALUE PROBLEMS **12**

Numerical Integration: Trapezoidal – Simpson's 1/3rd rule and 3/8th rule (double integration excluded) - Two point and three point Gaussian quadrature formulae – Single step methods: Euler's method – Modified Euler's method – Fourth order Runge – Kutta method for solving first order equations.

d. Activities

Students shall be exposed to Microsoft Excel for Design of Experiments and MATLAB programming to solve ordinary differential equations with initial condition.

e. Learning Resources

Text Books

1. Grewal, B.S, *Numerical Methods in Engineering and Science*, Eighth Edition Reprint, Khanna Publishers, New Delhi, India, 2018.
2. Johnson, R.A, Miller, I., & Freund, J.E, *Miller & Freund's Probability and Statistics for Engineers*, Eighth Edition, Pearson Education, Asia, 2015.

Reference Books

1. Gerald, C.F, Wheatley, P.O, *Applied Numerical Analysis*, Seventh Edition, Pearson Education, Asia, New Delhi, 2007.
2. Walpole, R.E, Myers, R.H, Myers, S.L, & Ye, K, *Probability and Statistics for Engineers and Scientists*, Ninth Edition, Pearson Education, Asia, 2012.
3. Kandasamy, P, Thilagavathy, K, & Gunavathy, K, *Numerical Methods*, Third Edition Reprint, S. Chand & Co. Ltd., New Delhi, 2014.
4. Gupta, S.C, & Kapoor, V.K, *Fundamentals of Mathematical Statistics*, Twelfth Edition Reprint, Sultan Chand & Sons, 2020.
5. Veerarajan, T, *Probability, Statistics and Random Processes*, Fourth Edition, Tata McGraw Hill Education, New Delhi, 2014.

Course Code	Course Name	L	T	P	C
BT2251	BASIC INDUSTRIAL BIOTECHNOLOGY	3	0	0	3

Category: Professional Core Course

a. Preamble

This course introduces the overall industrial bioprocess and requirement of the industrial needs. It also focuses on various strategies for the bulk production of commercially important modern bio products, industrial enzymes, products of plant and animal cell cultures

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Illustrate the steps involved in industrial bioprocess	K2
CO2	Explain the basic biotechnological principles, methods and models in the production of primary metabolites	K3
CO3	Outline the various metabolic engineering approaches in the production of secondary metabolites	K3
CO4	Apply various bioprocess principles in the production of industrial bioproducts	K3
CO5	Illustrate the instrumentation of electrochemical analysis and advanced surface microscopic techniques	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO INDUSTRIAL BIOPROCESS **9**

Biochemistry of fermentation; Concepts of upstream and downstream processing in Bioprocess, Process flow sheet – block diagrams, pictorial representation. Fermentation - Bacterial, Fungal and Yeast; Strategies for strain improvement; Bioprocess strategies in Plant Cell and Animal Cell culture; monitoring and control of contamination.

PRODUCTION OF PRIMARY METABOLITES **9**

Biosynthetic pathways and production of commercially important primary metabolites: Organic Acids – Citric acid, Lactic acid, Acetic acid, Gluconic acid; Amino Acids – L-Glutamic acid, L-Lysine, L-Tryptophan; Alcohols – Ethanol, Butanol; Enzymes.

PRODUCTION OF SECONDARY METABOLITES **9**

Biosynthetic pathways and production processes for various classes of secondary metabolites: Antibiotics – Penicillin, Cephalosporin, Tetracycline; Vitamins – Vitamin B12, Riboflavin, β-Carotene; Steroid Precursors - sapogenins.

