CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
BIOTECHNOLOGY
B. Tech. II – Year

I – Semester

THEORY						
S. No	**Code**	**Subject**	**L**	**T**	**P/D**	**Credits**
1	MT 213	Calculus for Biotechnology	4	0	0	3
2	BT 211	Process Engineering Principles	4	0	0	3
3	BT 212	Biochemistry	4	1	0	3
4	BT 213	Cell biology	4	0	0	3
5	BT 214	Microbiology	4	0	0	3
6	BT 215	Genetics	4	1	0	3
PRACTICALS						
7	BT 216	Biochemistry Lab	0	0	3	2
8	BT 217	Microbiology Lab	0	0	3	2
9	BT 218	Cell Biology and Genetics Lab	0	0	3	2
TOTAL			**24**	**2**	**9**	**24**

II – Semester

THEORY						
S. No	**Code**	**Subject**	**L**	**T**	**P/D**	**Credits**
1	MT 223	Computational numerical methods	4	0	0	3
2	BT 221	Chemical and Biochemical Thermodynamics	4	1	0	3
3	BT 222	Molecular Biology	4	0	0	3
4	BT 223	Immunology	4	1	0	3
5	BT 224	Instrumental Methods in Biotechnology	4	0	0	3
6	BT 225	Industrial Biotechnology	4	0	0	3
PRACTICALS						
7	BT 226	Molecular Biology Lab	0	0	3	2
8	BT 227	Immunology Lab	0	0	3	2
9	BT 228	Instrumentation Lab	0	0	3	2
TOTAL			**24**	**2**	**9**	**24**

MT 213

CALCULUS FOR BIOTECHNOLOGY

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT I:

Evaluation of Indeterminate forms

Types of indeterminate forms, L-Hospital's Rule, evaluation of indeterminate forms $0/0$; ∞/∞ ; $\infty-\infty$; 1^{∞} ; ∞^{0} ; 0^{0} ; $0x\infty$.

Problems on Newton's Law of cooling, problems on decay and growth.

UNIT II:

Infinite series

Definition of sequences and series, finite and infinite series, convergence, divergence and oscillating series. Geometric series, p-series, comparison test, Ratio-test, Cauchy's root test. Raabe's Test.Alternating series-Leibnitz test.Absolute and conditional convergence.

UNIT III:

Differential Calculus

Fundamental theorem, continuity and differentiability.Rolle 's Theorem and Mean Value theorems (statements and geometrical interpretation only)-related problems.Taylors and Maclaurin's and Taylors series for single variable. Radius of curvature(Cartesian and polar coordinates).Partial differentiation-Homogeneous functions-Euler's theorem on Homogeneous funcions. Taylor's series of two variables, maxima and minima.

UNIT IV:

Vector Differentiation

Definitions: scalar and vector point functions, vector differential operator, Gradient , Divergence and Curl. Solenoidal and Irrotational vectors. Properties of Gradient, divergence and curl(vector identities).

UNIT V:

Vector Integration

Multiple integrals: Double and triple integrals- change of order of integration.

Line integrals-circulation-work done. Greens theorem in a plane, Surface integrals-flux and volume integrals. Gauss divergence theorem and Stoke's theorem (Theorems without proofs)- related problems.

Text Books:

1. Mathematical Methods of Science and Engineering by KantiB.Datta (CENGAGE Learning)
2. Higher Engineering Mathematics by B.S.Grewal
3. Vector Calculus by Shanti Narayan

BT 211

PROCESS ENGINEERING PRINCIPLES

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT-1

Dimensions and system of units

Fundamental quantities, derived quantities and conversions; SI and MKS system of Units; Basic Chemical Engineering calculations- Atomic, Molecular and Equivalent weights, molar concept, Concentration units for pure components, Vapor pressures, Moles, Mixers and solutions, Molarity, Molality, Normality and Partial pressures; Laws of Chemical Combination; Definition of Stochiometry; Composition of mixers and solutions; Weight fraction; Mole fraction; Volumetric composition; Density and Specific gravity, Ideal gas law; Ideal mixtures and solution; Dalton's law of additive pressures; Amagots law of additive volumes.

UNIT- II

Vapour pressure and humidity

Vapor Pressure- Liquefaction & Liquid state, Vaporization, Boiling point, Effect of temperature on Vapor Pressure, Vapor Pressure plots, Vapor Pressure of immiscible liquids & solutions, Raoult's law and its limitations. Humidity- Relative and Percent saturation, Dew point, Wet and dry bulb temperatures, use of humidity charts.

UNIT- III

Material Balances

Laws of conservation of mass, meaning of material balance and its applications, Process flow sheet, Drawing material balance on non reacting steady system, Conversion, yield, Limiting reactants, Excess reactants, Recycling, By-passing, Material balances on steady state reacting systems with recycling and By-passing.

UNIT- IV

Energy Balances

Law of conservation of energy, Meaning of energy balance and its importance, Inputs of energy balance, Specific heat and sensible heat, Latent heat and heats of transition, Sublimation, Enthalpy of solutions, Standard heats of formation, Standard heats of combustion, Standard heats of reaction, Bess's law, Kirchoffs law, Determination of heat of reaction at temperature other than standard temperature using specific heat relationships, Combustion calculations, Combustion air requirements, determination of flue gas composition from fuel composition and vice versa.

