DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

Syllabus of

Second Year

[Bio-technology]

Under the Faculty of Engineering & Technology

[Effective from 2009-10 & onwards]

Scheme of Instructions and Examination for **Third Year** Engineering for the **Department of Biotechnology**

Semester I		Teaching Scheme (hrs/week)			Examination Scheme			Total Marks
Subject No.	Subject	Theory	Practical	Total	Theory	Term Work	Pract/ Oral	
1.	Biotransport Phenomena – II	4	2	6	100	25	--	125
2.	Biochemical Reaction Engineering – II	4	2	6	100	25	50	175
3.	Metabolic Pathways and Regulation	4	2	6	100	--	50	150
4.	Immunology	4	2	6	100	--	50	150
5.	Bioinstrumentation	4	2	6	100	--	50	150
	Total	20	10	30	500	50	200	750

Semester II		Teaching Scheme (hrs/week)			Examination Scheme			Total Marks
Subject No.	Subject	Theory	Practical	Total	Theory	Term Work	Pract/ Oral	
1.	Biological Thermodynamics – II	4	2	6	100	25	--	125
2.	Fermentation Technology – I	4	2	6	100	25	50	175
3.	Genetic Engineering	4	2	6	100	--	50	150
4.	Enzyme Engineering and Technology	4	2	6	100	--	50	150
5.	Industrial Organization and Management	4	--	4	100	--	--	100
6.	Seminar	--	--	--	--	50	--	50
	Total	20	8	28	500	100	150	750

Scheme of Instructions and Examination for **Second Year** Engineering for the **Department of Biotechnology**

Semester I		Teaching Scheme (hrs/week)			Examination Scheme			Total Marks
Subject No.	Subject	Theory	Practical	Total	Theory	Term Work	Pract/ Oral	
1.	Engineering Mathematics – III	4	--	4	100	--	--	100
2.	Biotransport Phenomena – I	4	2	6	100	25	--	125
3.	Bioprocess Calculations	4	2	6	100	25	--	125
4.	Biochemistry	4	2	6	100	25	50	175
5.	Microbiology	4	2	6	100	25	50	175
6.	Communication Skills	2	--	2	--	50	--	50
	Total	22	8	30	500	150	100	750

Semester II		Teaching Scheme (hrs/week)			Examination Scheme			Total Marks
Subject No.	Subject	Theory	Practical	Total	Theory	Term Work	Pract/ Oral	
1.	Engineering Mathematics – IV	4	--	4	100	--	--	100
2.	Biochemical Reaction Engineering – I	4	2	6	100	25	--	125
3.	Biological Thermodynamics – I	4	2	6	100	25	--	125
4.	Cell Biology	4	2	6	100	25	50	175
5.	Molecular Biology	4	2	6	100	25	50	175
6.	Numerical Methods and Computer Programming	2	2	4	--	25	25	50
	Total	22	10	32	500	125	125	750

Scheme of Instructions and Examination for **Final Year** Engineering for the **Department of Biotechnology**

Semester I		Teaching Scheme (hrs/week)			Examination Scheme			Total Marks
Subject No.	Subject	Theory	Practical	Total	Theory	Term Work	Pract/ Oral	
1.	Introduction to Biomedical Engineering	4	2	6	100	25	--	125
2.	Environmental Biotechnology	4	2	6	100	25	--	125
3.	Fermentation Technology – II	4	2	6	100	25	50	175
4.	Animal Cell Science and Technology	4	2	6	100	25	50	175
5.	Elective – I *	4	--	4	100	--	--	100
6.	Project Part I (Seminar)	--	2	2	--	50	--	50
	Total	20	10	30	500	100	150	750

