DAYANANDA SAGAR COLLEGE OF ENGINEERING

An Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi & recognized by AICTE
NAAC Accredited with A Grade, ISO 9001:2008 Certified CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME AND SYLLABUS OF TEACHING AND EXAMINATION 2015 – 2016

B. E. BIOTECHNOLOGY

III SEMESTER

Sl. No.	Subject Code	Subject	Teaching Department	Teaching Hours/Week			Examination			Credits
				L	T	P	CIE	SEE	Total	
1	MAT 31	Engineering Maths-III	MAT	4	0	0	50	50	100	4
2	BT 32	Basic Unit Operation	CHE/BT	4	0	0	50	50	100	4
3	BT 33	Biochemistry	BT	4	0	0	50	50	100	4
4	BT 34	Microbiology	BT	3	0	0	50	50	100	3
5	BT 35	Cell Biology and Genetics	BT	3	0	0	50	50	100	3
6	BT 36	Basics of Computer Application	BT/CSE/ISE	3	0	0	50	50	100	3
7	BTL 37	Biochemistry Lab	BT	0	1	2	50	50	100	2
8	BTL 38	Microbiology Lab	BT	0	1	2	50	50	100	2
Total							400	400	800	25

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ENGINEERING MATHEMATICS-III

Course code: MAT 31 **Credits: 04**
L: P: T: S: 4:0:0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**

Course Objectives:

1. Generalize a periodic function as a sum of series of trigonometric functions using Fourier series.
2. Explain the concept of Fourier and Z transform and state the use of it in time varying signals (continuous).
3. Finding solutions of equations and also evaluating approximate areas and volume using numerical methods.

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

CO1	Understand the use of periodic signals and Fourier series to analyze circuits
CO2	Demonstrate Fourier Transform as a tool for solving Integral equations.
CO3	Use Method of Least Square for appropriate Curves
CO4	Choose appropriate Numerical methods to solve Algebraic and Transcendental equations
CO5	Demonstrate the concept of Interpolation and Numerical Integration
CO6	Apply Z Transform to solve Difference Equation

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1								
CO2	3	3	2	1								
CO3	3	3	1	1								
CO4	3	3	2	1								
CO5	3	3	2	1								
CO6	3	3	2	1								

Unit	Course Contents	Hours	CO's
1	**FOURIER SERIES:** Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period 2π and with arbitrary period $2l$, Half-range Fourier sine and cosine series, Practical Harmonic Analysis	12	CO1
2	**FOURIER TRANSFORMS:** Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse Fourier sine and cosine transforms, Convolution theorem (without proof) and problems.	10	CO2
3	**CURVE FITTING:** Curve fitting by the method of least squares, Fitting of the curves of the form $y = ax + b, y = ax^2 + bx + c, y = ae^{bx}, y = ax^b$. **Numerical Methods:** Numerical solution of algebraic and transcendental equations, Regula-Falsi method, Newton-Raphson method.	10	CO3,CO4
4	**FINITE DIFFERENCES:** Forward and Backward differences, Newton's forward and Backward interpolation formulae. Newton's divided difference formula, Lagrange's interpolation formula and inverse interpolation formula (without proofs). **Numerical Integration**: Simpsons 1/3rd, 3/8th rule, Weddle's rule (all formulae/rules without proof).	10	CO4
5	**Z-TRANSFORMS:** Z-Transforms, Standard Z-transforms, Damping rule, Shifting rule, Initial value and final value theorems (without proof), Inverse Z-transforms, Application of Z-transforms to solve difference equations.	10	CO5

Self-study component:

UNIT 1: Infinite Series-Convergence, Divergence of infinite series of positive terms (p-series Ratio test, Comparison test).
UNIT 2: Properties of Fourier transforms (without proof)
UNIT 3: Fixed point iteration method.
UNIT 4: Trapezoidal rule
UNIT 5: Region of convergence

Note: NO questions from illustrative examples and from Self Study Component.

Text Books:

1. B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013, ISBN: 9788174091956.

2. H. K. Dass, Er. Rajnish Verma, "Higher Engineering Mathematics", S. Chand Publishers, 3rd Edition, 2014, ISBN: 9788121938907.

References:

1. B.V.Ramana, "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006; ISBN: 9780070634190.

2. N.P. Bali & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition; ISBN: 9788131808320.

3. Murray Speigel, Schaum's Outline of "Advanced Mathematics for Engineers and Scientists" McGraw-Hill, 1971; ISBN: 9780070602168.

4. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House, 2002; ISBN: 8173194203.

Assessment Pattern:
CIE –Continuous Internal Evaluation Theory (50 Marks)

Bloom's Category	**Tests**	**Assignments**	**AAT1**	**AAT2**
Marks (Out of 50)	**30**	**10**	**05**	**05**
Remember	10			01
Understand	10	05	01	01
Apply	10	05	02	01
Analyze			02	02
Evaluate				
Create				

***AAT** – Alternate Assessment Tool

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Theory(50)**
Remember	10
Understand	20
Apply	5
Analyze	5
Evaluate	10
Create	

BASIC UNIT OPERATION

Course code: BT 32 **Credits: 04**
L: P: T: S: 4: 0: 0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**
Total Hours: 52

Course Objectives:

1. To understand unit operations involved in biotechnological industry. To learn about various types of fluids, their characteristics and applications,
2. To understand different types of pumps and also size reduction equipment.
3. To study particle size, shape and size distribution. Types of filtration, agitation& mixing.
4. To classify unit operations involved in biotechnological industry along with heat transfer. To apply laws governing heat transfer operations, thermal conductivity & insulation, Solve related problems.
5. To study mass transfer coefficients and fluxes apply to design distillation, extraction, drying etc.

Course Outcomes: After completion of the course, the graduates will be able to

CO1	Students will be able to design and develop the bioprocess for manufacturing of biochemical.
CO2	Apply mathematical knowledge to formulate and analyze problems related to transfer operations and solid handling problems
CO3	Students will be able to understand the basic requirement for design and fabrication of the transfer and solid handling equipment's.
CO4	Comprehend the concepts of Fluid flow, mass transfer to upstream and downstream processes.
CO5	Students will be able to analyze mass transfer and heat transfer principle in bioreactor design
CO6	Student will be able to analyze fluid dynamics and momentum transfer in reactor design

Mapping of Course outcomes to Program outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	2	1	1	1	2	1	2
CO2	3	3	3	3	3	2	1	2	1	2	1	2
CO3	3	3	3	3	3	2	1	2	1	2	1	2
CO4	3	3	3	3	2	2	1	2	1	1	1	2
CO5	3	3	3	3	3	2	1	1	1	2	2	2
CO6	3	3	3	3	3	2	2	1	1	1	1	1

Unit	Course Content	Hours	COs
1	**BASIC MOMENTUM TRANSFER:** Fluid statics: Fluid definition, classification, pressure measurement equation, Hydrostatic equilibrium, Barometric equation. Fluid kinematics-Types of fluid flow, Continuity equation, Bernoulli's equation from Euler's equation and modified Bernoulli's equation, Shear stress distribution and Velocity distribution in steady laminar flow through pipes, Flow through circular conduits - Hagen Poiseuille equation. Conceptual numerical on above topics.	**10**	**CO1**
2	**MOMENTUM TRANSFER:** **Flow past immersed body:** Flow through bed of particle (pressure drop calculation): Eargan's equation, Burke-plummer equation and Kozney-Karmen equation. Motion of spherical particle in stagnant fluid-Stroke's and newton's range. Fluidization-Introduction, minimum fluidization velocity, types of fluidization. Transporting and metering of fluids- Characteristics curve of centrifugal pumps, cavitation and NPSH, Flow equations of venture and orifice meter. Conceptual numerical on above topics.	**10**	**CO1**
3	**PARTICULATE TECHNOLOGY:** **Particle size and shape:** Particle shape and size distribution, Mean particle sizes, Differential and cumulative sieve analysis, Size distribution equations, Average particle size of mixtures and number of particle in a mixture. Standard screen series. Size reduction – mechanism and laws of size reduction, working principle of ball mill (critical speed).Mixing-Mixing index in blending granular solid, rate of mixing, Power required for agitation Filtration: Introduction, classification, Principles of cake filtration, Pressure drop through filter cake, Compressible and incompressible cake, cake resistance and medium resistance, constant rate filtration and pressure filtration equations. Sedimentation: Kynch theory, theory of Settling and Sedimentation, batch settling test. Conceptual numerical on above topics.	**12**	**CO2**
4	**HEAT TRANSFER:** **Conduction :** Fourier's law, steady state heat conduction through uni-layer and multilayer walls and short cylinders, Insulation-, Critical thickness of insulation. Convection-Forced and Natural convection equations, Individual and overall heat transfer coefficient, Fouling factor, LMTD. Boiling: Correlations in pool boiling heat transfer. Condensation-film wise and drop wise condensation Nusselt's equation (no derivation). Evaporation- Equations to find capacity and area of evaporator. Conceptual numerical on above topics.	**10**	**CO3**
5	**MASS TRANSFER:** **Diffusion mass transfer-**Introduction, Molar fluxes, Fick's law of diffusion, Steady state diffusion through a non-diffusing stagnant film, Equimolar counter diffusion, Mass transfer coefficient. Drying-Introduction, Equilibria, Drying rate curves. Mechanism of drying. Adsorption -Theories of adsorption. Isotherms. Leaching Operation-Introduction, calculation of single stage leaching. Liquid-Liquid Extraction-Ternary equilibrium, single stage extraction. Distillation-relative volatility, Prediction of VLE from vapour pressure data using Raoult's law, Rayleigh's equation.	**10**	**CO4** **CO5**

Self study component:
Note:
1. Questions for CIE and SEE not to be set from self-study component.