UNIT – V

Unit operations in bioprocesses

Application of principles of unit operations and unit processes in biotech Industries, Application of principles of transport phenomenon (momentum, mass and heat transfer) in bioprocessing. Outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, generalized process flow sheets.

Text Books:

1. Hougen and Watson K M and Ragatz R A,1959, Chemical Process Principles, 2nd Edition ,Wiley.
2. Bhatt B I and S M Vora, Stoichiometry ,2006, 4th Edition ,Tata McGraw Hill.

Suggested Reading:

1. David M. Himmelblau, James B. Riggs, 2012, Basic Principles and Calculations in Chemical Engineering , 8th Edition, Prentice Hall
2. Silas Milton Henderson, Russell Lawrence Perry, J. H. Young, 1997, Principles of Process Engineering, 4th edition. ASAE
3. J. M. Coulson, J. F. Richardson, 2005, Coulson and Richardson's Chemical Engineering Vol.6, Elsevier
4. Michael L. Shuler, Fikret Kargı , 2002, Bioprocess Engineering basic concepts , 2nd Edition Prentice Hall
5. Michael R. Ladisch , 2001,Bioseparations Engineering Principles, Practice, and Economics , 1st edition ,Wiley
6. D.G.Rao, 2005, Introduction to Biochemical Engineering, 2nd Edition, Tata Mc Graw Hill
7. Pauline M.Doran ,2013,Bio-process Engineering Principles, 2nd Edition, Academic press
8. Warren Lee McCabe, Julian Smith, Peter Harriott, 2005,Unit operations of chemical engineering, Mc-Graw Hill, 7th Edition

BT 212

BIOCHEMISTRY

Instruction	4L + 1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT– I

Metabolism of Carbohydrates

Carbohydrate Metabolism- Glycolysis, Glycogenolysis, HMP, Citric Acid Cycle (TCA Cycle) and Oxidative Phosphorylation, Metabolic Pathways- Biosynthesis of Glucose, Glycogen and Starch.

UNIT– II

Metabolism of Lipids

Lipid Metabolism - Catabolism of Fatty Acids, Triglycerol and Cholesterol Metabolism; Metabolic Pathways- Biosynthesis of Saturated (Stearic acid) and Unsaturated (Oleic acid) Fatty Acids, Phospholipids and Sphingolipids; Glycoproteins and Glycolipids.

UNIT– III

Metabolism of Proteins and Nucleic Acids

Amino acids metabolism- Biosynthesis of Amino Acids, Peptides; Catabolism of Carbon skeletons of Amino Acids- Transamination, Oxidative Deamination and Oxidative Decarboxylation, Metabolic fate of Amino acids; Nitrogen Excretion and Urea Cycle; Nucleic Acid Metabolism- Biosynthesis of Purine and Pyrimidine, Ribonucleotides, synthesis of Deoxyribonucleiotides; Degradation of Purine and Pyrimidine Nucleotides.

UNIT– IV

Biochemical Pathway of Photosynthesis

Plant photosynthesis – Chloroplast-Organization of chloroplasts, chlorophylls trap solar energy; Photosynthetic pigments and photochemistry; Hill reaction; Photosynthetic reaction centers- Photosystem -I, Photosystem II; Oxygenic Photosynthesis-I; Photophosphorylation-Cyclic and Non-cyclic Photo Phosphorylation; Dark reaction - Carbon dioxide fixation (Calvin cycle).

UNIT– V

Enzymes, Coenzymes and Vitamins

Enzyme: nomenclature, classification, properties and functions; Coenzymes-Coenzymes in hydrogen transfer reactions (NAD+, FAD, Lipoic acid) and group transfer reactions(Biotin, TPP, Pyridoxal phosphate, Coenzyme A, Tetrahydrofolic acid); Vitamins - Classification (Water and Fat Soluble); Chemical Nature and Mechanism of Action of Vitamins; Biological Importance of Vitamins.

Texts Books:

1. David Lee Nelson and Michael M. Cox, 2013, Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman.
2. Donald Voet and Judith G. Voet, 2011, Biochemistry, 4th edition, John Wiley & Sons, New York.

Suggested Reading:

1. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, 2002, Biochemistry, 5th Edition. W. H. Freeman and Company.
2. Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Well, 2012, Harpers illustrated Biochemistry, 29th edition, McGraw Hill Professional.
3. Reginald Garrett and Charles Grisham, 2012, Biochemistry 5th edition, Cengage Learning.

BT 213

CELL BIOLOGY

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT – I

Cell structure, organelles and their functions

Cell structure and organization in bacteria, plants and animal cells; structure and functions of cell wall, lysosomes, ribosomes, golgi complex, peroxisomes, glyoxysomes, mitochondria, plastids, endoplasmic reticulum, vacuoles, centrioles; cytoskeleton - composition, structure and functions of microtubules, microfilaments and intermediate filaments; nucleus, its ultra structure, (nuclear envelope, nucleoplasm, chromatin fibers).

UNIT – II

Membrane transport

Biomembrane – lipid composition and structural organization, protein components and basic function, transport across membrane – passive diffusion, facilitated diffusion, osmosis, active transport (Na^+/K^+ Pump), cotransport; uniport, antiport, symport.

UNIT – III

Cell division and cell cycle

Cell Division: mitosis and meiosis- events and significance; meiosis and reproductive cycle.

Cell cycle: Different phases of cell cycle; check points of cell cycle; Regulation of cell cycle - cyclins and cyclin dependent kinases; apoptosis (programmed cell death).