Semester II		Teaching Scheme (hrs/week)			Examination Scheme			Total Marks
Subject No.	Subject	Theory	Practical	Total	Theory	Term Work	Pract/ Oral	
1.	Process Dynamics and Control	4	2	6	100	25	50	175
2.	Bioinformatics	4	2	6	100	25	50	175
3.	Protein Engineering	4	--	4	100	--	--	100
4.	Elective II **	4	2	6	100	--	--	100
5.	Project Part II	--	4	4	--	100	100	200
	Total	16	10	26	400	150	200	750

*** Elective – I**

1. Cellular and Tissue Engineering
2. Biophysics
3. Advanced Biomaterials
4. Molecular and Clinical Virology

**** Elective – II**

1. Drug Design, Development, and Manufacturing
2. Food Biotechnology
3. Plant Tissue Culture and Plant Biotechnology

Engineering Mathematics – III

Teaching Scheme Lectures: *4* hours/week
Examination Scheme Theory: *100* Marks, *3* Hours.

Unit 1 *(14 hours)*
Vector Calculus: Differentiation of vectors Radial and transverse components of velocity and acceleration, Tangential and normal components of velocity and accelerations. Scalar and Vector point function. Gradient of scalar point function. Divergence and Curl of vector point function. Solenoid and irrotational fields, Line integral, surface integral, Gauss's Divergence Theorem, Stoke's Theorem, Green's Theorem Cylindrical , Spherical Polar and Curvilinear coordinates.

Unit 2 *(6 hours)*
Fourier Transform: Fourier integral- Fourier sine and cosine integral. Complex form of Fourier integral. Fourier transforms. Fourier sine and cosine transform and inverse transform.

Unit 3 *(10 hours)*
Linear Differential Equations: solution of linear differential equation on n^{th} order with constant coefficients. General method, short cut methods to find P.I, method of variation of parameters. Equations reducible to linear from i.e. Cauchy's and Legendre's form. Solution of simultaneous linear differential equations. Application of LDE to Electrical, Mechanical and Electronics, Civil Engineering.

Unit 4 *(10 hours)*
Laplace transform: Introduction to Laplace transform, properties and theorems of to Laplace transforms Laplace transform of special function. Bessel's periodic, Error function. Heaviside unit step function, Displace Heaviside unit step function, Dirac-Delta function (impulse function) Inverse Laplace transform. Methods to find inverse Laplace transform. Use of Lap lace Transform Table, Use of theorems of Laplace Transform, Use of partial function. Convolution theorem. Solution of linear differential equation with constant coefficient by Laplace transform. solution of linear differential equation on n^{th} order with constant coefficients and simultaneous linear differential equation by Laplace transform.

General instructions
Section A, chapters 01 and 02.
Section B, chapters 03 and 04.
More stress should be given on engineering applications.

Text Book

1. "A text book of Applied Mathematics, volumes – II and III," P. N. Wartikar and J. N. Wartikar

Reference Books

1. "Advanced Engineering Mathematics," H. K. Das
2. "Higher Engineering Mathematics," Dr. B. S. Grewal
3. "Engineering Mathematics," G.V.Kumbhojkar

Biotransport Phenomena – I

Teaching Scheme Lectures: *4* hours/week
Examination Scheme
Theory: *100* Marks, *3* Hours.
Term Work: *25* Marks.

Unit 1 *(16 hours)*
Molecular transport of momentum and the concept of viscosity. Newton's law of viscosity, pressure and temperature dependence of viscosity, convective momentum transport. Shell momentum balances and distribution of velocity in laminar flows. Boundary conditions, flow of a falling film, flow through a circular tube, flow through an annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

Unit 2 *(12 hours)*
Equations of change for isothermal systems. The equation of continuity, the equation of motion, the equation of mechanical energy, the equations of change in terms of the substantial derivative, use of equations of change to solve flow problems, dimensional analysis of the equations of change.

Unit 3 *(4 hours)*
Velocity distributions with more than one independent variable; time dependent flow of Newtonian fluids.