2. Assignment Questions should be from self-study component only.

UNIT 1: Dimensionless numbers– Reynold's number, Nusselt number, Prandtl number, Grashoff number, (definition and equation) Boundary layer theory-Introduction, Importance of boundary layer in heat and mass transfer).
UNIT 2: Types of drag, drag coefficient on spherical particle, Pumps and types of pumps
UNIT 3: Storage- Bulk and bin storage**,** Particle shape and size distribution
UNIT 4: Modes of heat transfer. Thermal insulation**,** Types of boiling, Types of evaporator
UNIT 5: Molecular and eddy diffusion, Types of distillation

TEXT BOOKS

1. Unit operations in Chemical Engineering by McCabe W.L. and Smith J.C, McGraw-Hill
2. Transport Process Principles and Unit Operations by Christie Geankoplis, Prentice Hall of India.
3. Introduction to chemical Engineering by Badger and Banchero, T M H Publication.
4. Unit Operations in Food Processing, By Earle R L, Pergamon Press.
5. Fluid Mechanics by K L Kumar, S Chand & Company Ltd.
6. Unit operation 1 and 2 by K.A.Ghavane, Nirali publications.

REFERENCE BOOKS

1. Biochemical Engineering Fundamentals by Bailey J.E. and Oillis K, McGraw Hill.
2. Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B.Anderson , John Wiley & Sons.
3. Chemical Engineering by Coulson and Richardson. Vols I & II. Elsevier Science.
4. Chemical Engineers Hand Book by Perry, McGraw Hill Publications
5. Process Heat Transfer by Kern, McGraw Hill.
6. Heat Transfer by J P Holman, McGraw Hill International Ed.
7. Mass Transfer Operations by Robert E. Treybal. McGraw-Hill Education

Assessment Pattern:

CIE –Continuous Internal Evaluation Theory (50 Marks)

Bloom's Category	**Tests**	**Assignments**	**AAT1**	**AAT2**
Marks (Out of 50)	**30**	**10**	**05**	**05**
Remember	--	--	02	01
Understand	10	--	01	01
Apply	10	05	--	01
Analyze	05	05	02	02
Evaluate	05			
Create				

***AAT 1– Alternate Assessment Tool 1: Quiz**
AAT 2 - Alternate Assessment Tool 2: Surprise Test

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Theory(50)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

BIOCHEMISTRY

Course code: BT 33 **Credits: 04**
L: P: T: S: 4: 0: 0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**
Total Hours: 52

Course Objectives:

1. To provide an introduction to the basic concepts of organic chemistry and biochemistry and the basic structures of biological compounds.
2. To establish an understanding of energy flow in living systems and various transport mechanisms of biomolecules to the living cells and signal transductions.
3. To understand the biosynthetic and biodegradative pathways of carbohydrates, lipids, amino acids and nucleotides and the cellular regulations of these pathways.
4. To learn and analyze the biodegradative pathways of carbohydrates, lipids, amino acids and nucleotides and their interconversions to each other.
5. To examine the various metabolic disorders and underlying mechanisms that causes them.

Course Outcomes: After completion of the course

CO1	Graduates use fundamentals major classes of biomolecules *ie* Nucleotides, proteins, carbohydrates and lipids for describing the properties and their cellular metabolism.
CO2	Graduates identify the consequences for a variety of inborn errors of metabolism
CO3	Graduates examine the fundamental energetics of cellular biochemical processes
CO4	Graduates assess importance of metabolism of biomolecules and apply in treatments of diseases .
CO5	Graduates connect the thermodynamic principles for biological energy conversions
CO6	Graduates plan and apply fundamentals of biochemistry to project work in all fields of Biotechnology

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2		2	2		1		2	2
CO2	3	2	2	3		2	2				1	2
CO3	2	1	3	3	2	3	3	1	2	1	1	2
CO4	2	1	3	3	2	3	3	1	2	2	2	2
CO5	1	2	2	2	2	2	3	1	2	1	2	1
CO6	2	2	1	1	1	1		2		1	2	1

Unit	Course Content	Hours	COs
1	**BASIC CONCEPTS & BIOMOLECULES** Carbohydrates, fats and lipids, structure and properties of phospholipids, glycolipids, steroids, amino acids and proteins. Saponification, Iodination, Hydrogenation, Classes of Enzymes with examples. Biologically important peptides, purines, pyrimidines.	**10**	**CO1**
2	**METABOLISM OF CARBOHYDRATES AND LIPIDS** Glycolysis –metabolism. Aerobic and anaerobic pathway and regulation, TCA cycle, NADPH Cycle, Glyoxylate cycle, Pentose Phosphate Pathway. Electron transport chain and oxidative phosphorylation, energy balance sheet, Gluconeogenesis – regulation of gluconeogenesis. Biosynthesis of polysaccharides. Biosynthesis of fatty acids, cholesterol, phospholipids, glycolipids. Biodegradation of triglycerides and fatty acids**.,** interconnection of pathways and metabolic regulation.	**12**	**CO1** **CO2**
3	**BIOENERGETICS:** Structure and properties of ATP. High energy compounds, Thermodynamic considerations, Coupling reactions of ATP and NDP (Nucleotide di phosphate); photosynthesis, light reaction, dark reaction, Photosystems PS I & II; Mitochondrial Electron transport chain and oxidative phosphorylation	**10** **10**	**CO2**
4	**TRANSPORT MECHANISM:** Passive transport and active transport, facilitated transport, energy requirement, mechanism of Na^+ / K^+, glucose and amino acid transport. Organization of transport activity in cell. Action Potentials: voltage gated and Ligand gated Ion channels, acetyl choline and signal transduction. Role of transport in signal transduction processes.	**10**	**CO3,CO4**
5	**METABOLISM OF AMINO ACIDS & NUCLEIC ACIDS:** Biosynthesis and catabolism of essential amino acids: Lysine, Phenylalaninine and Glutamine. Deamination, transamination and urea cycle. Disorders of amino acid metabolism. Metabolism and regulation of Purines, pyrimidines and precursors of nucleic acids (nucleosides & nucleotides).	**10**	**CO4** **CO5**

Self study component:
Note: 1. Questions for CIE and SEE not to be set from self-study component.
2. Assignment Questions should be from self-study component only.

UNIT 1*:* Types of chemical reactions, pH, buffers and their properties, concentration of solutions. Stereo chemistr y
UNIT 2: Disorders of carbohydrate metabolism, Disorders of Lipid metabolism y of carbon compounds
UNIT 3 Energy, energy flow cycle, energy conversion, ancillary Pigments

UNIT 4: Biological membranes: structure, permeability, properties, chloride-bicarbonate exchanger of erythrocyte
UNIT 5: Disorders of nucleic acid metabolism, Case study on overproduction of glutamic acid.)

TEXT BOOKS

1. Principles of Biochemistry by Albert Lehninger, CBS publishers.
2. Biochemistry by Nelson and Cox, Palgrave Macmilan, Freeman Edn.
3. Principles of Biochemistry by Lubert Stryer, Freeman Int. Edition.
4. Biochemistry by U Sathyanarayana, Books & Allied Publishers.

REFERENCE BOOKS

1. Biochemistry by Voet&Voet, Wiley New York.
2. Biochemistry by Trehan. K, New Age International.
3. Biochemistry & Molecular Biology by Elliot, William H., Oxford University Press.
4. Biochemistry of cell signaling by Helmreich, Oxford University Press.

Assessment Pattern:
CIE –Continuous Internal Evaluation Theory (50 Marks)

Bloom's Category	**Tests**	**Assignments**	**AAT1**	**AAT2**
Marks (Out of 50)	**30**	**10**	**05**	**05**
Remember	--	--	02	01
Understand	10	--	01	01
Apply	10	05	--	01
Analyze	05	05	02	02
Evaluate	05			
Create				

***AAT 1– Alternate Assessment Tool 1: Quiz**
AAT 2 - Alternate Assessment Tool 2: Surprise Test

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Theory(50)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

MICROBIOLOGY

Course Code : BT 34 **Credits : 03**
L:P:T:S : 3:0:0:0 **CIE Marks : 50**
Exam Hours : 03 **SEE Marks: 50**

Course Objective:

1. To understand the fundamentals of microbiology and various kinds of microorganisms.
2. To study the basic principles and techniques involved in microscopy, sterilization and microbial cultivation.
3. To study the scope of microbial physiology, metabolism and genetics.
4. To study the medical microbiological concepts of bacteria, virus, protozoa and fungi.
5. To study the fundamental applications of microorganisms in agricultural, environmental and industrial fields.

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

CO1	Graduates will be able to compare the salient features, classification and reproduction of micro-organisms and microbial taxonomy
CO2	Graduates will be adapt the theoretical principles behind various techniques in microbiology
CO3	Graduates will be build knowledge on growth kinetics and metabolic pathways of micro-organisms
CO4	Graduates will be able to assess the various diseases of micro-organisms and their management
CO5	Graduates will be compile the importance of soil, agriculture and air microbiology
CO6	Graduates will be remember the role of microbes in environment and their possible mechanism

Mapping of Course Outcomes to Program Outcomes:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	1	2	2	2	2	3	3	1	2	-	2	2
CO2	2	2	2	2	2	3	3	1	1	-	2	2
CO3	2	2	2	2	2	2	2	2	2	-	2	2
CO4	2	2	2	2	2	3	3	2	2	1	2	2
CO5	2	2	2	2	2	3	3	2	2	-	2	2
CO6	2	2	2	2	2	2	3	2	2	-	2	2