UNIT – IV

Cell communication

Basic concepts of cell communication; bacterial cell communication - Quorum sensing; multicellular organisms- intercellular communication through channels (gap junctions and plasmodesmata, cell-cell junctions), chemical signals (autocrine, paracrine, hormonal); cell signaling-signal transduction pathway; signal receptor proteins- G protein linked receptors(Jak/stat kinases), tyrosine kinase receptors, secondary messengers (cAMP) signaling path ways in cancer (hedgehog signaling, frizzled signaling).

UNIT – V

Protein targeting

Targeting signals, targeting cytosolic proteins to mitochondria, chloroplast, nucleus; co-translational transport into RER, vesicle formation and transport, role of chaperones, applications of protein targeting.

Text Books:

1. Geoffrey M. Cooper and Robert E. Hausman, 2013, The cell: A molecular approach, 6th edition, Sinauer Associates.
2. Gerald Karp, 2009, Cell and Molecular Biology: concepts and experiments, 6th edition, John Wiley & sons.

Suggested Reading:

1. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, 2013, Essential Cell Biology, 4th edition, Garland Science
2. Rastogi S.C., 2005, Cell Biology, 3rd edition, New Age International
3. Powar, C.B., 2006, Cell Biology, Himalya Publishing house
4. De Robertis and De Roberits, 2002, Cell and Molecular biology, BI Waverly Pvt. Ltd

BT 214

MICROBIOLOGY

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT – I

History and Introduction to Microbiology

History and scope of microbiology, contributions of Antony van Leuwenhoek, Louis Pasteur, Robert Koch, Iwanowskii, Edward Jenner; prokaryotic cell structure – plasma membranes, cytoplasmic matrix – inclusion bodies, ribosome, bacterial chromosome and plasmids, cell wall, components external to cell wall – capsule, slime layer, pili, fimbriae, flagella, bacterial endospores and their formation.

UNIT – II

Classification of Microorganisms

General and colony characters of major groups of microorganisms - algae, fungi, protozoa, bacteria and virus; identification of microorganisms by major taxonomical characteristics (morphological, physiological, ecological, cultural, metabolic/biochemical, immunological and genetic). classification of microorganisms - concept of classification; taxonomic groups; Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese.

UNIT – III

Microbiological Techniques

Methods of culturing of microorganisms in lab and industry - culture media, (liquid, semi-solid and solid media, synthetic media and complex media), types of media (simple, routine lab, selective, differential, enrichment and enriched), isolation of pure cultures (streak, spread and pour plate methods). concept of sterilization - methods and their application- physical methods (heat, filtration and radiation), chemical methods (phenolics, alcohols, halogens, heavy metals, dyes, quaternary ammonium compounds, aldehydes, gaseous agents); methods of preservation of microorganisms and their importance (Bacterial cultures).

UNIT – IV

Microbial Physiology and Growth

Nutrition in microorganisms and assimilation of major nutrients; nutritional groups of microbes and their importance in fermentation industry; microbiological media and their application growth of microorganisms - growth factors, growth curve, mathematical expression of growth, measurement of microbial growth (cell numbers and cell mass), importance of growth phases of microorganisms; balanced and unbalanced growth, synchronous growth, diauxic growth, factors affecting bacterial growth (solutes, water activity, ph, temperature, oxygen concentration, osmotic pressure, radiation).

UNIT – V

Medical Microbiology

Microbial toxins – botulinum neurotoxin, tetanus toxin, staphylococcal toxin; enteric pathogens – salmonella, vibrio cholerae, extracellular pathogens – staphylococcus, streptococcus; facultative intracellular pathogen – mycobacterium, obligate intracellular pathogen – rickettsia, chlamydias; sexually transmitted disease – syphilis; viral diseases – influenza, measles and HIV; antimicrobial agents and drug resistance.

Text Books:

1. Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A-Stahl and Clark, 2010, Brock Biology of Microorganisms, 13th edition, Prentice Hall International Inc.
2. Joanne M. Willey, Linda Sherwook and Christopher J. Woolverton, 2013, Prescott's Microbiology, 9th edition, McGraw Hill higher education publication.

Suggested Reading:

1. Powar C.B. and Daginawala H.F., 2005, General Microbiology – Vol I & II, 2nd edition, Himalaya publishing house.
2. Arti Kapil, 2013, Ananthanarayan and Paniker's Text book of Microbiology, 9th edition, Orient Blackswan.
3. Pelczar Michael J., Krieg Noel R., Chan, E.C., 1993. Microbiology, 5th edition, McGraw Hill higher education.
4. Roger Y Stanier, 1999, General Microbiology, 5th edition, Palgrave Macmillan Limited.

BT 215

GENETICS

Instruction	4L + 1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT – I

Physical Basis of Heredity

Mendel's laws of inheritance – segregation, independent assortment, modification of mendelian principles: co-dominance, incomplete dominance, multiple alleles, gene interactions, epistatic interactions, pleotropism. Interaction of genotype and environment: penetrance, expressivity, phenocopy.

UNIT – II

Chromosome Structure and Abberations

Eukaryotic chromosome structure, function, karyotyping; specialized chromosomes: gaint chromosomes – polytene and lamp brush chromosomes; chromosomal aberrations- structural aberrations (deletions, duplication, inversion and translocation), numerical aberrations (aneuploidy, euploidy, auto polyploidy and allopolyploidy). Mutations – spontaneous, induced; physical and chemical mutagens; lethal mutation (characteristics and types), AMES test, applications of mutations.