Unit 4 *(4 hours)*
Energy transport. Thermal conductivity and the mechanisms of energy transport, Fourier's law of heat conduction, temperature and pressure dependence of thermal conductivity, convective transport of energy. Shell energy balances and temperature distributions in solids and laminar flow, boundary conditions.

Unit 5 *(4 hours)*
Mass transport. Diffusivity and the mechanisms of mass transport. Fick's law of binary diffusion, temperature and pressure dependence of diffusivities, mass and molar transport by convection, mass and molar fluxes, concentration distributions in solids and laminar flow.

General Instructions
The term work will comprise of at least eight weekly assignments designed to assess the students' ability to apply concepts learned in the classroom to solve numerical problems.

Nature of the Question Paper
There will be two sections worth 50 marks each. There will be five questions in each section. The students are expected to answer any three questions from each section. The focus will be on assessing the ability of students to apply fundamental principles learned during the semester to solve numerical problems.

Text Book

1. "Transport Phenomena," R.B. Bird, W.E. Stewart and E. W.Lighfoot, John Wiley and Sons.

Reference Books

1. "Transport Phenomena," Brodkey, R. S. and Hershey, H. C., McGraw-Hill
2. "Fundamentals of Momentum, Heat, and Mass Transfer," Welty, J.R., Wicks, C.W., Wilson, R.E. and Rorrer, G., John Wiley and Sons.

Bioprocess Calculations

Teaching Scheme Lectures: *4* hours/week
Examination Scheme
Theory: *100* Marks, *3* Hours.
Term Work: *25* Marks.

Unit 1 *(6 hours)*
Dimensions and units, fundamental quantities, derived quantities, conversions. Basic chemical calculations, mole, atomic weight and molecular weight, equivalent weight, solids, liquids and solutions, physical properties of solutions.

Unit 2 *(8 hours)*
Material balances without chemical reactions, process flow sheet, material balances, graphical solution of problems, recycling and bypassing operations, material balances of unsteady-state operations.

Unit 3 *(8 hours)*
Material balances involving chemical reactions, electrochemical reactions, recycling, parallel and bypassing operations, metallurgical applications.

Unit 4 *(10 hours)*
Energy balances, energy and thermochemistry, heat capacity, heat capacity of gases at constant pressure, sensible heat changes in liquids, heat capacity of gaseous mixtures, heat capacity of liquid mixtures, latent heats, enthalpy changes for pure substances and their mixtures in ideal states, equilibrium flash calculations of a multicomponent system, enthalpy changes accompanying chemical reactions, absolute enthalpy, heat of reaction, adiabatic reactions, thermochemistry of mixing processes, dissolution of solids, liquid-liquid mixture, gas-liquid system, heat of solution by partial molal quantities.

Unit 5 *(8 hours)*
Stoichiometry and unit operations, distillation, absorption and stripping, extraction and leaching, crystallization, psychrometry, drying, evaporation. Combustion, fuels, calorific value of fuels, coal, liquid fuels, gaseous fuels, air requirement and flue gases.

General Instructions
Throughout the semester, at least eight weekly take-home assignments will be given to the students. The goal is to assess the students' ability to apply concepts learned in the classroom to solve numerical problems.

Nature of the Question Paper
There will be two sections worth 50 marks each. There will be five questions in each section. The students are expected to answer any three questions from each section. The focus will be on assessing the ability of students to apply fundamental principles learned during the semester to solve numerical problems.

Text Book

1. <u>"Stoichiometry,"</u> Bhatt and Vora.

Reference Books

1. <u>"Basic Principles and Calculations in Chemical Engineering,"</u> D.M. Himmelblau, 6th edition, Prentice Hall India, 1997.
2. <u>"Kinetics and Energetics in Biotechnology,"</u> J.A. Rocks, Elsevier, Amsterdam, 1983.
3. <u>"Biochemical Calculations,"</u> I.H. Segel, Wiley, 1976.
4. <u>"Stoichiometry and Process Calculations,"</u> B. Lakshmikutty, K. V. Narayanan

Biochemistry

Teaching Scheme Lectures: *4* hours/week
Examination Scheme
Theory: *100* marks, *3* hours.
Practical: *50* marks.
Term Work: *25* marks.