PRODUCTION OF BIOFUELS, AGRI AND FOOD PRODUCTS **9**

Production of Biodiesel, Biogas, Biopesticides, Biofertilizers, Biopolymers, Cheese, Beer, Single Cell Proteins – Bacterial, Yeast, Algal & Mushroom culture

PRODUCTION OF RECOMBINANT BIOPRODUCTS **9**

Production of recombinant proteins having therapeutic and diagnostic applications, Insulin, Monoclonal antibodies, Human Growth Factor, Tumor Suppressor Proteins, Future Aspects - Vaccines.

d. Activities

Students shall visit industries related to biotechnology, understand the process flow and prepare a report on the same

e. Learning Resources

Text Books

1. Casida, L.E., 1968. *Industrial microbiology*.
2. Crueger, W., Crueger, A., Brock, T.D. and Brock, T.D., 1990. *Biotechnology: a textbook of industrial microbiology*.
3. Stanbury, P.F., Whitaker, A. and Hall, S.J., 2013. *Principles of fermentation technology*. Elsevier.
4. Watson, J.D., Myers, R.M., Caudy, A.A. and Witkowski, J.A., 2007. *Recombinant DNA: genes and genomes: a short course*. Macmillan.

Reference Books

1. Prescott, S.C. and Dunn, C.G., 1949. *Industrial microbiology*.
2. Moo-Young, M., 2019. *Comprehensive biotechnology*. Elsevier.

Course Code	Course Name	L	T	P	C
BT2252	ENZYME TECHNOLOGY AND BIOTRANSFORMATION	3	0	0	3

Category: Professional Core Course

a. Preamble

This course introduces basic concepts of enzyme classification, mechanism of action, enzyme reaction kinetics, enzyme purification, characterization and its applications in various biotransformation reactions.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the complexities of enzyme action for biotechnological applications	K2
CO2	Outline the kinetics of enzyme action.	K2
CO3	Apply the knowledge of immobilized enzyme and its kinetics	K3
CO4	Design strategies for the production and purification of enzymes	K3
CO5	Comprehend the uses of enzymes catalyst in various biotransformation reactions	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO ENZYMES **9**

Classification of enzymes; Mechanisms of enzyme action; Concept of active site and energetics of enzyme substrate complex formation; Specificity of enzyme action; Principles of catalysis - collision theory, transition state theory; role of entropy in catalysis.

KINETICS OF ENZYME ACTION **9**

Kinetics of single substrate reactions; Estimation of Michaelis-Menten parameters; Types of inhibition & models; Multi substrate enzyme kinetics; Allosteric regulation of enzymes; Monod Changeux-Wyman models; Effect of pH and temperature on enzyme action. Determination of single substrate reaction kinetic parameters using MATLAB simulation.

ENZYME IMMOBILIZATION **9**

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding - examples, advantages and

disadvantages; Kinetics of immobilized enzyme - Factors affecting the kinetics of bound enzymes, Effect of internal and external diffusional limitations. Demonstration of mathematical model for diffusional effects in immobilized enzyme reaction.

ENZYME PRODUCTION AND PURIFICATION **9**

Production and purification of crude enzyme from microbial, plant and animal sources; Development of enzymatic assays; methods of characterization of enzymes – structural and functional properties.

APPLICATIONS OF ENZYMES **9**

Use of enzymes for production of drug (Penicilin acylases), fine chemicals and chiral intermediates (Hydrolase, Oxidase, Nitrilase, Esterase, Racemase). Design, and fabrication of enzyme-based biosensors and their applications in healthcare and environment. Immobilized enzymes in biofuel research.

d. Activities

Demonstration of enzyme kinetics using MATLAB

Demonstration of enzyme immobilization

Fabrication of enzyme biosensors

e. Learning Resources

Text Books

1. Trevor Palmer and Philip Bonner., 2008. *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry*. 2nd Edn, East West Publishers.
2. Harvey W. Blanch, Douglas S. Clark., 2007. *Biochemical Engineering*, Taylor & Francis.
3. Harvey W. Blanch and Douglas S. Clark., 2021. *Applied Biocatalysis.* 1st Edn. CRC Press.