Unit	Course Content	Hours	COs
1	**INTRODUCTION TO MICROBILOGY AND STUDY OF MICROORGANISMS:** Microbial Diversity and Taxonomy, Numerical taxonomy, Study of microorganism-Structure, classification and reproduction of bacteria, Fungi, Protozoa and Algae. Viruses, General features of Prions, Actinomycetes.	8	CO1, CO2,
2	**METHODS AND TECHNIQUES IN MICROBIOLOGY:** Microscopy: Concepts, Bright field, Dark Field, Phase Contrast, Fluorescence and Electron Microscopy, Micrometry. Pure culture techniques, Media preparation, Types of culture media, Culture methods, staining techniques. Sterilization &disinfection-Physical methods, chemical, methods, sterilization control .	8	CO1, CO2
3	**MICROBIAL PHYSIOLOGY, METABOLISM AND GENETICS:** Microbial growth kinetics, Sporulation and germination, metabolic pathways (Respiration and Fermentation) important in Microorganisms, Genetic recombination of bacteria-Transformation, conjugation and transduction.	8	CO3
4	**MEDICAL MICROBIOLOGY:** Common diseases caused by microbes-Bacterial diseases: Typhoid, Diphtheria, Cholera, Tuberculosis, Leprosy, Plague, Syphilis, Gonorrhea; Viral diseases: Herpes, Hepatitis, AIDS, SARS, H1N1, Dengue, Ebola, Zika and MERS. Protozoan diseases: Malaria.	8	CO4, CO5
5	**SOIL, ENVIRONMENTAL AND INDUSTRIAL MICROBIOLOGY:** Soil andAgricultural Microbiology: Biofertilizers: Mycorrhizae and Rhizobium, Trichoderma Air Microbiology: Air sampling principles and devices, significance of aerobiological studies. Aquatic Microbiology: Microbiology of potable water, wastewater treatment, Microbes in Bioremediation.	8	CO5, CO6

Self-study component

UNIT-1: History and scope of microbiology, Prokaryotes and Eukaryotes
UNIT-2: Nutritional requirement of bacteria, Primary and secondary metabolites with examples.
UNIT-3: Introduction to Medical Microbiology, Common types of fungal infections.
UNIT-4: Soil micro flora and biogeochemical cycles, Major types of microorganism in air, Marine micro flora, Fresh water microflora.
UNIT-5: Soil micro flora and biogeochemical cycles, Major types of microorganism in air, Marine micro flora, Fresh water microflora

TEXT BOOKS

1. General Microbiology by Roger Y Stanier, John L Ingraham, and Mark L Wheels, Macmillan Press Ltd.

2. Microbiology by Michael J Pelczar Jr Chan ECS, Noel R Krieg, Tata McGraw Hill Publishing co ltd.
3. Prescott, Harley, and Klein's Microbiology 8th edition. Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton. McGraw-Hill Higher Education.
4. Principles of Microbiology: Ronald M Atlas, 1995.McGraw-Hill Inc., US.

REFERENCE BOOKS

1. Alcamos Fundamentals of Microbiology, Jeffery C Pommerville, Jones and Bartlett Publishers.
2. Microbiology, An Introduction, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 2012. Pearson.
3. Microbiology: Principles and Explorations, Jacquelyn G. Black, 8th Edition, John Wiley & Sons,2012.
4. Microbial Physiology II Ed., Moat, A.G. and Foster, J.W, Wiley-Liss, New York.

Assessment pattern
CIE – Continuous Internal Evaluation (50 Marks)

Bloom's Category	Tests	Assignments	AAT1 (Quiz)	AAT2 (Seminar/ Surprise Test)
Marks(50)	30	10	05	05
Remember	10		02	01
Understand	10	05	01	02
Apply	10	05	02	02
Analyze				
Evaluate				
Create				

*AAT- Alternate Assessment Tool

SEE –Semester End Examination (50 Marks)

Bloom's Category	Marks
Remember	20
Understand	20
Apply	10
Analyze	
Evaluate	
Create	

CELL BIOLOGY & GENETICS

Course code: BT 35 **Credits: 03**
L: P: T: S: 3: 0: 0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**
Total Hours: 40

Course Objectives

1. To make students understand the basics of Cell structure and functions including cell division.
2. To make students appreciate the importance of cytoskeleton, receptors and cell signaling.
3. To provide students the *knowledge and understanding of the basics of genetics.*
4. To enlighten students on chromosomes structure and organization & population genetics.
5. To afford students with the knowledge on sex chromosomes, inherited diseases, linkage and crossing over.

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

CO1	Graduates would be able to illustrate their basic knowledge in the field of cell biology and genetics and comprehend the associated biological processes.
CO2	The knowledge acquired gives Graduates the foundation to experiment with complex biological systems and enable them to have a perspective of genetic material and the abnormalities associated with it.
CO3	This course equips Graduates to distinguish structural and functional details of cell and the genetic material.
CO4	Graduates would acquire ability to explain in clear and well argued descriptions on these topics on cell biology and genetics.
CO5	Graduates will be able to elaborate on the nature, practice and applications of the subject.
CO6	Graduates will gain and apply knowledge that will ready themselves for engaging in lifelong learning

Mapping of Course Outcomes to Program Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	1	2	3	3	1	3	2	2	1	3
CO2	3	3	3	3	3	3	1	3	2	2	1	3
CO3	3	3	3	3	3	2	1	3	2	2	1	3
CO4	3	3	3	3	3	1	1	3	2	2	1	3
CO5	3	3	3	2	3	3	1	3	3	2	1	3
CO6	2	2	2	1	2	1	-	2	2	1	1	3

Unit	Course Content	Hours	COs
1	**CELL STRUCTURE AND FUNCTION** Eukaryotic and prokaryotic cells, Eukaryotic and prokaryotic cells, Plant and animal cells, models of plasma membrane with special reference to Singer and Nicolson model, Structure of cell organelles(cytoplasm, Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes. Endoplasmic Reticulum, Peroxisomes, Chloroplast and Vacuoles) Extra cellular matrix. Cell to cell integration, Cell division-Mitosis and Meiosis.	**08**	**CO1 CO3**
2	**CYTOSKELETON, RECEPTORS AND CELL SIGNALING** Microtubules: structure & functions, Microfilaments: structure & functions. Structure of intermediate filaments. Cytoplasmic microtrabecular system (lattice). Structure, Mechanism, Action of receptors (cytosolic, Nuclear, Membrane bound receptors), cell signalling (Autocrine, Paracrine, Endocrine models), endocytosis and exocytosis	**08**	**CO3**
3	**INTRODUCTION TO GENETICS** Structure of DNA and RNA, Classical experiments that led to Identification of genetic material (Griffith, Hershey & Chase, Avery and McLeod) Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower colour in sweet peas, Epistasis.	**08**	**CO3 CO4**
4	**CHROMOSOMES STRUCTURE AND TYPES & POPULATION GENETICS** Chromosome, Centrosome, telomere, Chemical composition of chromatin, structural organization of nucleosomes, heterochromatin. Polytene and lamp-brush chromosomes, human chromosomes, morphology, classification, karyotyping. Introduction to population genetics, Hardy –Weinberg equilibrium, Gene frequency, Mutation (Spontaneous and induced), Eugenics.	**08**	**CO3 CO5**
5	**SEX CHROMOSOMES, INHERITED DISEASES, LINKAGE AND CROSSING OVER:** Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance of molecular diseases, hemoglobinopathies, Colour blindness, haemophilia. Linkage: Sutton's view on linkage, Morgan's view on linkage, Bateson & Punnet's Coupling & Repulsion hypothesis. Chromosome theory of Linkage, kinds of linkage, linkage groups, types of Crossing over.	**08**	**CO2 CO5**

Self study component:

Note:

1. Questions for CIE and SEE not to be set from self-study component.

2. Assignment Questions should be from self-study component only.

UNIT 1: Interactions of cells with extra cellular materials; Types of cell functions
UNIT 2: Cell locomotion -Ameoboid, Flagella, Cilia
UNIT 3: Multiple alleles and groups antigens; Non-Mendelian extranuclear inheritance; maternal inheritance
UNIT 4: Changes in gene frequency, equilibrium estimation inbreeding and heterosis, genetic structure of population, speciation and evolution
UNIT 5: Mechanism of Meiotic Crossing over; kinds of Crossing over; cytological detection of Crossing over; significance of Crossing over; chromosomal maps; interference and coincidence

TEXT BOOKS

1. Cell Biology by Kimbal, Willey Pub.1978, 2nd edition. ISBN 13- 9780201036282.
2. Cell Biology by S C Rastogi, New Age International Pub,2005; ISBN- 8122416888, 9788122416886.
3. Genetics by Monroe W Strickberger, 3rd edition,Macmillan Pub. Newyork. ISBN-0029467403, 9780029467404.
4. Principles of Genetics by Gardener, Simmons and Slustad.8th edition. Wiley Pub. ISBN-9788126510436.
5. Molecular Biology of cell. Bruce Alberts.4th edition.cbs publishers and distributors.ISBN-10: 0815340729.

REFERENCE BOOKS

1. Essential cell biology,4th edition, 2013,Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. ISBN-9780815344544.ASM press.
2. Molecular Aspects of Cell Biology,Garrett; Grisham, Harcourt College Publishers, Orlando, FL, 1994,ISBN 10: 0030075971 / ISBN 13: 9780030075971
3. Cellular & Biochemical Science , G. Tripathi,2010, *I K International* Publishing House Pvt. Ltd. *ISBN*-10: 818823785X; *ISBN*-13: 978-8188237852
4. Genes and Genomes-a changing perspective, M Singer, and P Berg, University science Books,1991.ISBN-0935702172,9780935702170.
5. Molecular Cell Biology 3rd Edition, 1995, Harvey Lodish , David Baltimore , Arnold Berk. W H Freeman & Co (Sd). ISBN-10: 0716723808;ISBN-13**:** 978-0716723806

Assessment Pattern:

CIE –Continuous Internal Evaluation Theory (50 Marks)

Bloom's Category	**Tests**	**Assignments**	**AAT1**	**AAT2**
Marks (Out of 50)	**30**	**10**	**05**	**05**
Remember	--	--	02	01
Understand	10		01	01
Apply	10	05	--	01
Analyze	05	05	02	02
Evaluate	05			
Create				

***AAT 1– Alternate Assessment Tool 1: Quiz**
AAT 2 - Alternate Assessment Tool 2: Surprise Test

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Theory(50)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

BASICS OF COMPUTER APPLICATIONS

Course Code : BT 36 **Credits : 03**
L:P:T:S : 3:0:0:0 **CIE Marks : 50**
Exam Hours : 03 **SEE Marks: 50**
Total Hours: 40

Course Objective:

1. To make students learn fundamental concepts about programming and database management concepts.
2. To equip students with basic concepts of Ontologies and Matlab.
3. To make students learn the basics concepts of different data structures.
4. To make students learn the programming applications of C and C++.
5. To equip students with fundamental concepts of PERL and BIOPERL.