Unit 1 The Foundations of Biochemistry

Cellular foundations: cells are structural and functional unit of life, domains of life, Prokaryotic and eukaryotic cell, Structural hierarchy of cells. Chemical foundations. Physical foundations: Dynamic steady state, transformation of energy and matter from surroundings, flow of electrons. Genetic foundations. Evolutionary foundations.

Water: Weak interactions in aqueous systems, ionization of water, weak acids and weak bases, buffering against pH change in biological systems, water as a reactant.

Unit 2 Amino Acids, Peptides and Proteins

Amino acids: structural features, classification - classified by R Group, uncommon amino acids and their functions, amino acids can act as acids and bases, titration curves.

Peptides and Proteins: peptides are chains of amino acids, ionization behavior of peptides, peptides and polypeptide occur in vast range of sizes. Proteins: – Protein classification – fibrous and globular proteins, chemical groups other than amino acids, several levels of protein structure – protein conformation is stabilized by weak interactions, peptide bond, primary structure, Secondary structure, tertiary structure and Quaternary structure. Protein denaturation and folding. Protein-protein and protein-ligand interactions.

Unit 3 Carbohydrates and Glycobiology

Classification, structure and properties of carbohydrates, Monosaccharides and Disaccharides: Monosaccharides – aldoses and ketoses, have asymmetric centers, have cyclic structures, contain variety of hexose derivatives, are reducing agents. Disaccharides contain glycosidic bond.

Polysaccharides – homopolysaccharides are: stored forms of fuel, serve structural role, homopolysaccharide folding. Heteropolysacchrides: bacterial and algal cell walls, glycosaminoglycans (extracellular matrix).

Glycoconjugates: proteoglycans, Glycoproteins and Glycolipids. Carbohydrates are informational molecules: The sugar code.

Unit 4 Nucleotides and Nucleic Acids

Nucleotides have: bases and pentoses, phosphodiester bonds, nucleotide base affect the three dimensional structure of nucleic acids

DNA: Stores genetic information, have distinct base composition, is a double helix, different forms, unusual structures of certain DNA sequences. Messenger RNA code for polypeptide chains, RNA has complex three dimensional structures. Denaturation of double helical DNA and RNA. Nucleic acids from different species can form hybrids.

Other functions of nucleotides: carry chemical energy in cell, Adenine are components of many enzyme cofactors and regulatory molecules.

Unit 5 Lipids

Definition of lipids, classification, storage lipids, structural lipids in membrane, essential and nonessential fatty acids and functions.

Unit 6 Vitamins and Hormones

Vitamins: Classification, functions, role in metabolism, vitamins as cofactors. Hormones, classification, endocrine glands, function and mechanism of action of hormones.

List of Experiments

1. Determining pKa of an unknown acid.
2. Demonstrating buffer's resistance to change the pH on addition of acid/ alkali
3. Color reactions for identification of amino acids:
   a. Ninhydrin Test for amino acids
   b. Xanthoproteic Test for aromatic amino acids
   c. Millon's Test
   d. Sakaguchi Test
4. Biuret test for the identification of peptide bonds.
5. Detection of DNA by Diphenylamine reaction
6. Detection of RNA by Orcinol Method
7. Tests for identification of carbohydrates:
   1. Molisch test
   2. Bial's test for pentoses
   3. Seliwinoff's Test for ketoses
   4. Barfords test for monosaccharides
   5. Benedicts test for reducing sugars
   6. Felings test
8. Hydrolysis of sucrose with acid
9. Identification of an unknown carbohydrate
10. Estimation of reducing sugars with Benedicts quantitative reagent.
11. Determination of Free fatty acids or acid value of an oil

General Instructions

Throughout the semester, at least eight weekly assignments will be given to the students. The goal is to assess the students' ability to apply concepts learned in the classroom to solve problems.