Reference Books

1. Nelson DL, Cox MM., 2021. *Lehninger Principles of Biochemistry*. 8th Edn. W.H.Freeman & Co Ltd.
2. Alka Dwevedi, 2018. *Enzyme Immobilization: Advances in Industry, Agriculture, Medicine, and the Environment*. Springer.
3. Ajit Sadana, Neeti Sadana., 2010. *Handbook of Biosensors and Biosensor Kinetics*. 1st Edn. Elsevier Science

Course Code	Course Name	L	T	P	C
BT2253	FLUID MECHANICS AND HEAT TRANSFER OPERATIONS	3	0	0	3

Category: Engineering Science Course

a. Preamble

This course introduces the basic principles of fluid statics, fluid dynamics, fluid moving machinery and fundamental laws, design equations that governs heat transfer process

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Solve the problems related to fluid statics and dynamics in momentum transfer	K3
CO2	Outline the concepts of fluid moving machinery, flow through packed column as well as fluidized column	K3
CO3	Differentiate among different modes of heat transfer, various laws and terms used for design purpose	K3
CO4	Solve problems related to convection, boiling and condensation phenomena	K3
CO5	Design the heat exchanger and evaporator equipment	K3

c. Course Syllabus **Total : 45 Periods**

FLUID PROPERTIES & FLUID MECHANICS **9**

Fluid definition; compressible, incompressible fluids; coefficient of isothermal compressibility; Fluid properties - Density Specific gravity, Specific weight, Surface tension, Vapour pressure, Viscosity; Newtonian and Non-Newtonian fluids; Fluid statics – Barometric equation – application for incompressible and compressible fluids; Pressure changes in atmospheric air – Gauge and absolute pressure – pressure measurement with Bourdon gauge & manometers. Centre of pressure concept. Fluid Dynamics – equation of continuity – Bernoulli's equation – press loss in straight pipes – in fittings – expansion and contraction losses (applied to Newtonian Fluids only); Fluid flow measurement - Orifice, Venturi & Rotameter for Newtonian fluids

FLOW OF FLUID THROUGH PACKINGS **9**

Fluidization, Fluid transport Industrial application of fluid flow through packing-characteristics of packed bed-Bed surface area-void fraction-Laminar flow through packed

bed and turbulent flow pressure drop experienced by the fluid-equations and application problems. Fluidization phenomena-Industrial application - minimum fluidization velocities. Fluid moving machinery-pumps centrifugal, Reciprocating-gear, Peristaltic pumps, Introduction to gas moving machinery-Fans, blowers, compressors.

CONDUCTION HEAT TRANSFER **9**

Heat transfer phenomena-thermodynamics & heat transfer. Heat conduction – Fourier's equation – steady-state conduction in plexor and radial systems – Resistance concept – series and resistance in conduction –and parallel resistance in conduction – unsteady state conduction – lumped capacity model – extended surfaces (Fins) –combined conduction & convection – two dimensional conduction.

CONVECTION HEAT TRANSFER **9**

Forced and natural convection – Dimensional analysis, Dimensional numbers, Convection heat transfer coefficient, Correlations for flow over plate, through tubes, over spheres and cylinders, Agitated systems, Packed columns, condensation phenomena, Film and dropwise condensation over tubes. Boiling and Condensation phenomena.

HEAT TRANSFER EQUIPMENT **9**

Heat exchangers - types, boilers, kettles, heat exchanger design concept, NTU concept; Evaporators – types, single, double and multiple effect evaporators, enthalpy balance, evaporator design.

d. Activities

Heat exchanger equipment – model making

e. Learning Resources

Text Books

1. Geankoplis, C.J. 2015, *Transport Processes and Unit Operations,* IV edition, Prentice Hall of India.
2. Nag, P.K. 2003, *Heat & Mass Transfer,* 3rd edition, Tata McGraw Hill.
3. McCabe, W.L, Sonith, J. C and Harriot, P, 2001, *Unit operations of chemical Engineering,* 6th edition, McGraw Hill.

Reference Books

1. Frank Kreith, Raj, M. Manglik and Mark S. Bohn, 2011, *Principles of Heat Transfer,* 7th edition, Cenage Learning Inc.
2. Coulson, J.M., 1999, *Coulson and Richardson's Chemical Engineering Volume 1-Fluid Flow, Heat Transfer and Mass Transfer,* 6th Edition, Elsevier.