UNIT – III

Linkage and Crossing Over

Concept of linkage and crossing over, cytological basis of crossing over (in Drosophila and Maize), factors affecting recombination frequency, linkage maps; mechanism of recombination – model involving single strand breaks and double strand break in DNA duplex, significance of Crossing over. Two point and three point test cross. Interference. Tetrad analysis.

UNIT – IV

Sex Determination, Sex Linked and Genetic Disorders

Sex chromosomes, sex determination, mechanism of sex determination in animals (insects and humans) and plants, sex determination by genic balance and Y-linked genes. dosage compensation, maryleon's hypothesis; sex linkage, non disjunction of x chromosomes, sex linked disorders and autosomal disorders in human beings. Garrod's inborn errors of metabolism, one gene one enzyme hypothesis, one gene one polypeptide hypothesis.

UNIT – V

Extrachromosomal Inheritance and Quantitatve Genetics

Extra chromosomal inheritance – inheritance of mitochondrial and chloroplast genes, maternal inheritance(CMS, nuclear petites in yeast, Mirabilus jalapa. Transgressive segregation, quantitative characters, Gene frequency, gene pool, Hardy- Weinberg Law,equilibrium, Fitness and selection Goodness of fit : Chi-square-test.

Text Books:

1. Singh, B.D. 2004. Genetics - 3rd edition. Kalyani Publications
2. Snustad, D.Peter, Simmons Michael, 2011, Principle of Genetics 6th edition, Wiley publication.
3. Gardner, E. J., Simmons, M. J., Snustad, D. P. and Snustad, 1985, Principles of Genetics, John Wiley and Sons, Inc.

Suggested Reading:

1. Verma, P. S. and V. K. Agrawal. 2004. Cell Biology, Genetics, Molecular Biology, Evolution and
2. Ecology. S. Chand & Company Ltd., New Delhi.
3. Cummings Michael R, Charlotte A. Spencer, Michael A. Palladino 2012. Concepts of Genetics . Pearson Education. ISBN 0321754352, 9780321754356
4. Krebs JE., Goldstein E.S and Kilpatrick S.T., 2014, Lewin's Genes XI, Jones Bartlett publishers.
5. Gupta PK, 2011, Genetics, 4th Rev Edition (2nd Reprint) Rastogi Publications.
6. Hartl L, Daniel and Ruvolo M, 2012, Genetics , analysis of genes and genomes, Eight edition, Jonnes and Bartlett Learning Books. USA.

BT 216

BIOCHEMISTRY LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. Introduction to Biochemistry Lab: Units, Volume / Weight measurements, concentration units
2. Preparation of Solutions – percentage solutions, molar solutions, normal solutions and dilution of stock solution
3. Measurement of pH
4. Preparation of buffers and reagents
5. Titration curve of amino acid and calculation of pK and pI values
6. Estimation of Carbohydrates by Anthrone method
7. Estimation of Amino acids by Ninhydrin method
8. Estimation of Proteins by Biuret method
9. Estimation of Proteins by Lowry method
10. Determination of Acid value, Saponification value and Iodine Number of Fat
11. Estimation of Cholesterol by Liebermann Burchard method
12. Estimation of Ascorbic acid in foods

Suggested Reading:

1. David, T. Plummer, 1988, An introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill.
2. Beedu Sashidhar Rao and Vijay Deshpande, 2006, Experimental Biochemistry – A student companion, Anshan Pub.
3. Sharma R.K., 2008, Basic technique in Biochemistry and Molecular Biology, I.K. International Pvt. Ltd., New Delhi.

BT 217

MICROBIOLOGY LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. Calibration of Microscope and Measurement of Microorganisms- Microtome
2. Staining and Identification of microorganism: (a) Simple and Differential staining techniques
3. Sterilization techniques (Autoclaving, Hot Air Oven, Radiation and Filtration)
4. Preparation of culture media (a) broth type of media (b) Agar
5. Culturing of microorganism (a) broth (b) pure culture techniques- Streak plate, Pour plate
6. Isolation and preservation of bacterial culture
7. Antibiotic tests- Disc diffusion method, minimum inhibitory concentration.
8. Biochemical tests- IMIVC test, Catalase, Coagulase test, Gelatinase test, Oxidase
9. Factors affecting the bacterial growth and study of growth curve
10. Measurement of Microbial Growth (Viable Count and Turbidometry) and enumeration of bacterial numbers by serial dilution
11. Detection of food pathogens

Suggested Reading:

1. Gopal Reddy M, M.N. Reddy, D.V.R. Sai Gopal and K.V. Mallaiah , 2008, Laboratory Experiments in Microbiology, 3rd edition, Himalaya Publishing House Pvt Ltd
2. Gunasekaran P., 2007, Laboratory manual in Microbiology, 3rd edition, New Age International Publ., New Delhi
3. Kannan N., 2002, Laboratory manual in General Microbiology, 1st edition, Panima Publishing Corp., New Delhi
4. Alfred E. Brown, 2011, Benson's Microbiological Applications: Laboratory manual in general microbiology, 12th edition, McGraw hill Education