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

CO1	Graduates will be able to apply their knowledge of data structures in C and C++ programs
CO2	Graduates will be able to design programs involving decision structures, loops and functions
CO3	Graduates will be able to implement PERL and BIOPERL in programming related to biological applications
CO4	Graduates will be able to apply and execute ontology and MATLAB aspects in managing and structured representation of data
CO5	Graduates will be able to implement SQL and HTML for database development
CO6	Graduates will be able to utilize various programming applications for multidisciplinary domains

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	-	-	1	3	3	1	2
CO2	3	3	3	2	3	-	-	1	3	3	1	1
CO3	3	3	3	3	3	2	-	1	3	3	2	1
CO4	3	3	3	3	3	2	-	1	3	3	1	1
CO5	3	3	3	3	3	2	-	1	3	3	1	1
CO6	3	3	3	3	3	3	-	2	3	3	1	2

Unit	Course Content	Hours	COs
1	**INTERNET AND DATABASE MANAGEMENT:** Internet Addresses, Internet Protocol, Transport layer, Upper layer protocols, Web based applications, Biology search engines, legal and ethical issues. DBMS and RDBMS, E-R relationship, Introduction to SQL, basic commands, using SQL in MS Access, creating and modifying tables, joining tables, simple queries using SQL, inner join, outer joins.	8	CO2, CO5, CO6
2	**ONTOLOGIES AND MATLAB:** Overview of ontologies, gene ontologies, Open biological ontologies (OBO) and its applications, TAMBIS ontology, cell cycle ontology, GeneX ontology. Building ontology, ontology development tools (protégé 2000, GKB editor, OilEd). Introduction to MATLAB, features of MATLAB toolbox, Usage of MATLAB towards biostatistical and biochemical applications. Modeling of biochemical and biotechnological systems using MATLAB scientific computing environment**.**	8	CO4, CO6
3	**DATA STRUCTURES AND C++ CONCEPTS:** Basic data types, Stacks: Stack specifications, Pushing, Popping, and Other Methods. Queues: Definitions, Queue Operations. Linked lists: Basic concepts, Single liked list and Circular Linked Lists. Introduction to Classes, Objects, C++ string classes, Introduction to OOPs concepts with respect to C++ (Encapsulation, polymorphism, Inheritance).	8	CO1, CO2, CO6
4	**APPLICATIONS OF C AND C++ IN BIOTECHNOLOGY:** Writing a C program using numerical analysis technique towards solving the differential equations to biotechnology (holding time for sterilization, estimating the length of the lag phase, calculation of specific growth rate, doubling time, and substrate-to-cell yield coefficient, etc). Write a C++ Program to find the optimum pH and temperature for maximum enzyme activity, to derive the column height needed to achieve the specified degree of conversion in a fluidized-bed biofilm reactor.	8	CO1, CO2, CO6
5	**PERL:** Introduction to Perl, writing and executing a Perl program. Data Types – Scalar, Arrays and Associative arrays. Operators, Variables and Special variables. Regular expressions, Subroutines. Introduction to BioPerl, BioPerl Modules, Applications of BioPerl.	8	CO2, CO3, CO6

Self-study component

UNIT-1: Derivations Overview of HTML and HTTP, Introduction to flat files.
UNIT-3: Overview of C programming concepts, Variables, Operators, Statements, Functions and Pointers.

Text Books:

1. Internet: The complete reference by Margaret Levine Young, Tata McGraw Hill.
2. Principles Of Data Structures Using C And C++ by Vinu V. Das, New Age International, 2006
3. D. Curtis Jamison. Perl Programming for Biologists by, Wiley-IEEE, 2003.

Reference Books:

1. SQL Simplified: Learn to read and write SQL by Cecelia. L. Allison, Jones and Bartlett.
2. SQL queries for mere mortals: A hands-on guide to data manipulation in SQL by Michael J. Hernandez and John. L. Viescas, Addison Wesley.
3. Curtis Jamison D. Perl Programming for Biologists, John Wiley & Sons, 2003

Assessment pattern
CIE – Continuous Internal Evaluation (50 Marks)

Bloom's Category	Tests	Assignments	AAT1 (Quiz)	AAT2 (Seminar/ Surprise Test)
Marks(50)	30	10	05	05
Remember	10		02	01
Understand	10	05	01	02
Apply	10	05	02	02
Analyze				
Evaluate				
Create				

*AAT- Alternate Assessment Tool

SEE –Semester End Examination (50 Marks)

Bloom's Category	Marks
Remember	20
Understand	20
Apply	10
Analyze	
Evaluate	
Create	

BIOCHEMISTRY LAB

Sub Code: BTL 37 **CIE: 50**
Hrs/ Week: 03 **SEE: 50**
Exam Hours: 03

COURSE OBJECTIVES

1. To learn fundamental approaches for solving biochemical problems.
2. To have the basic understanding of qualitative and quantitative estimations.
3. To learn to apply the biochemical methods to realistic situations.
4. To extract and analyze bioactive compounds from plant sources.
5. To equip students with basic methods of laboratory analysis and interpretation of results.

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

CO1	Graduates apply knowledge to test many of the chemical reactions and structures of biological molecules essential to life .
CO2	Graduates connect the biochemical estimations to quantify a biomolecule of clinical importance.
CO3	Graduates use calculations for solution preparations, estimations and data analysis of biomolecules.
CO4	Graduates focus to plan experiments, validate assays, write protocols, and interpret results.
CO5	Graduates display technical experience in handling equipments.
CO6	Graduates appraise the basic concepts biochemistry experiments in metabolic engg and genetic engineering

Mapping of Course Outcomes to Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	2	2	2						
CO2	3	3	2	2	1	3						
CO3	2	2	2	2	2	2	2	2	2	2	2	2
CO4	1	2	3	2	2	2	2	2	2	2	2	2
CO5	1	1	3	2	3	2	2	2	2	2	3	3
CO6	1	1	1	2	1			1	1	1	2	2

Sl. No	List of Experiments	Hours	COs
1	Qualitative tests for carbohydrate and lipids	**3**	**CO1**
2	Qualitative tests for amino acids and proteins	**3**	**CO2**
3	Estimation of blood sugar by Folin method	**3**	**CO1**
4	Estimation of inorganic phosphate by Fiske-Subbarao method.	**3**	**CO1**
5	Estimation of amino acid by ninhydrin method.	**3**	**CO1**
6	Estimation of total cholesterol from Serum	**3**	**CO3**
7	Determination of Saponification and Acid Value value of lipids.	**3**	**CO2**
8	Determination of Iodine value of lipid	**3**	**CO2**
9	Estimation of urea by diacetylmonooxime method	**3**	**CO1 CO5**
10	Estimation of iron from hemoglobin	**3**	**CO2 CO5**

Text Books

1. An introduction to practical biochemistry by Plummer, Tata McGraw Hill.
2. Modern Experimental Biochemistry by Rodney Boyer, Pearson Education.
3. Practical Biochemistry by Cole, Cambridge University Press.
4. Practical Biochemistry by Keith Wilson, Cambridge University Press.

Reference Books

1. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K.Intl.
2. Lab Math by Dany Spencer Adams, IK Intl. Pub. House.
3. Laboratory Manual for Practical **B**iochemistry Shivaraja Shankara YM, Shankara, Ganesh MK.
4. Lab Ref by Jaine Roskams& Linda Rodgers, IK Intl. Pub. House.

MICROBIOLOGY LABORATORY

Course code: BTL 38 **Credits: 04**
L: P: T: S: 4: 4: 0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**

Course objectives:

1. To learn various aseptic techniques required for routine microbiology exercises.
2. To get technical exposure to the procedures required for the cultivation of bacteria and fungi.
3. To acquire technical skills for the morphological, physiological and biochemical characterization of bacteria and fungi.
4. To learn basic microbiological techniques employed in medical microbiology.
5. To acquire the skills required for performing various exercises in food microbiology.

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

CO1	Graduates apply standard microbiological principles in safe handling of laboratory equipments for various exercises.
CO2	Graduates dissect the aseptic techniques required to perform various microbiology protocols.
CO3	Graduates develop technical skills in isolation, identification and characterisation of microorganisms from various sources.
CO4	Graduates design novel microbiological intervention to address societal and environmental concerns.
CO5	Graduate examine the scope of novel microbiology protocols in pharma, food and bioenergy by teamwork and professionalism.
CO6	Graduate develops novel microbiological protocols to address the recent issues associated with mankind by undertaking minor projects as individual or team, communicate their finding and engage them for lifelong learning.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	1	1	3	2	1	-	1
CO2	3	2	3	3	3	2	2	3	2	1	-	1
CO3	3	2	3	3	2	2	2	3	2	1	-	1
CO4	3	3	3	3	3	3	3	3	2	1	1	1
CO5	3	3	3	3	3	3	2	3	3	2	1	1
CO6	3	3	3	3	3	3	3	3	3	3	1	3

Sl.No	List of Experiments Content of Course	Hours	COs
1	Instrumentation-Microscopy, Autoclave, Hot air over, Bacteriological Incubator, Laminar Airflow and other instruments used in Microbiology labs.	**3**	**CO1, CO2, CO4**
2	Culture media preparation: Preparation of agar plates, agar slants and agar deeps	**3**	**CO1, CO2, CO6**
3	Isolation of bacteria (streak plate, pour plate and spread plate techniques) and fungi	**3**	**CO1, CO2, CO3**
4	Enumeration of viable count (serial dilution techniques) and total count (haemocytometer).	**3**	**CO1, CO2, CO4**
5	Determination of size of cell or spore by micrometry	**3**	**CO1, CO2**
6	Staining- Simple staining-Negative staining; Differential staining-Gram staining, Capsule staining, endospore and flagella staining	**3**	**CO1, CO2, CO3**
7	Staining of Fungi by LPCB method	**3**	**CO1, CO2, CO5**
8	Determination of bacterial motility by hanging drop techniques	**3**	**CO1, CO2, CO3**
9	Characterization of bacteria by Biochemical tests: IMViC, Catalase, Oxidase, Urease, hydrogen sulphide, carbohydrate fermentation, Nitrate reduction, Starch hydrolysis	**3**	**CO1, CO2, CO3**
10	Determination of quality of milk by MBRT and Resazurine tests	**3**	**CO1, CO2, CO4, CO5, CO6**
11	Study of bacterial growth curves	**3**	**CO1, CO2**
12	Antibiotic sensitivity tests by disc diffusion test	**3**	**CO1, CO2, CO4, CO6**

TEXT BOOKS

1. James Cappuccino & Natalie Sherman, Microbiology: A Laboratory Manual, Benjamin Cummings

2. Aneja, K.R. Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International
3. Principles of Microbiology, Ronald M Atlas, McGraw-Hill Higher Education
4. Microbiology-Ananthanaryan & Jayaram Panicker, Orient Blackswan.