Course Code	Course Name	L	T	P	C
BT2254	MICROBIOLOGY	3	0	0	3

Category: Professional Core Course

a. Preamble

This course introduces different types of microorganisms and Structural organization, Define Multiplication, growth, pathogenicity and control of microorganisms. It enables to familiarize the applications of microorganisms in different sectors of Biotechnology

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the categories of microorganisms, their classification, diversity and microscopy	K2
CO2	Demonstrate structural differences among diversified microbes	K3
CO3	Explain method to cultivate microorganisms and microbial metabolic pathways	K2
CO4	Describe the pathogenicity and parameters to control microbes and evaluation of microbial control	K2
CO5	Apply various microbial systems in biotechnological industries for commercial products	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

History and Scope of microbiology; Classification and Nomenclature of microorganisms; Microscopy – Light, dark field, phase contrast, fluorescent and Electron microscopy (TEM, SEM); Stains and Staining techniques- Simple staining, Differential staining (Gram & Acid fast); Special staining-(Capsular, Flagellar & Endospore).

MICROBES- STRUCTURE AND MULTIPLICATION **9**

Structural organization and multiplication of viruses, bacteria, Bacteriophages; General characteristics and reproduction of Fungi (Mould & Yeast), Algae, Actinomycetes and Mycoplasma.

MICROBIAL NUTRITION, GROWTH AND METABOLISM **9**

Nutritional classification of microorganisms based on carbon, Energy and electron sources; Definition of growth, Different media used for bacterial culture; Cultural characteristics;

Growth curve – Batch and continuous culture and quantification of growth – Direct and indirect methods; Cultivation of anaerobic microorganisms.

PATHOGENICITY AND CONTROL OF MICROORGANISMS 9

Host-microbe interactions – Pathogenecity of Bacterial and viral diseases; clinically important microorganisms – case studies: Mycobacterium tuberculosis, Candida, SARS-COVID; Physical and chemical control of microorganisms; Antibiotics - anti-bacterial, antifungal and antiviral agents; Mode of action and Resistance to antibiotics..

APPLICATIONS OF MICROBIOLOGY 9

Primary metabolites; secondary metabolites and their applications; Production of biogas; Bioremediation; Biofertilizers and Biopesticides; Food preservation; Leaching of ores by microorganisms (Eg. *Thiobacillus* sp.).

d. Activities

Preparation of poster related to industrial application of microorganisms

e. Learning Resources

Text Books

1. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., 2001. *Microbiology*. Tata McGraw Hill Edition, New Delhi, India
2. Brock, T.D., Madigan, M.T., Martinko, J.M. and Parker, J., 2014. *Brock biology of Microorganisms*, Upper Saddle River (NJ): Prentice-Hall.
3. Gerard J. Tortora, Berdell R. Funke & Christine L. Case. 2018 *Microbiology: An Introduction*, 13th Edn, Pearson.

Reference Books

1. Willey, J.M., Sherwood, L. and Woolverton, C.J., 2011. *Prescott's microbiology* (Vol. 7). New York: McGraw-Hill.
2. Louise Hawley, Don Dunn, 2002 *Microbiology and Immunology* Kaplan, Inc.

   Cruger Wulf and Anneliese Crueger, 2017, *Biotechnology: A Textbook of. Industrial Microbiology*, 3nd Edn, Panima Publishers

Course Code	Course Name	L	T	P	C
BT2255	MOLECULAR BIOLOGY	3	0	0	3

Category: Professional Core Courses

a. Preamble

This course introduces the basic principles of molecular biology and explore skills in molecular biology to aware the complexity and harmony of the cells.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Familiarize the concepts of physical and chemical characteristics of nucleic acid	K2
CO2	Comprehend the DNA replication mechanism in prokaryotic and eukaryotic cells	K2
CO3	Demonstrate the transcription and post transcriptional events to find out the check points in drug discovery	K3
CO4	Demonstrate the translation and post translation modification events to find out the check points in drug discovery	K3
CO5	Articulate the concepts of gene regulation in molecular biotechnology applications	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO NUCLEIC ACIDS **9**

Organization of prokaryotic chromosomes - lampbrush chromosome, Polytene chromosomes; Organization of eukaryotic chromosomes – Histone proteins; Structure and physicochemical properties of elements in DNA and RNA; Primary and secondary structure of DNA - Chargaff's rule, Watson & Crick model; Conformational variants of double helical DNA - Hoogsteen base pairing, Triple helix, Quadruple helix; Tertiary structure of DNA - DNA supercoiling, Forces stabilizes DNA structure, Reversible denaturation and hyperchromic effect.