BT 218

CELL BIOLOGY AND GENETICS LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. Demonstration of cytochemical methods: Fixation of plant material /cells and nuclear staining for mitotic and meiotic studies
2. Study of various stages of mitosis using cytological preparation of plant tissues (Onion root tips)
3. Study of various stages of meiosis using cytological preparation of plant materials (Onion flower buds)
4. Solving genetic problems related to monohybrid and dihybrid ratio (minimum of six problems in each topic)
5. Solving genetic problems related to gene interaction (minimum of six problems in each topic)
6. Construction of linkage maps, two point test cross.
7. Chi-square test
8. Problems related to polygenic inheritance
9. T- test
10. Problems related to Drosophila genetics

Suggested Reading:

1. Chaitanya K. V., 2013, Cell and Molecular Biology : A Lab Manual, PHI Learning Pvt. Ltd.Delhi, ISBN 978-81-203-4800-4
2. Susan L. Elrod and William D. Stansfield, 2010, Schaum's Outline of Genetics, Fifth Edition (Schaum's Outline Series).
3. William D and Stansfield, 1991, Schaum's outline of theory and problems of genetics, 3rd ed.

MT 223

COMPUTATIONAL NUMERICAL METHODS

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT-I:
Solutions of algebraic and transcendental equations
Successive approximation method, Method of Bisection, Regular false method and Newton Raphson method.

UNIT-II:
Numerical solutions of simultaneous linear equations
Pivoting of elements, ill-conditioned and well condition system of equations,Gauss elimination method, Gauss seidal method of iteration and decomposition method.

UNIT-III:
Finite differences and interpolation
Finite differences- Forward differences, Backward differences and divided differences. Newton's forward interpolation formula (NFIF), Newton's backward interpolation formula (NBIF).Lagrange's interpolation formula for un-equal intervals, Newton's divided difference interpolation formula (NDDIF).

UNIT-IV:
Numerical differentiation and numerical integration
Numerical differentiation using NFIF, NBIF and NDDIF. Numerical integration, General quadrature formula,Trapezoidal- rule. Simpson's $1/3^{rd}$ - rule, Simpson's $3/8^{th}$ –rule

UNIT-V:
Numerical solutions of ordinarl differential equations
Picard's method, Taylor's series method, Euler's method, Classical Runge-kutta Method (4^{th} -order)and Predictor and corrector method.

Text Books:

1. Mathematical Methods of Science and Engineering by KantiB.Datta (CENGAGE Learning)
2. Numerical Analysis for scientists and Engineers- by Mittal
3. Numerical Methods by B.S.Grewal
4. Numerical Methods by S .S.Shastry

BT 221

CHEMICAL AND BIOCHEMICAL THERMODYNAMICS

Instruction	4L + 1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT – I

First law of Thermodynamics: System: Definition and Classification of system – based on number of components, homogeneity and heterogeneity and exchange of mass and heat. Processes: Based on flow [batch or flow] – based on thermodynamic properties (Isothermal, Isobaric, Isochoric, Adiabatic, Polytropic). State and Path Functions, equilibrium, Phase rule. Thermodynamic Properties of fluids. Forms of energy, classification of properties. I-Law of Thermodynamics, application of I-law to closed systems and cyclic processes. Application of I-law to an open system (steady state-steady flow process) I-law applied to flow processes – nozzle, turbine and compressor, throttling device (capillary tube)

Volumetric Properties of Fluids: PVT behaviour of pure fluids. Real and Ideal Gas. Equations of state – Ideal gas law, Virial equations of state (restricted to first two terms). Cubic equations of state – Van der Waals and Redlich kwong. Processes involving ideal gases (isochoric,isobaric,isothermal,adiabatic,polytropic – simple applications)

UNIT – II

The Second law of Thermodynamics: II-law of thermodynamics: Limitations to I-law, qualitative statement of Kelvin Plank and Clausius versions of II-law, entropy – definition, entropy and heat calculations, Simple applications involving calculation of entropy change (for phase change, mixing) for ideal gases. Qualitative statement of III-law of thermodynamics.Maxwell relations – problems not included, Residual properties – definition (V^R, H^R, S^R, G^R – basic property relations for ideal gases, problems not included)

UNIT – III

Solution Thermodynamics: Partial molar properties – definition and related mathematical expressions, simple applications involving calculation of partial molar properties for binary systems using analytical methods (no graphical method). Concepts of Chemical potential and fugacity (for pure species and species in solution). Derivation of most general Gibbs Duhem equation and its different forms. Lewis Randall rule, Raoult's law, Henry's law – Definition and simple applications. Excess properties – definition and fundamental relation for excess Gibbs free energy, problems not included, property changes of mixing- not included. Activity and activity coefficients, correlations to calculate activity coefficients – Margules, Van Laar and Wilson equations simple applications involving binary systems (NRTL, UNIQUAC, UNIFAC – not included)

UNIT – IV

Topics In Phase Equilibria: Vapor-liquid equilibrium calculations for binary systems – P-x-y ,T-x-y diagrams, procedures to calculate Bubble Pressure, Bubble temperature, Dew pressure, Dew temperature**.** Introduction to Liquid-liquid equlibria, Solid-liquid equilibria - qualitative treatment only

Chemical Reaction Equilibria: Equilibrium criteria for homogenous chemical reactions. Standard Gibbs energy change of reaction, Reaction co-ordinate –definition. Evaluation of equilibrium constant – numerical problems not included. Effect of pressure and temperature on equilibrium constant – qualitative treatment, simple problems involving temperature dependence of equilibrium constant. Calculation of equilibrium conversions and yields for single reactions.