REFERENCE BOOKS

1. Microbiology by Pelczar, Chan and Krig, W.C Brown Pub.
2. General Microbiology by Stainer Ingraham and Wheeler, Mac Milan Pub.
3. A text book of Microbiology by P.Chakraborthy, New Central Book Agency.
4. Fundamentals of Microbiology and Immunology by Ajit Kumar Banerjee. CABI Publishing.

Assessment Pattern:
CIE –Continuous Internal Evaluation Theory (50 Marks) CIE –Continuous Internal Evaluation Lab (50 Marks)

Bloom's Category	**Performance (Day To Day)**			**Internal Test**
Marks (Out of 50)	**25**			**25**
	Performance	**Record**	**Viva**	
Remember	10	10	05	5
Understand				5
Apply				5
Analyze				7
Evaluate				3
Create				

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Practicals(50)**
Remember	12
Understand	10
Apply	13
Analyze	07
Evaluate	08
Create	

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SCHEME AND SYLLABUS OF TEACHING AND EXAMINATION 2015 – 2016

B E. BIOTECHNOLOGY

IV SEMESTER

Sl. No.	Subject Code	Subject	Teaching Department	Teaching Hours/Week			Examination			Credits
				L	T	P	CIE	SEE	Total	
1	BT 41	Bioprocess Principles and Calculations	CHE/BT	4	0	0	50	50	100	4
2	BT 42	Structural Biology	BT	4	0	0	50	50	100	4
3	BT 43	Applied Unit Operation	BT	4	0	0	50	50	100	4
4	BT 44	Biostatistics and Biomodelling	MAT/BT	3	0	0	50	50	100	3
5	BT 45	Biochemical Thermodynamics	BT	3	0	0	50	50	100	3
6	BT 46	Molecular Biology	BT	3	0	0	50	50	100	3
7	BTL 47	Cell and Molecular Biology Lab	BT	0	1	2	50	50	100	2
8	BTL 48	Momentum Transfer and Mechanical Operations Lab	CHE/BT	0	1	2	50	50	100	2
Total							400	400	800	25

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SCHEME AND SYLLABUS OF TEACHING AND EXAMINATION 2015 – 2016

BIOPROCESS PRINCIPLES AND CALCULATIONS

Course code: BT 41 **Credits: 04**
L: P: T: S: 4:0:0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**
Total Hours: 52

COURSE OBJECTIVES:

1. To introduce the basic principles & calculation techniques in stoichiometry.
2. To introduce students with material balances calculations without reactions in industrial unit operations. To review principles in thermochemistry.
3. To introduce students with principles of material balances calculations with chemical and biochemical reactions in industrial operations.
4. To introduce to basic thermodynamics and basic energy balance calculations.
5. To make student aware of concepts of conversion, yield & selectivity and biological calculations.

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

CO1	Analyze the basic concepts of process calculations in biochemical engineering applications.
CO2	Formulate and solve the material balances on steady state unit operations involving with & without reaction Students will be able to formulate and solve the energy balances of chemical reactions.
CO3	Students will be able design and solve the stoichiometric equations for microbial growth & product formation.
CO4	Students will have knowledge to access of basic calculations for biological systems & access the property data from appropriate sources.
CO5	Student will be able to analyze thermodynamic principles in biochemical reactions.
CO6	Students will be able to formulate energy and mass balance in plant design.

Mapping of Course outcomes to Program outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	2	2	1	2	--	2	1
CO2	3	3	2	2	1	1	1	--	1	--	1	1
CO3	2	3	3	3	2	1	1	--	2	2	2	2
CO4	3	3	3	2	1	2	1	--	1	1	2	2
CO5	3	3	3	2	1	2	2	--	1	--	2	2
CO6	3	3	3	2	3	2	2					

Unit	Course Contents	Hours	COs
1	**BASIC CHEMICAL CALCULATIONS AND MATERIAL BALANCE** Expressing composition of mixtures and solutions - Percentage by weight percentage, mole percentage and Volume percentage; Normality, Morality, Molality.	12	CO1
2	**MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS AND FUELS** Material balances calculation in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing and Evaporation Operations, numerical**.** characteristics of fuels, Ultimate and proximate analyses of fuels	10	CO2
3	**MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS** Material balances calculation involving bypass and recycle operations. Generalized material balance equations, Principles of stoichiometry, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, Selectivity, problems relating to these unit processes.	12	CO2 CO3
4	**ENERGY BALANCE** General energy balance equation for steady state. Heat capacity, estimation of heat capacity. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion, Calculation of heat of reaction at elevated temperature.	10	CO5 CO6
5	**BIOPROCESS PRINCIPLES AND STOICHIOMETRY OF BIOPROCESS** General material balance equation for manufacture of penicillin and ethanol - outline of and bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses. Stoichiometry of microbial growth and product formation, yield coefficients calculation.	8	CO3 CO4

Self study component:

UNIT-1: Generalized material balance equations for distillation, absorption, extraction, crystallization, mixing, drying and evaporation.
UNIT-2: Fuels – types of fuels, (solid, liquid and gaseous fuel), relevance to biofuels,)
UNIT-3: unit process – neutralization, oxidation, nitration, hydrolysis)
UNIT-4: Laws of thermodynamics and calorific value)
UNIT-5: Historical development of bioprocess technology;Bioprocess principles and operations).

TEXT BOOKS:

1. Principles of Biochemistry by David L. Nelson (Editors), W.H. freeman and company.
2. Bioprocess Engineering Principles by Pauline Doran, Academic Press.

3. Biochemical Engg. Fundamentals by J E Bailey & D. F. Ollis, McGraw Hill.
4. Biochemical Calculations by I.H.Segel, John Wiley & Sons.
5. Stoichiometry by K AGhavane, Nirali publications.

REFERENCE BOOKS:

1. Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI
2. Bioprocess Engineering by Shule and Kargi, Prentice Hall.

Assessment Pattern:
CIE –Continuous Internal Evaluation Theory (50 Marks)

Bloom's Category	**Tests**	**Assignments**	**AAT1**	**AAT2**
Marks (Out of 50)	**30**	**10**	**05**	**05**
Remember	10			01
Understand	10	05	01	01
Apply	10	05	02	01
Analyze			02	
Evaluate				
Create				02

***AAT** – Alternate Assessment Tool

CIE –Continuous Internal Evaluation Lab (50 Marks)

Bloom's Category	**Performance (Day To Day)**	**Internal Test**
Marks (Out of 50)	**25**	**25**
Remember	05	05
Understand	05	10
Apply	05	05
Analyze	05	05
Evaluate	05	
Create		

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Theory(50)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

STRUCTURAL BIOLOGY

Course code: BT 42 **Credits: 04**
L: P: T: S: 4: 0: 0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**
Total Hours: 52

Course Objectives:

1. To study the fundamentals of biomolecules and structural and functional aspects of proteins.
2. To study the structural and functional perspectives of nucleic acids and biomembranes.
3. To study various biophysical techniques involved in the structural elucidation of biomolecules.
4. To study various spectroscopic techniques involved in the structural elucidation of biomolecules.
5. The study the scope of biomolecular interactions and molecular dynamics in functional analysis of macromolecules.