DNA REPLICATION & REPAIR **9**

Central dogma, Meselson & Stahl experiment; DNA replication - bi–directional DNA replication, Okazaki fragments, D-loop, rolling circle and theta mode of replication, Differences in prokaryotic and eukaryotic DNA replication, Proteins involved in DNA

replication, Fidelity of DNA replication - DNA mutations and repair mechanisms; Inhibitors of DNA replication; Telomere replication in eukaryotes.

TRANSCRIPTION **9**

Structure and function of mRNA, rRNA and tRNA; Characteristics of promoter and enhancer sequences; RNA synthesis - Initiation, elongation and termination of RNA synthesis, Proteins involved in RNA synthesis, Fidelity of RNA synthesis; Inhibitors of transcription; Differences in prokaryotic and eukaryotic transcription; Post transcriptional modification - RNA processing, 5'-Capping, Poly 'A' tail addition and base modification, Splicing, Alternative splicing.

TRANSLATION **9**

Introduction to Genetic code - Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and Eukaryotic ribosomes; Translation - Initiation, Elongation and termination of protein synthesis; Differences in prokaryotic and eukaryotic translation mechanism; Inhibitors of protein synthesis; Post-translational modifications.

REGULATION OF GENE EXPRESSION **9**

Hierarchical levels of gene regulation; Introduction to operon concept; Prokaryotic gene regulation - lac and trp operon; Regulation of gene expression with reference to λ phage life cycle; Eukaryotic gene regulation – at replication, transcriptional and translational levels; Recombination and crossing over as mechanism of gene regulation – Holliday model, Jumping genes.

d. Activities

Model making on concepts of Central dogma of life ; Role play on gene regulation

e. Learning Resources

Text Books

1. Malacinski G.M., 2015, *Freifelder's Essentials Of Molecular Biology*, 4th Edn, Narosa Publication.
2. Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P., 2016. *Molecular Biology of the cell*, 8th Edn. Garland Science Publishers.
3. Krebs JE, Goldstein ES, Kilpatrick ST., 2017. *Lewin's Essential GENES XII*, 12th Edn. Jones and Bartlett Publishers.

Reference Books

1. Cooper GM, Hausman RE., 2015. *The Cell: A Molecular approach*. 7th Edn. Sinauer Associates Inc.,U.S.
2. Nelson DL, Cox MM., 2021. *Lehninger Principles of Biochemistry*. 8th Edn. W.H.Freeman & Co Ltd.

Course Code	Course Name	L	T	P	C
GE2251	QUANTITATIVE APTITUDE	1	0	0	1

Category: Employability Enhancement Course

a. Preamble

To develop the thinking ability and problem solving skills of students to compete themselves in placement and competitive examinations.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Apply the concept of profit in real life problems	K3
CO2	Solve the problems by using proportion	K3
CO3	Compute accurate speed, time and distance	K3
CO4	Apply the concept of Time & Speed	K3
CO5	Calculate the work done based on various methods	K3

c. Course Syllabus **Total : 15 Periods**

PROFIT AND LOSS **3**

Profit and Loss - Cost Price, Selling Price, Profit and Loss %, Marked Price, Discount.

RATIO AND PROPORTION **3**

Ratio and Proportion - Ratio, Proportion, Comparison of Ratios, Duplicate, Triplcate Ratio.

TIME, SPEED AND DISTANCE **3**

Time, Speed and Distance - Concept of time, speed and distance, Conversion of units and proportionality, Avearge speed concept.

APPLICATIONS ON TIME, SPEED AND DISTANCE **3**

Problems on trains - Relative speed concept and application. Boats and Streams - Upstream speed, Downstream speed, Speed of stream, Speed of boat.