UNIT – V

Biochemical Thermodynamics: Energetics of Metabolic Pathways, Energy coupling (ATP & NADH). Stoichiometry and energetic analysis of Cell Growth and Product Formation. Thermodynamics of microbial growth. Oxygen consumption and heat evolution in aerobic cultures. Energy balance equation for cell culture

Text Books:

1. J.M.Smith, H.C.Van Ness and M.M.Abbott, Introduction to Chemical Engineering Thermodynamics, 6th ed, TMH, 2003
2. Y.V.C.Rao , Revised edition , An introduction to thermodynamics ,Universities Press, 2004
3. K.V.Narayanan,2004,A Textbook of Chemical Engineering Thermodynamics, PHI Learning Pvt. Ltd
4. J.A.Roels, Energetics and kinetics in biotechnology , Elsevier, 1983

Suggested Reading:

1. Robert A.Alberty,2006,Biochemical Thermodynamics: Applications of Mathematica, John Wiley and Sons
2. Stanley I. Sandler,1999 ,Chemical and Engineering Thermodynamics, 3rd Edition, Wiley
3. Robert A. Alberty , 2005,Thermodynamics of Biochemical Reactions ,John Wiley and Sons

BT 222

MOLECULAR BIOLOGY

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT – I

Structute and Organization of Genetic Material: Structure of DNA – Watson and Crick's model; types of DNA – A-DNA, B-DNA, Z-DNA; difference between DNA and RNA; denaturation and renaturation of DNA, DNA packing – prokaryotes (nucleoid model), eukaryotes (nucleosome solenoid model), euchromatin, heterochromatin, role of histone and non histone proteins in structural organization of chromosomes; telomere and its importance; repetitive DNA, satellite DNA, pseudo genes, overlapping and split genes.

UNIT – II

DNA Replication and Repair: Replication of DNA - semi conservative replication and its experimental evidences, enzymology of replication, continuous and discontinuous DNA synthesis, complex replication apparatus, unidirectional replication, bi-directional replication, rolling circle replication; DNA damage and repair: Types of DNA damages- deamination, alkylation, pyrimidine dimmers; DNA Repair mechanisms- photo reactivation, Excision repair, mismatch repair, recombination repair, SOS repair.

UNIT – III

Mechanism of Transcription: Structure of promoters- RNA polymerases of prokaryotic and eukaryotic organism; transcription-initiation, elongation and termination; post transcriptional processes of eukaryotic RNA; structure and functions of RNA- (rRNA, mRNA, tRNA, Sn RNA), prokaryotic and eukaryotic transcription. processing of t-RNA, r-RNA, m-RNA splicing; concept of ribozyme, inhibitors of transcription.

UNIT – IV

Mechanism of Translation: Ribosome- structural features of prokaryotic and eukaryotic ribosome; genetic code-triplet code, cracking of genetic code, features of genetic code, wobble hypothesis; protein synthesis: translation in prokaryotes and eukaryotes-initiation of translation, elongation of polypeptide chain, termination of translation. post translation modification, inhibitors of protein synthesis.

UNIT – V

REGULATION OF GENE EXPRESSION AND TRANSPOSABLE ELEMENTS: Operon concept of prokaryotic gene regulation, inducible operon – lac operon, repressible operon – trp operon, attenuation, negative and positive control of transcription. Britten Davidson model for eukaryotic gene regulation, eukaryotic gene regulation – transcriptional level, processing level, translational level; transposable elements – insertion sequences, composite transposons, transposable elements of eukaryotes (Ac-Ds in Maize, Ty elements in Yeast and P elements in Drosophila).

Text Books:

1. David Freifelder, 2007, Molecular Biology, 2nd edition, Narosa Publication.
2. Harvey F. Lodish, 2012, Molecular Cell Biology, 7th edition, W. H. Freeman.

Reference Books:

1. Burton E. Tropp, 2012, Molecular Biology: Genes to proteins, 4th editions, Jones & Bartlett publishers.
2. Benjamin Lewin, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2014, Lewin's Genes XI, Jones and Bartlett publishers.
3. Rastogi S.C., 2006, Cell and Molecular Biology, 2nd edition, New Age International.

BT 223

IMMUNOLOGY

Instruction	4L + 1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT – I

Immume System: Introduction to immunity, types of immunity – innate and adaptive immunity, humoral and cell mediated immune response, hematopoiesis, cells of the immune system, organs of immune system – primary (bone marrow and thymus) and secondary (lymph node, spleen, MALT, GALT), molecules of immune system (cytokines, interleukins, interferons, chemokines).

UNIT – II

Antigen, Antibody And Its Interaction: Antigen – immunogenicity and antigenicity, factors influencing immunogenicity, haptens and adjutants, epitopes; Immunoglobulin – structure, classes and function, antigenic determinants of immunoglobulin – isotype, allotype, idiotype, generation of antibody diversity, production of monoclonal antibodies by hybridoma technology and its applications. Strength of antigen antibody interaction, affinity, avidity, cross reactivity, precipitation, agglutination, immunoelectrophoresis, RIA, ELISA, western blotting, immunoprecipitation, immunofluorescence, FACS.

UNIT – III

Antigen Processing And Presentation: Major histocompatibility complex (MHC) – organization, classes and function; Antigen processing and presentation – role of antigen presenting cells, endogenous antigens (cytosolic pathway), exogenous antigens (endocytic pathway), presentation of nonpeptide antigen.