Course Outcomes: After completion of the course, the graduates will be able to

CO1	Apply the concept of structural organizations of biomolecules for demonstrating functional aspects.
CO2	Apply the theoretical perspectives involved in various biophysical techniques used for the structural elucidation of macromolecules.
CO3	Inspect the utility of various spectroscopic techniques for the structural and functional elucidation of biomolecules.
CO4	Evaluate the scope of various macromolecular interaction studies in the metabolic network analysis.
CO5	Create novel computational models for the better understanding of life processes by molecular dynamics, mechanics, and other simulation approaches.
CO6	Plan and execute the structural biology and biophysical techniques for solving complex problems in atomic level and encourage them to perform various experimentation and minor projects.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	2	2	1	-	1
CO2	3	2	3	2	1	-	-	2	2	1	-	1
CO3	3	2	3	2	1	-	-	2	2	1	-	1
CO4	3	2	2	3	-	-	-	2	2	1	-	1
CO5	3	3	3	2	2	-	-	2	2	1	-	1
CO6	3	3	3	3	2	2	-	2	2	2	1	1

Unit	Course Content	Hours	COs
1	**INTRODUCTION & PROTEIN STRUCTURE** Structural organization of proteins- Primary structures of proteins, peptide bond-features, phi, psi, omega angles, Ramachandran or steric contour diagram, Secondary structures of proteins- alpha helices, beta sheets, super secondary structures, Tertiary structure of proteins- Forces stabilizes, Fibrous and globular proteins, Quaternary structures - Dimers, trimers, tetramers, Structural families and domains. Protein folding- General features and thermodynamic aspects, folding kinetics.	11	CO1
2	**STRUCTURE OF NUCLEIC ACIDS AND BIOMEMBRANE** General characteristics of nucleic acid structures (A, T, G, C, U), Forces and stabilizing geometries, Base pairing types, Base stacking, Ribose puckering. Stabilizing ordered forms of DNA (A, B and Z), Tertiary structure of DNA (Supercoiled DNA) and RNA (tRNA). Thermodynamic aspects of DNA melting, Hyperchromicity.	11	CO1
3	**BIOPHYSICAL TECHNIQUES** Rayleigh scattering, Ultra centrifugation, Electron microscopy (SEM-TEM), Atomic Force Microscopy, Cryoelectron Miroscopy, Luminescence (fluorescence & phosphorescence), Viscometry. Calorimetry-DSC, Mass spectrometry-LC-MS, MALDI-TOF, Voltage Clamp and Patch Clamp.	10	CO2
4	**SPECTROSCOPIC TECHNIQUES** X-ray diffraction: Structure détermination via single Crystal diffraction, Fibre diffraction; Neutron diffraction. XAFS. NMR spectroscopy, ORD/CD, UV, IR, Fluorescence Spectroscopy, Laser Raman, ESR/EPR.	10	CO3
5	**BIOMOLECULAR INTERACTIONS & MOLECULAR DYNAMICS** Protein-protein interactions, Protein-nucleic acid interactions, Protein–lipid interaction. Introduction to molecular mechanics and dynamics, Newtonian mechanics and Monte Carlo Simulations, Force field, Eenergy calculations	10	CO4 CO5

Self study component:
Note:
1. Questions for CIE and SEE not to be set from self-study component.

2. Assignment Questions should be from self-study component only.

UNIT 1: Introduction to structural biology, scope and application. Brief discussions on biomolecules- Amino acids, Nucleic acids, Adenylates, Carbohydrates, Lipids, Cofactors, Vitamins and Hormones
UNIT 2: Historical perspectives of nucleic acid structure elucidation, Structure of biomembrane, molecular reception and signal transduction.
UNIT 5: Association of macromolecules, Molecular conjugates, supramolecular interactions, Results of molecular dynamics calculations and their implications to biological function.

TEXT BOOKS

1. Biochemical techniques by Wilson and Walker, Cambridge University Press.
2. Biochemistry, L. Stryer, W.H. Freeman, San Francisco.
3. Lehninger, Nelson and Cox, Principles of Biochemistry, 4th Edition, W. H. Freeman & Company, 2006.
4. Voet & Voet, Fundamentals of Biochemistry, 4th Edition, Wiley, 2012.

REFERENCE BOOKS

1. Biophysical Chemistry by Cantor R. and Schimmel P.R, W. H. Freeman.
2. Biophysics – An Introduction by Cotterill, Wiley Student Edition.
3. Introduction to Protein Structure by Carl Branden and John Tooze, Garland Publishing.
4. Principles of protein structure by G Schulz and R H Schrimer, Springer Verlag.

Assessment Pattern:
CIE –Continuous Internal Evaluation Theory (50 Marks)

Bloom's Category	**Tests**	**Assignments**	**AAT1**	**AAT2**
Marks (Out of 50)	**30**	**10**	**05**	**05**
Remember	--	--	02	01
Understand	10	--	01	01
Apply	10	05	--	01
Analyze	05	05	02	02
Evaluate	05			
Create				

***AAT 1– Alternate Assessment Tool 1: Quiz**
AAT 2 - Alternate Assessment Tool 2: Surprise Test

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Theory(50)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

APPLIED UNIT OPERATION

Course code: BT 43 **Credits: 04**
L: P: T: S: 4: 0: 0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**
Total Hours: 52

Course Objectives:

1. To understand unit operations involved in biotechnological industry. To learn about various types design considerations in momentum transfer operations, particulate technology.
2. Students will study Heat transfer operations, they will know about preliminary design considerations of heat exchanger, condenser and evaporator.
3. To understand mass transfer operations, students will study the design aspects of drying, extraction, adsorption and distillation
4. Students will also be introduced about various types of unit operation applications involved in separation techniques like Chromatographic, Electrophoretic separations, Centrifugation.
5. They will learn membrane based separations principle and design aspects.

Course Outcomes: After completion of the course, the graduates will be able to know

CO1	Various types of fluid transporting and fluid metering equipment's, contacting columns.
CO2	Comprehend the concepts of mixing, size reduction, filtration, sedimentation equipment's and storage technique.
CO3	Apply Design concept of heat transfer equipment's to design heat exchanger condensers and evaporators.
CO4	Analyze diffusional processes to design distillation, drying, leaching, extraction equipment's. Understand the downstream separation techniques for separating valuable products including membrane techniques.
CO5	Various principles of mass transfer operations such as adsorption and distillation.
CO6	The different techniques and principles involved in chromatographic methods.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	1	1	2	2	2	1	2
CO2	3	3	2	2	1	1	1	2	2	2	1	2
CO3	3	3	1	1	1	1	1	2	2	2	1	2
CO4	3	3	2	2	1	1	1	2	2	2	1	2
CO5	3	3	2	2	1	1	1	2	2	2	1	2
CO6	3	3	2	2	1	1	1	2	2	1	1	2

Unit	Course Content	Hours	COs
1	**APPLIED MOMENTUM TRANSFER AND MECHANICAL OPERATIONS** **Pressure measurement-** Manometers, (simple and differential).Columns-Packed bed columns and fluidised bed columns, types of packing. Pumps and Pipes-Capacity of pump calculation by modified Bouroullie's equation, Flow measurements-Venturimeter, Orificemeter, Rotameter and Pitot tube (construction and working).Size Reduction-Jaw crusher, Ball mill and hammer mill(construction and working).Screening-Capacity and efficiency of screen, Filtration-Plate and frame, rotary drum and leaf filters, Filter aids, Filter media, Design of filtration (to find cake and medium resistance),Rate of washing. Sedimentation-Design of thickner, Dorr thickner (construction and working).Storage-Storage equipments.	**11**	**CO1**
2	**APPLIED HEAT TRANSFER** **Convection:** Application of dimensionless analysis to find heat transfer coefficients for natural and forced convention. Overall heat transfer coefficients from individual coefficients, Introduction to design of heat exchangers(No mechanical design).Condensers: Vertical and Horizontal condensers, Introduction to design of condensers, Evaporator-Open pan, horizontal tube, verticaltube, forced circulation, forward feed, backword feed, multiple effect evaporators (construction and working).	**10**	**CO1**
3	**APPLIED MASS TRANSFER:** **Drying:** Continuous through-circulation rotary drier, Liquid-Liquid Extraction-Design of continuous contact columns, Adsorption-Continuous contactor, Fixed bed adsorber (construction and working).Distillation-Design of distillation column by McCabe-Thiele method and introduction to column design by Ponchon-savarit method, Plate columns and packed columns (construction and working).Azeotrops and Azeotropic distillation techniques.	**11**	**CO2**
4	**SEPERATION TECHNIQUE:** **S**upercritical extraction, Chromatographic separation processes, Electrophoretic separations, hybrid separation technologies, Dialysis, Crystallization (Qualitative description).Partition chromatography- Single dimensional (Both Ascending and Descending) and two dimensional chromatography - Thin layer chromatography, Gas liquid Chromatography, Adsorption column chromatography. Ion Exchange Chromatography (Qualitative description). Centrifugation-Centrifugation principles and design considerations.	**10**	**CO3**
5	**MEMBRANE SEPERATION TECHNIQUES:** Membrane based separations theory- Design and configuration of membrane separation equipment, Solute polarization and cake formation in membrane. Application of membrane separation- enzyme processing using ultrafiltration membranes; separation by solvent membranes; reverse osmosis.	**10**	**CO4** **CO5**

Self study component:
Note:
1. Questions for CIE and SEE not to be set from self-study component.

2. Assignment Questions should be from self-study component only.

UNIT-1: Types of manometers, Pipe fittings, Valves (Gate, Globe, Plug and Ball valve),Positive displacement pump, Rotary pump and centrifugal pump(construction and working),Mixing-Pony mixer, Beater mixer, Muller mixer, and Ribbon blender(construction and working),Screening equipment (Gyrated, vibrated and Trommel)).
UNIT-2: Heat exchangers: Construction and working of double pipe and shell and tube(1-2,2-4 and 1-4 type) heat exchangers).
UNIT-3: Spray drier, Fluidised bed dryer (construction and working),Mixer settlers, plate column, packed column (construction and working),Leaching- Bollman extractor, Rotocel extractor(construction and working)).
UNIT-4: Cell disruption-Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris).
UNIT-5: Ultra-filtration-causes, consequences and control techniques, Use of membrane diffusion as a tool forseparating and characterizing naturally occurring polymers)**.**

Text Books:

1. Unit operations in Chemical Engineering by McCabe W.L. and Smith J.C, McGraw-Hill
2. Transport Process Principles and Unit Operations by Christie Geankoplis, Prentice Hall of India.
3. Introduction to chemical Engineering by Badger and Banchero, T M H Publication.
4. Unit Operations in Food Processing, By Earle R L, Pergamon Press.
5. Fluid Mechanics by K L Kumar, S Chand & Company Ltd.
6. Unit operation 1 and 2 by K.A.Ghavane, Nirali publications.

Reference Books:

1. Biochemical Engineering Fundamentals by Bailey J.E. and Oillis K, McGraw Hill.
2. Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B.Anderson , John Wiley & Sons.
3. Chemical Engineering by Coulson and Richardson. Vols I & II. Elsevier Science.
4. Chemical Engineers Hand Book by Perry, McGraw Hill Publications
5. Process Heat Transfer by Kern, McGraw Hill.