TIME AND WORK **3**

Time & work - Problems based on time and work, Formulae, Computation of work together, Wages based work problems. Pipes & Cisterns - Inlet-outlet, Part of tank filled, Time based problems.

d. Learning Resources

Text Book

1. Dinesh Khattar, *Quantitative Aptitude for Competitive Examinations,* Pearson India Education services Pvt Ltd, Fourth Edition, Uttar Pradesh, 2019.

Reference Books

1. TCY online, *Reasoning ability and Quantitative Aptitude*, Wiley India Pvt. Ltd, First Edition, New Delhi, 2016.
2. Agarwal.R.S, *Quantitative Aptitude for Competitive Examinations*, S.Chand Limited, 2011.
3. Abhijit Guha, *Quantitative Aptitude for Competitive Examinations*, Tata McGraw Hill, 3rd Edition, 2011

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Course Code	Course Name	L	T	P	C
BT2256	CHEMICAL ENGINEERING LABORATORY FOR BIOTECHNOLOGIST	0	0	3	1

Category: Professional Core Course

a. Preamble

This course introduces the characteristics of fluid flow, principles of mechanical separations, heat and mass transfer operations in chemical and biotechnology field.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Calibrate the flow measuring devices and measure the flow rate.	K3
CO2	Investigate the pressure drop in various conduits.	K3
CO3	Analyze the operating characteristics of pumps	K3
CO4	Separate solid-liquid slurries using filtration equipment	K3
CO5	Find the heat and mass transfer terminologies using heat exchanger, distillation, extraction, adsorption and drying equipment	K3

c. Course Syllabus **Total : 45 Periods**

1. Flow measurement – Variable Head Meters (Venturimeter and Orificemeter)
2. Flow measurement – Variable Area Meter (Rotameter)
3. Pressure drop in flow through pipes
4. Pressure drop in flow through packed column
5. Pressure drop in flow through fluidized bed
6. Characteristics of centrifugal pump
7. Characteristics of reciprocating pump
8. Solid-Liquid Separation - Filtration
9. Settling and Sedimentation
10. Heat transfer characteristics in heat exchanger
11. Simple distillation
12. Liquid-Liquid extraction
13. Drying characteristics in a pan dryer
14. Adsorption - adsorption capacity and adsorption isotherms

d. Activities

Demonstration of Extraction - Flavours and perfumes extraction from given plant source.

e. Learning Resources

Text Books

1. McCabe, W.L., Smith, J.C. and Harriott, P., 2001. *Unit operations of chemical engineering*, 6th Edn, New York: McGraw-Hill.
2. Kreith, F. and Bohn, M.S., 1997. *Principles of heat transfer* 7th Edn. Cenage Learning Inc
3. Geankoplis, C.J., 2006. *Transport processes and separation process principles*, 4th Edn. Prentice Hall Professional Technical Reference

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Colorimeter	2
2.	Filter leaf	1
3.	Orifice meter	1
4.	Venturimeter	1
5.	Rotameter	1
6.	Hot air oven	1
7.	Fluidized Bed	1
8.	Packed Bed	1
9.	Plate and Frame Filter Press	1
10.	Heat Exchanger	1

Course Code	Course Name	L	T	P	C
BT2257	MICROBIOLOGY LABORATORY	0	0	3	1

Category: Professional Core Course

a. Preamble

This course introduces the basic idea about biosafety, sterilization and microscopic techniques. It also focuses on the media preparation and sterilization. It also provides platform to familiarize the cultivation, enumeration, biochemical and control of microorganisms.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Demonstrate different culture techniques	K3
CO2	Demonstrate the different types of staining for microbe identification	K3
CO3	Demonstrate different methods of enumeration of microorganisms in different samples and microbial growth	K3
CO4	Evaluate the effect of various physical factors on growth and microbial biochemical efficacy.	K3
CO5	Evaluate antibiotic sensitivity and effect of disinfectant on growth of microbes	K3

c. Course Syllabus **Total : 45 Periods**

1. Laboratory Safety, Use of Equipment; Sterilization Techniques
2. Culture Media- Preparation of Nutrient medium (broth and agar – Slant, Deep)
3. Pure Culture Techniques, Streak plate, Pour plates, spread plate, slants, stabs
4. Microscopy – Working and principles, Microscopic identification of yeast/mould
5. Staining
   - Simple staining
   - Differential - Gram’s Staining
   - Endospore staining
   - Capsular staining
   - Lacto-phenol Cotton blue staining – Fungi
6. Motility test – Hanging drop method
7. Enumeration of Microbes: Sampling and Serial Dilution; Bacterial count in Soil – TVC
8. Growth Curve (Bacteria)
9. Effect of pH, Temperature, UV radiation on Growth Bacteria