UNIT – IV

The Complement System and Hypersensitivity: Complement system – components, function, activation (classical and alternative pathway); Hypersensitive reactions – Type I (IgE mediated hypersensitivity), type II (antibody mediated cytotoxic hypersensitivity), type III (Immune complex mediated hypersensitivity), type IV (delayed type hypersensitivity).

UNIT – V

Medical Applications Of Immunology: Autoimmunity – organ specific (insulin dependent diabetes mellitus, Graves' disease, myasthenia gravis) and systemic (systemic lupus erythematosus, multiple sclerosis, rheumatoid arthritis) autoimmune diseases, treatment of autoimmune diseases; Transplantation – immunological basis of graft rejection, immunosuppressive therapy (general and specific), immunoprophylaxis (attenuated, inactivated and DNA vaccines), immunology of cancer- tumour antigens, immune response to tumour, cancer immunotherapy

Text Books:

1. Judith A. Owen, Jenni Punt, Sharon A.Stranford, 2013, Kuby Immunology, 7th edition, W.H. Freeman.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011, Roitt's Essential Immunology, 12th edition, John Wiley & Sons.

Suggested Reading:

1. Kenneth Murphy, 2011, Janeway's Immunobiology, 8th edition, Garland Science
2. Abdul K. Abbas, Andrew H. Lichtman, Shiv Pillai, 2011, Cellular and Molecular Immunology 7th edition, Elsevier Health Sciences
3. Sunil Kumar Mohanty and K. Sai Leela, 2014, Text book of Immunology, 2nd edition, JP Medical Ltd

BT 224

INSTRUMENTAL METHODS IN BIOTECHNOLOGY

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT – I

Analytical Methods And Microscopy: Types of Analytical Methods - Instruments for Analysis - Uncertainties in Instrumental measurements - Sensitivity and detection limit for instruments; principle, procedure, and applications of Bright field. Dark field, fluorescent and electron microscopy.

UNIT – II

Instruments For Isolation Techniques: Cell disruption by French press, Sonification, freeze thaw technique; use of liquid N_2 and chemical approaches involved in cell disruption; Isolation of Biomolecules and cell organelles: centrifugation; basic principles of sedimentation, sedimentation coefficient, Svedberg Unit; various types of centrifuges, their uses, rotors, fixed angle, vertical, swing out, zonal rotors; preparative centrifugation, differential density gradient centrifugation, analytical ultra centrifugation; Materials used in preparation of density gradient- sucrose & cesium chloride; Isolation of sub cellular organelles and Biomolecules. Determination of molecular weight and purity of Biomolecules by analytical ultra centrifugation.

UNIT – III

Separation Techniques: Partition coefficient, partition chromatography, counter current distribution, adsorption chromatography, Paper, TLC& GLC, adsorption media, solvent, continuous and gradient elution, fraction collection and detection of pure molecules. Methods based on size: Gel permeation chromatography, principle application- Molecular weight determination. Dialysis and its significance. Affinity chromatography, application & technique for purification of proteins and nucleic acids.

UNIT – IV

Charge Based Separation Techniques: Principle and application of Ion exchange chromatography, use of ion exchange- cation & anion exchangers, pH and salt gradients for elution of proteins, amino acids and nucleotides. Electrophoresis: Migration of charged molecules in electric field-moving boundary, paper, cellulose acetate, starch gel electrophoresis, SDS PAGE, Determination molecular weight, iso-electric focusing and its significance. Identification of specific proteins by western blotting. Agarose gel electrophoresis-separation of DNA & RNA, by agarose gel electrophoresis, recovery of DNA fragments from agarose gels, southern & northern blot techniques and their significance, pulse field gel electrophoresis.

UNIT – V

Spectrometric Identification Techniques: Basic concepts of spectroscopy, Visible & UV spectroscopy & Explain Beer lamberts law; Principles and application of Colorimetry & Flame photometry, Nephlometry; Principles and applications of Atomic absorption Spectrophotometry; Principles & applications of IR, ESR NMR & Mass spectroscopy; Explains the laws of photometry.

Text Books:

1. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, 6th edition, Cambridge University Press, 2005
2. Sivasankar, Instrumental Methods of Analysis, Oxford higher education, OUP, India, 2012

Suggested Reading:

1. GW Ewing, Instrumental Methods of Chemical Analysis, 4th edition, Mc Graw Hill, 1985
2. Hobert H Willard D.L.Merritt and J.R.J.A.Dean, Instrumental Methods of Analysis, CBS publishers & Distributors, 1992
3. Skoog DA, Fundamentals of Analytical Chemistry, Thomson Brooks/Cole, 2004

BT 225

INDUSTRIAL BIOTECHNOLOGY

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT – I

Introduction To Basics Of Biotechnology: A historical overview on scope and development of biotechnology and products; biotechnology as an interdisciplinary enterprise; a brief survey of organisms, processes, products and market economics relating to modern industrial biotechnology; concepts of tools and techniques used in biotechnology; areas of application of biotechnology.

UNIT – II

Introduction to Industrial Bioprocesses: Role of a bioprocess engineer in the biotechnology industry; introduction, development and maintenance and characterization of industrial microorganisms; primary and secondary screening of inoculum, starter and industrial cultures, analysis of microbial fermentation processes; batch and continuous fermentations, process controls, oxygen supply and demand, single and multiple bubble aeration, sparger aeration, foam control equipment, scale-up of fermentors; an overview of aerobic and anaerobic fermentation processes.