Nature of the Question Paper

One question from each unit with internal choice.

Practical Examination

The students will be expected to perform two of the above experiments (one major, one minor), followed by an oral examination based on subject material covered in the class and during practical. Throughout the semester, students will maintain a journal to record their practical work.

Text Book

1. "Principles pf Biochemistry," A. L. Lehninger, D.L. Nelson and M.M. Cox.
2. "Outline of Biochemistry," Cohn and Stump – Wiley Eastern Ltd.

Reference Books

1. "Review of Biochemistry," Harpers – Prentice Hall
2. "Protein structure and molecular properties," Cregnton
3. "Biochemistry," Lubert Stryer
4. "Biochemistry: The chemical reactions of living cells," David Meltzear- Academic Press New York.
5. "Enzymes," Dixon and Web
6. "Practical biochemistry," J. Jayraman
7. "Practical Biochemistry," Plummer
8. "Principles of Biochemistry," Horton
9. "Instant Notes in Biochemistry," Hames
10. "Analytical Biochemistry," Holmes
11. "The Tools of Biochemistry," Cooper
12. "Fundamentals of Biochemistry," A.C. Deb
13. "Text Book of Medical Biochemistry," Ramakrishnan
14. "Concepts in Biochemistry," Boyer
15. "Practical Biochemistry," A. Rameshwar

Microbiology

Teaching Scheme Lectures: *4* hours/week
Examination Scheme
Theory: *100* marks, *3* hours.
Practical: *50* marks.
Term Work: *25* marks.

Unit 1 Microscopic Techniques

Properties of light, Microscopic resolution, numerical aperture, types of lens aberration and their correlation, Principles and applications of light microscopy: Bright field microscopy, dark field microscopy, Phase contrast microscopy, Fluorescence microscopy, NIDC microscopy, Confocal microscopy.

Principles and applications of Electron Microscopy: SEM, TEM, STEM, and High voltage electron microscopy.

Stain and staining: Classification of stains, Staining theories and staining techniques: Negative, Monochrome and Differential stainings (Gram, Capsule, Spore, and Acid fast staining).

Unit 2 The diversity of the microbial world

Microbial evolution and diversity, Taxonomic ranks, major characteristics used in taxonomy, Bacterial taxonomy, New approaches to bacterial taxonomy, classification including ribotyping, rRNA sequencing, Important genera from gram negative bacteria, gram positive bacteria, cyanobacteria, actinomycetes, fungi and slime moulds. Archaebacteria; thermophiles, methanogens, halophiles.

Unit 3 Microbial Growth

Growth: Bacterial cell division, generation time, specific growth rate, Monoauxic, diauxic and synchronized growth curves, various methods to obtain synchronized cultures, measurement of microbial growth, the continuous culture of microorganisms, sporulation and germination, Effect of environmental factors on microbial growth, Control of microorganisms by physical and chemical agents.

Unit 4 Nutrition

Common nutrient requirements, requirements for carbon, hydrogen and oxygen, nutritional types of microorganisms: autotrophic, heterotrophic, saprophytic and parasitic microbes, requirements for nitrogen, phosphorus and sulfur, growth factors, microbial culture media, isolation of pure cultures and preservation of microbes.

Unit 5 Viruses

Discovery of viruses, Baltimore Classification and Nomenclature of Viruses, general characteristics of viruses, Morphology of viruses. Building a protective coat: Helical structure, capsids or nucleocapsids with icosahedral symmetry (Triangulation numbers) and complex viruses. Viruses with Envelopes: Viral Envelope components, Simple enveloped viruses, enveloped viruses with one or two additional protein layers.

Bacteriophages - isolation, Lytic and Lysogenic Life Cycles, Structure, genome organization, replication or infectious cycle of lambda phage, Antitermination and lambda-repressor control of lysogeny. Animal viruses: life cycle of herpes simplex virus type – I (DNA virus), influenza A virus (RNA virus)

Plant viruses: life cycle of TMV, Viroids and Prions.