10. Antibiotic Sensitivity Assay

11. Effect of Disinfectants- Phenol Coefficient

d. Activities

Isolation of microorganisms from different environmental sources

e. Learning Resources

Text Books

1. Brown, A. and Smith, H., 2014. *Benson's Microbiological Applications, Laboratory Manual in General Microbiology*, Short Version. McGraw-Hill Education.
2. Cappuccino, J.G. and N. Sherman 2013 - *Microbiology: A Laboratory Manual*, 10th Edn, Addison-Wesley

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Autoclave	1
2.	Hot Air Oven	1
3.	Incubators	2
4.	Light Microscopes	4
5.	Incubator Shaker	1
6.	Colorimeter	2
7.	Laminar Flow Chamber	2

Course Code	Course Name	L	T	P	C
EM2252	AN INTRODUCTION TO ADVANCED READING AND WRITING	0	0	2	1

Category: Employability Enhancement Course

a. Preamble

The course will enable learners to

- To strengthen the reading skills of students of engineering.
- To enhance their writing skills with specific reference to technical writing
- To develop their critical thinking skills.
- To provide more opportunities to develop their project and proposal writing skills

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Understand how the text positions the reader	K3
CO2	Develop critical thinking while reading a text	K3
CO3	Develop a descriptive paragraph	K4
CO4	Make use of sentence structures effectively when creating an essay.	K3
CO5	Demonstrate proper usage of grammar in writing E-Mails, Job application and project proposals	K3

c. Course Syllabus **Total : 30 Periods**

EFFECTIVE READING **6**

Reading – Strategies for effective reading-Use glosses and footnotes to aid reading comprehension- Read and recognize different text types-Predicting content using photos and title. Reading-Read for details-Use of graphic organizers to review and aid comprehension

CRITICAL READING **6**

Reading– Understanding pronoun reference and use of connectors in a passage- speed reading techniques. Reading– Genre and Organization of Ideas- Reading– Critical reading and thinking- understanding how the text positions the reader.

PARAGRAPH WRITING **6**

Writing-Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence.-Write a descriptive paragraph Writing-State reasons and examples to support ideas in writing– Write a paragraph with reasons and examples- Write an opinion paragraph

ESSAY WRITING **6**

Writing– Elements of a good essay - Types of essays- descriptive-narrative- issue-based-argumentative- analytical.

EFFECTIVE WRITING **6**

Writing– Email writing- visumes – Job application- Report Writing - Project writing-Writing convincing proposals

d. Activities: Students shall be exposed to various passages for reading and trained to write in different forms.

e. Learning Resources

Text Book

1. Gramer, F, Margot and Colin, S, Ward, 2011, *Reading and Writing* (Level 3) Oxford University Press, Oxford.
2. Debra Daise, Charl Norloff, and Paul Carne, 2011, *Reading and Writing* (Level 4) Oxford University Press: Oxford

Reference Books

1. Davis, Jason & Rhonda LIss. 2006 *Effective Academic Writing (Level 3)* Oxford University Press: Oxford.
2. E. Suresh Kumar and et al. 2012, *Enriching Speaking and Writing Skills,* Second Edition,Orient Black swan: Hyderabad.
3. Withrow, Jeans and et al. 2004 *Inspired to Write. Readings and Tasks to develop writingskills*, Cambridge University Press: Cambridge.
4. Goatly, Andrew, 2000 *Critical Reading and Writing,* Routledge: United States ofAmerica.
5. Petelin, Roslyn & Marsh Durham, 2004 *The Professional Writing Guide: Knowing Welland Knowing Why,* Business & Professional Publishing: Australia.