UNIT – III

Production of Primary and Secondary Metabolites: A brief outline of processes for the production of some commercially important organic acids (e.g. citric acid and lactic acid); amino acids (glutamic acid and lysine); alcohols (ethanol, and n-butanol). study of production processes for various classes of low molecular weight secondary metabolites-" antibiotics, beta-lactams (penicillins), amino glycosides (streptomycin), macrolides (erythromycin), quinones, aromatics and vitamins (B-12).

UNIT – IV

Bioporducts Production: Production of beverages (beer, wine), production of commercially important industrial enzymes-proteases, amylases, lipases, cellulase, pectinase, and isomerase, production of recombinant proteins: insulin, interleukins, tumor necrosis factor and interferons.

UNIT – V

Speciality Bioproducts for Agricultural, Food and Pharmaceutical Industries: Bio-pesticides; bio-fertilizers and plant growth factors; natural biopreservatives (nisin); biopolymers (Xanthan gum and PHB); single cell protein; high fructose corn syrup; biotransformation of steroids ; production of semi-synthetic penicillins and cephalosporins; racemically pure drug intermediates.

Text Books:

1. Crueger W and Crueger A, Biotechnology: Text Book of Industrial microbiology. 2nd edition, Panima Publisher, 2005
2. Casida L. E., Industrial Microbiology, 1st edition, New Age International, 2006
3. Patel A.H., Industrial Microbiology, 6th edition, Mc Millan India ltd, 2007

Suggested Reading:

1. Samuel Cate Prescott, Cecil Gordon Dunn, Industrial Microbiology by, edition 2, Agrobios, India, 2009
2. Bhatia S.C., Industrial Biotechnology, Vol-I, Shree Publishers & distributors, 2011
3. Poonam Singh nee' Nigam and Ashok Pandey, Biotechnology for agro industrial residue utilisation, 2nd edition, Springer, 2009
4. John E. Smith, Biotechnology, 3rd edition, Cambridge low price edition, 2009

BT 226

MOLECULAR BIOLOGY LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. Isolation of genomic DNA - from Plant tissues , Animal (Goat liver), Human Blood (Fresh / Stored / Frozen) & Microbes
2. Isolation of RNA form Yeast
3. Isolation of Plasmid DNA
4. Preparation of Agarose Gel and visualization of
    a) Genomic DNA
    b) Plasmid DNA
5. Determination of purity of DNA
6. Determination of Tm of DNA
7. Estimation of DNA by Diphenylamine (DPA) method
8. Estimation of RNA by Orcinol method
9. Demonstration of Polymerase Chain Reaction.
10. Separation of proteins using SDS-PAGE

Suggested Reading:

1. Chaitanya K. V., Cell and Molecular Biology: A Lab Manual, PHI Learning pvt. Ltd.Delhi, 2013
2. Priyanka Siwach and Namita Singh, Molecular Biology, Principles and practices, Laxmi Publications(P) Ltd., 2007

BT 227

IMMUNOLOGY LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. ABO Blood Grouping and Identification of Rh typing
2. Quantitative Precipitin Assay (QPA)(Rocket immuno electrophoresis)
3. Ouchterlony Double Diffusion for Antigen Antibody Patterns (ODD)
4. Immuno-electrophoresis (IEP)
5. Radial Immune Diffusion test (RID)
6. Widal test
7. VDRL tests
8. Total and Differential count of RBC & WBC by Micropipette method
9. Erythrocyte sedimentation rate
10. Enzyme Linked Immunosorbent Assay (ELISA) for Antigen capture and Antibody capture.
11. Estimation of Immunoglobullins by Precipitation with Saturated Ammonium Sulphate.

Suggested Reading:

1. Arti Nigam and Archana Ayyagari, Lab Manual in Biochemistry, Immunology and Biotechnology, Tata McGraw Hill Education, 2007
2. S. Ramakrishna and K.N. Sulochana, Manual of Medical Laboratory Techniques, 1st edition, J.P. Medical Ltd, 2013
3. Kanai L. Mukherjee and Swarajith Ghosh, medical Laboratory Techniques, (Vol-I): Procedure Manual for Routine Diagnostic tests, 2nd edition, Tata McGraw Hill education.

BT 228

INSTRUMENTATION LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. The calibration of pH meter and measurement of pH for different solutions
2. Estimation of Ascorbic acid by colorimetric assay
3. Estimation of unknown samples by using conductivity meter
4. Estimation of different macromolecules by visible spectrophotometer
5. Verification of Lambert - Beers law by UV -VIS spectrophotometer
6. Estimation of proteins and nucleic acids by U.V method
7. Estimation of turbidity using Nephlometer
8. The separation of different macromolecules by Paper, Thin layer chromatography
9. The separation of different macromolecules by Paper, PAGE, SDS-PAGE
10. Estimation of minerals by Flame photometry
11. Estimation of Thiamine and Riboflavin by Fluorimetry
12. Preparation of Standard curve using UV-VIS & Flame Photometry
13. Fractionation of Plasma Proteins by Electrophoresis
14. Subcellular fractionation studies by differential centrifugation

Suggested Reading:

1. Sivasankar, Instrumental Methods of Analysis, Oxford higher education, OUP, India., 2012