List of Experiments

1. Staining of Microorganisms: Gram staining, acid fast staining, negative staining and monochrome staining.
2. Microscopic examination of bacteria, yeasts and molds.
3. Motility determination
4. Isolation and maintenance of organisms by plating techniques and serial dilution methods.
5. Storage and preservation of microorganisms.
6. Isolation of pure cultures from soil, water and air.
7. Growth curve of bacteria.
8. Measurement of bacterial population by turbidometry, serial dilutionmethods.
9. Effect of temperature and pH sources on microbial growth.
10. Biochemical characterization of selected microorganisms.
11. Assay of antibiotics
12. Isolation of phage from sewage.
13. Lysate preparation.
14. Phage titration (phage enumeration by plaque assay)
15. Phage typing

General Instructions
For the term work, class tests will be conducted upon completion of each unit.

Practical Exam
The students will be expected to perform one of the above experiments, followed by an oral examination. The students will also maintain a journal to record their practical work throughout the semester.

Nature of the Question Paper
There will be two sections worth 50 marks each. There will be four questions in each section; the students are expected to answer any three from each.

Text Book

1. "Microbiology," Prescott Harley Klein, McGraw Hill
2. "Microbiology," Pelczar, Reid et al – TMH publications

Reference Books

1. "General Microbiology," Stenier R.Y. et al, McMillan Press. Inc.
2. "Microbiology – Fundamentals and Applications," Purohit

3. "Text Book Of Microbiology," Ananthanarayan
4. "Biology of Microorganisms," Madigam M.T., et.al., Brock, J Prenctice Hall Inc.
5. "Microbial Biotechnology and Fundamentals of applied Microbiology," Glazer A. N., et. al., Freeman.
6. "Extremophiles," Johri B. N 2000, Springer Verlag, NY.
7. "Experiments in Microbiology," Singer.
8. "General Microbiology," Schiegel.
9. "Foundations in Microbiology," Talaro.
10. "Microbiology: a laboratory manual," Cappucinno; 4th edition.
11. "Laboratory Methods in Food Microbiology," Harrigan W. E., Academic Press
12. "Principles of Microbiology," Atlas
13. "Methods In Microbiology" Series
14. "Microbiology – Essentials and Application," Maenne
15. "Practical aspects of Gas Chromatography and mass Spectrometry," G. M. Message, John Wiley and sons, New York.
16. "Gel Chromatography," T. Kremmery, Wiley Publications.
17. "The Use of Radioactive Isotopes in Life Sciences," J.M.Chapman and G. Ayrey, George Allen and Uniwin Ltd, London
18. "Isotopes and Radiation in Biology," C.C. Thornburn, Butterworth and co. Ltd. London.
19. "Microbiology: an Introduction," Tortora Funke Case, the Benjamin/Cummings Publishing Company,INC.
20. "Principles of Virology," S.J. Flint.
21. "Microbiological applications laboratory manual in general microbiology," Benson, McGraw Hill

Communication Skills

Teaching Scheme Lectures: *2* hours/week
Examination Scheme Term Work: *50* Marks

Reading, skimming, scanning, detailed reading, predicting content, interpreting charts and tables, identifying stylistic features in texts, evaluating texts, understanding discourse coherence, guessing meaning from the context, note making, transferring information.

Word formation with prefixes and suffixes, discourse markers and their functions, degrees of comparison, expressions relating to recommendations and comparisons, active and passive voice, antonyms, tense forms, gerunds, conditional sentences, modal verbs of probability and improbability, acronyms and abbreviations, compound nounds and adjectives, spelling, punctuation, sentence definition, static description, comparison and contras, classification of information, recommendations, highlighting problems and providing solutions, formal and informal letter writing, using flow charts/diagrams, paragraph writing, editing.