6. Heat Transfer by J P Holman, McGraw Hill International Ed.
7. Mass Transfer Operations by Robert E. Treybal. McGraw-Hill Education.

Assessment Pattern:
CIE –Continuous Internal Evaluation Theory (50 Marks)

Bloom's Category	**Tests**	**Assignments**	**AAT1**	**AAT2**
Marks (Out of 50)	**30**	**10**	**05**	**05**
Remember	--	--	02	01
Understand	10	--	01	01
Apply	10	05	--	01
Analyze	05	05	02	02
Evaluate	05			
Create				

***AAT 1– Alternate Assessment Tool 1: Quiz**
AAT 2 - Alternate Assessment Tool 2: Surprise Test

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Theory(50)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

BIOSTATISTICS AND BIOMODELING

Course Code : BT 44 **Credits : 03**
L:P:T:S : 3:0:0:0 **CIE Marks : 50**
Exam Hours : 03 **SEE Marks: 50**

Course Objective:

1. To make students learn the basic concepts of statistics.
2. To make students learn fundamental concepts of probability.
3. To equip students with the concepts of statistical tests and inference.
4. To improve their ability to analyze the statistical data with relevance to biotechnology.
5. To make students understand different statistical models and applications in biotechnology.

Course Outcomes : At the end of the course:

CO1	Graduates will apply and implement basic concepts of statistics in different applications
CO2	Graduates are able to design and develop statistical models to solve problems with relevance to biotechnology
CO3	Graduates will be able to ascertain different statistical hypothesis tests to assess statistical significance
CO4	Graduates will be able to assess and analyze the statistical models for specific datasets
CO5	Graduates will be able to implement population statistics and formulate models.
CO6	Graduates will be able to decide and apply different statistical tests for various biotechnological applications

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	3	3	1	-	1	1	1	1	3
CO2	3	1	1	3	3	1	1	1	3	-	3	1
CO3	3	2	-	3	3	-	-	1	1	-	2	-
CO4	3	2	1	3	3	-	-	1	3	1	2	3
CO5	3	2	1	3	3	1	-	1	3	-	3	-
CO6	3	3	2	3	2	1	-	1	1	1	1	3

Unit	Course Content	Hours	COs
1	**INTRODUCTION:** Scope of biostatistics, definition. Sampling & selection bias, probability sampling, random sampling, sampling designs. Descriptive statistics: Measure of central tendency (arithmetic mean, geometric mean, harmonic mean, median, quartiles, mode); Measure of dispersion (range, quartile deviation, mean deviation and standard deviation, coefficient of variation). Correlation and regression analysis (simple and linear) curve fitting (linear, non-linear and exponential).	8	CO1, CO5
2	**PROBABILITY:** Axioms, models, conditional probability, Bayes rule, Genetic Applications of Probability, Hardy - Weinberg law, Wahlund's Principle, Likelihood of paternity, Probability distributions: Discrete probability distributions - Binomial, Poisson, geometric – derivations. Central limit theorem. Continuous probability distribution – normal, exponential, gamma distributions, beta and Weibull distributions, t & F distributions.	8	CO1, CO2, CO5, CO6
3	**STATISTICAL INFERENCE:** Estimation theory and testing of hypothesis, point estimation, interval estimation, sample size determination, simultaneous confidence intervals, parametric and non-parametric distributions (t-test, F-test, Chi Squared distribution, goodness of fit test) analysis of variance (one-way and two-way classifications).	8	CO1, CO3
4	**DESIGN OF EXPERIMENTS:** Sample surveys, comparisons groups and randomization, random assignments, single and double blind experiments, blocking and extraneous variables, limitations of experiments. Case studies: Statistical tools for setting in process acceptance criteria; t-Test based approach for confirming human antibody response to therapeutic drug; Population statistics for cases related to cigarette smoking, Lung cancer, endangered plants species, epidemics etc.	8	CO1, CO3, CO2, CO5, CO6
5	**BIOMODELING:** Microbial Growth in a Chemostat, Growth Equations of Microbial populations, Models of Commensalisms, Mutualism, Predation and Mutation. Volterra's Model for n Interacting Species. Basic Models for Inheritance, Selection and Mutation Models, Genetic Inbreeding Models.	8	CO1, CO2, CO4, CO6

Self-study component

UNIT -1: Data collection, presentation of data, graphs, charts (scale diagram, histogram, frequency polygon, frequency curve, logarithmic curves.

Text Books:

1. Principles of Biostatistics by Marcello Pagano & Kimberlee G, Thompson Learning.
2. Introduction to Biostatistics by Ronadd N Forthofer and Eun Sul Lee, Academic Press.
3. Statistical methods in Biology by Norman T J Bailey, Cambridge Press.
4. Mathematical Models in Biology and Medicine by J.N.Kapur New Age International.

Reference Books:

1. Introduction to Mathematical Biology by S I Rubinow, John Wiley.
2. An introduction to Biostatistics by P.S.S.Sundar Rao and J.Richard, Prentice Hall of India.
3. Probability and statistics for engineers by Miller, Freund and Johnson, Prentice Hall.
4. Fundamentals of Biostatistics by Veer Bala Rastogi, Ane Books India

Assessment pattern
CIE – Continuous Internal Evaluation (50 Marks)

Bloom's Categoty	**Tests**	**Assignments**	**AAT1 (Quiz)**	**AAT2 (Seminar/ Surprise Test)**
Marks(50)	30	10	05	05
Remember	10		02	01
Understand	10	05	01	02
Apply	10	05	02	02
Analyze				
Evaluate				
Create				

***AAT- Alternate Assessment Tool**

SEE –Semester End Examination (50 Marks)

Bloom's Category	**Marks**
Remember	20
Understand	20
Apply	10
Analyze	
Evaluate	
Create	

BIOCHEMICAL THERMODYNAMICS

Course code: BT45 **Credits: 03**
L: P: T: S: 4: 0: 0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**
Total Hours: 40

Course Objectives:

1. To gain basic understanding of thermodynamics laws and concepts.
2. Application of thermodynamic basic concepts in Bio-chemical reaction.
3. To understand the PVT behavior and biochemical equilibria in biological application.
4. Study of Pure fluids behavior like fugacity, partial molar properties and chemical potential in fluids.
5. Understand the concept of VLE in Pure fluids and Azeotropic mixtures.

Course Outcomes: After completion of the course, the graduates will be able to

CO1	Use fundamentals of integrated bio chemical thermodynamics principles to evaluate a biology and real world topic.
CO2	Demonstrate an understanding of the role bio chemical thermodynamics in the reactor designs, vapour liquid equilibrium and industrial applications.
CO3	How energy flows in biological cells and how heat energy is use full for assembling macro structures like the cell.
CO4	Enhance their problem solving in basics of design and bio-chemical principles.
CO5	Able to evaluate basic principle in reactor design.
CO6	Students will be able to analyze energetic problems in biochemical reaction.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	1	-	1	1	-	-	2
CO2	2	3	2	2	3	2	1	1	-	-	-	2
CO3	3	3	3	3	2	1	1	1	-	-	-	2
CO4	3	3	3	3	3	2	1	1	1	-	1	2
CO5	2	3	2	3	3	2	1	2	1	-	1	1
CO6	3	3	3	3	3	2	-	-	-	-	-	2

Unit	Course Content	Hours	COs
1	**BASIC CONCEPTS** System, Surrounding & Processes, Closed and Open systems, State and Properties, Intensive & Extensive Properties, State and Path functions, Equilibrium state and Phase rule, Zeroth law of Thermodynamics, Heat reservoir and Heat engines. General statement of First law of Thermodynamics, First law for Cyclic Process, Non-Flow Process, Flow process, Heat capacity. General statements of the second law, Concept of entropy, the carnot principle, Calculation of entropy changes, Clausius inequality.	**08**	**CO1**
2	**PVT BEHAVIOR AND BIOCHEMICAL EQUILIBRIUM** PVT behavior of pure fluids, equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure constant temperature, adiabatic and polytrophic processes. Equations of state for real gases: Van-der Waals equation, virial equation. Coupled reactions and energy rise compounds, reaction stoichiometry, criteria of biochemical Reaction equilibrium, equilibrium constant and standard free energy change, effect of Temperature, pressure on equilibrium constants.	**08**	**CO1**
3	**THERMODYNAMIC PROPERTIES** Energy properties, Derived properties, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, Relationships between Cp & Cv, Gibbs- Helmholtz equation.	**08**	**CO2**
4	**FUGACITY AND PARTIAL MOLAR PROPERTIES** Fugacity: Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, Fugacities of solids and liquids, Activity: Effect of temperature and pressure on activity. Departure functions and generalized charts, thermodynamic diagrams – types of diagrams and construction of thermodynamic diagrams. Partial molar properties - Partial molar properties of solutions, determination of partial molar properties, chemical potential – effect of temperature and pressure, Gibbs - Duhem equation.	**08**	**CO3**
5	**VAPOUR LIQUID EQUILIBRIA** Criteria of phase equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions - azeotropes, VLE at low pressures – activity co –efficient equation, bubble point and dew point equilibria, Liquid-Liquid Equilibrium diagrams – binary liquid Equilibrium diagrams.	**08**	**CO4** **CO5**

Self study component:
Note:
1. Questions for CIE and SEE not to be set from self-study component.

2. Assignment Questions should be from self-study component only.

UNIT 1: Reversible and Irreversible processes Entropy and Irreversibility, Third law of Thermodynamics
UNIT 2: Liquid phase reactions, heterogeneous bio-reaction equilibria, phase rule for reacting systems actors affecting equilibrium conversion – Le – chatelier's principle
UNIT 3: Effect of temperature on U, H & Entropy (S), modified equations for internal energy (U) & enthalpy (H) Principles of corresponding states, generalized compressibility charts. Reference properties.
UNIT 4: lewis – randall rule, Raoult's law for ideal solutions, Henry's law and dilute solutions – ideal behavior of real solutions and Henry's law, Activity in solutions, Activity coefficients – effect of temperature and pressure, Property changes of mixing, excess properties – excess Gibb's free energy
UNIT 5: Consistency test for VLE data – using slope of ln γ curves, using partial pressure data, calculation of activity coefficients using Gibbs -Duhem equation.

TEXT BOOKS

1. Introduction to Chemical Engineering thermodynamics by Smith & Vanness, MGH.
2. Biochemical Calculations by I.H.Segel, John Wiley & Sons.
3. Engineering Thermodynamics by R K Singal, I K Intl.
4. Engineering Thermodynamics by Spading and Cole, ELBS.
5. Engineering Thermodynamics by Jones J.B. Hawkins, John Wiley.
6. Principles of Biochemistry by Albert Lehninger, CBS publishers.
7. Biochemistry by Nelson and Cox, Palgrave Macmilan.
8. Bioenergetics by L Eruster, Academic Press, New York.

REFERENCE BOOKS

1. Chemical Engineering Thermodynamics by Y.V.C. Rao, New Age International.
2. A Textbook of Chemical Engineering Thermodynamics by K.V. Narayanan, PHI.
3. Principles of Biochemistry by Lubert Stryer, Freeman Int. Edition.
4. Biochemistry by Mathews, Vanholde & Arhen, Pearson Education.

5. Biochemistry by Garett & Grisham, Thompson Learning.

Assessment Pattern:
CIE –Continuous Internal Evaluation Theory (50 Marks)

Bloom's Category	**Tests**	**Assignments**	**AAT1**	**AAT2**
Marks (Out of 50)	**30**	**10**	**05**	**05**
Remember	--	--	02	01
Understand	10	--	01	01
Apply	10	05	--	01
Analyze	05	05	02	02
Evaluate	05			
Create				

***AAT 1– Alternate Assessment Tool 1: Quiz**
AAT 2 - Alternate Assessment Tool 2: Surprise Test

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Theory(50)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

CELL & MOLECULAR BIOLOGY LABORATORY

Course code: BTL 47 **Credits: 04**
L: P: T: S: 4: 4: 0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**

Course objectives:

1. Understand the concept and techniques related to cell and molecular biology.
2. Understand analyze cell division, types of chromosomes and somatic cell hybridization.
3. Understand the acquire technical skills to isolate DNA from different sources.
4. Understand techniques of identifying leukocytes and chlorophyll pigments.
5. Understand techniques related to cloning in the field of genetic engineering.

Course outcome:

CO1	Graduates develop the concepts and techniques related to cell and molecular biology.
CO2	Graduates analyze cell division, types of chromosomes and somatic cell hybridization.
CO3	Graduates acquire technical skills to isolate and quantify DNA and plasmid from different sources, identify types of leukocytes and chlorophyll pigments.
CO4	Graduates apply molecular biology techniques of DNA isolation and electrophoresis
CO5	Graduates appraise the basic techniques of molecular biology for cloning in the field of genetic engineering.
CO6	Graduates formulate the basic techniques of molecular biology for various rDNA technology.

Mapping of Course outcomes to Program outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	2	1	1	-	3	3	1	1	2
CO2	2	2	2	3	1	2	-	3	3	1	1	2
CO3	2	2	3	3	3	2	-	3	3	1	1	2
CO4	2	2	3	3	3	2	-	3	3	1	1	2
CO5	3	2	2	2	3	2	-	3	3	1	1	2
CO6	3	2	2	2	3	2	-	3	3	1	1	2

Sl. No	LIST OF EXPERIMENTS:	Hours	COs
1	Study of divisional stages in Mitosis using onion root tips.	**3**	**CO1 CO2**
2	Study of divisional stages in Meiosis using onion flower buds/grass hopper testes.	**3**	**CO2**
3	Study of Polytene and Lampbrush chromosomes using salivary glands of *Drosophila melanogaster* and permanent slides.	**3**	**CO2**
4	Isolation of plant protoplasts by enzymatic method and Chemical fusion of plant protoplasts (PEG).	**3**	**CO2**
5	Determination of chlorophyll pigment by paper chromatography.	**3**	**CO3**
6	Study of leukocytes in human blood sample (microscopic method)	**3**	**CO3**
7	Isolation of plasmid DNA from *E.coli*	**3**	**CO5**
8	Isolation of plant genomic DNA	**3**	**CO3**
9	Isolation of bacterial genomic DNA	**3**	**CO3**
10	Agarose gel electrophoresis	**3**	**CO1**
11	Quantification of nucleic acids (spectrophotometric method)	**3**	**CO3**
12	Restriction Digestion of plasmid DNA.	**3**	**CO4**

TEXT BOOKS

1. Essentials of Molecular Biology by David Freifelder, Narosa Pub. House.
2. Molecular Biology of the Cell by Alberts et al., Garland Publishing.
3. Principles of Gene manipulation and Genomics by Primrose, Oxford University Press.
4. Molecular Biology of the Gene by James D Watson et al., Pearson Education.

REFERENCE BOOKS

1. Molecular Cell Biology by Darnell J Lodish & H Baltimore, Freeman Pub.
2. Biochemistry & Molecular Biology by William H Elliot and Daphane C Elliot, Oxford University Press.
3. Current protocols in molecular biology, edited by Frederick M. Ausubel et al., John Wiley & Sons.

Assessment Pattern:
CIE –Continuous Internal Evaluation Theory (50 Marks) CIE –Continuous Internal Evaluation Lab (50 Marks)

Bloom's Category Marks (Out of 50)	**Performance (Day To Day)**			**Internal Test**
	25			**25**
	Performance	**Record**	**Viva**	
Remember	10	10	05	5
Understand				5
Apply				5
Analyze				7
Evaluate				3
Create				

SEE –Semester End Examination Theory (50 Marks)

Bloom's Category	**Marks Practicals (50)**
Remember	12
Understand	10
Apply	13
Analyze	07
Evaluate	08
Create	

MOMENTUM TRANSFER &MECHANICAL OPERATIONS LAB

Course code: BTL 48 **Credits: 03**
L: P: T: S: 0: 3: 0: 0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**

Course Objectives:

1. To measure the flow rate of the fluids using variable head meters.
2. To calculate the frictional losses in pipes.
3. To separate the particles based on size.
4. To calculate the area of filtration and sedimentation equipment.
5. To analyze and interpret the results of their experimental work.

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

CO1	Apply the concepts of momentum transfer to understand the coefficients of friction and coefficient of discharge.
CO2	Theoretically verify the pressure drop in packed and fluidized bed.
CO3	Using the fundamental knowledge of mechanical operations able to calculate the average diameters and effectiveness of screen.
CO4	Apply design aspects to find thickener area and cake resistance and filter medium resistance.
CO5	The co – efficient of discharge through venturimeter and orificemeter both experimentally and theoretically.
CO6	The minimum cross sectional area of a continuous thickener by batch sedimentation.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	2	1	2	--	2	1
CO2	3	3	2	2	1	1	1	--	1	--	1	1
CO3	2	3	3	3	2	1	1	--	2	2	2	2
CO4	3	3	3	2	1	2	1	--	1	1	2	2
CO5	3	3	3	2	1	2	2	--	1	--	2	2
CO6	3	3	3	2	3	2	2					

Sl. No	LIST OF EXPERIMENTS:	Hours	COs
1	Determination of co – efficient of Discharge through Venturimeter both experimentally & theoretically.	**3**	**CO1 CO5**
2	Determination of co – efficient of Discharge through orificemeter both experimentally & theoretically.	**3**	**CO1 CO5**
3	Determination of the resistance offered by the circular pipes.	**3**	**CO1**
4	Determination of the resistance offered by fittings and to express in terms of diameter and vertical head.	**3**	**CO2**
5	Determination of the friction factor f_P experimentally & theoretically and verification of the Ergun's equation through packed bed	**3**	**CO2**
6	Determination of the friction factor f_P experimentally & theoretically and verification of the Ergun's equation through fluidized bed.	**3**	**CO2**
7	Determination of the average particle sizes, volume mean diameter, D_V& Number of particles by sieve analysis.	**3**	**CO3**
8	Determination of the particle size distribution in the given sample and effectiveness of given screen.	**3**	**CO3**
9	Determination of the minimum cross sectional area of a continuous thickener by batch sedimentation.	**3**	**CO4 CO6**
10	Determination of the specific cake resistance, α and filter medium resistance, Rm by filtering $CaCO_3$ slurry in a vacuum leaf filter apparatus.	**3**	**CO4**
11	Determination of the crushing law constants and verification of the laws of crushing using jaw crusher.	**3**	**CO4**
12	Determination of the average particle size of the given powdered sample by beaker decantation method and also to plot the particle size distribution of the sample.	**3**	**CO6**

REFERENCE BOOKS

1. Unit operations in Chemical Engineering by McCabe W.L. and Smith J.C, McGraw-Hill.
2. Transport Process Principles and Unit Operations by Christie Geankoplis, Prentice Hall of India.
3. Introduction to chemical Engineering by Badger and Banchero, T M H Publication.
4. Unit Operations in Food Processing, By Earle R L, Pergamon Press.
5. Fluid Mechanics by K L Kumar, S Chand & Company Ltd.

6. Mechanics of fluids by B.S. Massey, Chapman & Hall Publishers.
7. Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson , John Wiley & Sons.
8. Chemical Engineering by Coulson and Richardson. Vol. I& II. Elsevier Science.
9. Chemical Engineers Hand Book by Perry, McGraw Hill Publications.

Assessment Pattern:

CIE –Continuous Internal Evaluation Lab (50 Marks)

Bloom's Category	**Performance (Day To Day)**	**Internal Test**
Marks (Out of 50)	**25**	**25**
Remember	05	05
Understand	05	10
Apply	05	05
Analyze	05	05
Evaluate	05	
Create		

SEE –Semester End Examination Lab (50 Marks)

Bloom's Category	**Marks Theory(50)**
Remember	10
Understand	10
Apply	15
Analyze	10
Evaluate	05
Create	