Defining, describing objects, describing uses/functions, comparing, offering suggestions, analyzing problems and providing solutions, expressing opinions (agreement./disagreement), expressing possibility/certainty, framing questions, providing answers.

Text Books

1. "English for Engineers and Technologists," Volume 1, Humanities and Social Science Department, Anna University, Published by Orient Longman, Ltd., 1990.
2. "Written Communication in English," Sarah Freeman, Orient Longman, 1977.

Reference Books

"Strengthen Your Writing," Narayanaswami, V.R., Orient Longman Ltd., Chennai, 1996 (Revised Edition).

"Technical English, Writing, Reading and Speaking," Pickett and Laster, New York Harper and Row Publications.

"Basic English Usage," Swan, Michael, Oxford University Press, 1984.

"Communication in English," Bhatnagar and Bell, Orient Longman, 1979.

"Professional Communication Skills," Pravin S.R., Bhatia, A.M. Sheikh, S. Chand and Company Ltd., 2003.

Engineering Mathematics – IV

Teaching Scheme Lectures: 4 hours/week
Examination Scheme Theory: 100 Marks, 3 Hours.

Unit 1

Function of complex variables, Introduction, analytical function, Cauchy-Reimann equations in Cartesian and polar form. Harmonic function. Integration, line integral, contour integral, Cauchy integral theorem, extension and Cauchy integral formula (without proof), Taylor's and Laurent's series (without proof). Integration along unit circle and along the upper half semicircle. Conformal transformation and bilinear transformations.

Unit 2

Vector Calculus, Differentiation of vectors, radial and transverse components of velocity and accelerations. Scalar and vector point function. Gradient of scalar point functions. Divergence and curl of vector point function. Solenoid and irrotational fields, line integral, surface integral, Gauss's divergence theorem, Stokes theorem, Green's theorem.

Unit 3

Numerical Methods, Solution of algebraic and transcendental equations by Newton Raphson method, solution of linear simultaneous equation by Gauss eliminations, Gauss Seidal method, Lagrange's interpolation formula. Numerical differentiation, solution of ordinary differential equations by Picard's method. Taylor's series, Euler's modified method, Runge Kutta fourth order method.

Measures of disperation, moments, skewness, and kurtosis.

Unit 4

Z-transforms, Z-transform for elementary functions and properties (without proof), inverse Z transform by residue. Solution of differential equations by Z transform.

Text Book

1. A text book of Applied Mathematics, Volumes – II and III, P. N. Wartikar and J. N. Wartikar

Reference Books

1. Advanced Engineering Mathematics H. K. Das
2. Higher Engineering Mathematics, Dr. B. S. Grewal
3. Engineering Mathematics, G.V.Kumbhojkar

Biological Thermodynamics – I

Teaching Scheme Lectures: *4* hours/week
Examination Scheme
Theory: *100* marks, *3* hours.
Term Work: *25* marks.

Unit 1.
Criterion of phase equilibrium; Ideal solutions and use of Roult's Law to generate P-X-Y and t-x-y diagrams for ideal solutions; flash calculations for ideal solutions; non ideal behavior, partial properties; Gibb's – Duhem equation; fugacity and fugacity coefficient for pure components and for species in solution; calculations of fugacity coefficient using generalized correlation; the excess Gibbs energy; Lewis – Randall rule – activity coefficients from vapor-liquid equilibrium (VLE) data.

Unit 2.
The nature of Phase equilibrium; the phase rule, Duhem's theorem; description of phase diagrams; low- pressure VLE from correlation of data – equations of Margules, van Laar, Wilson, UNIQUAC, UNIFAC; dew-point and bubble – point calculations; flash vaporization calculations; ideal solute behaviour based on Henry's law.

Unit 3.
Solution thermodynamics ; fundamental residual – property relation and fundamental excess – property relation; evaluation of partial properties and property changes of mixing; equilibrium and stability; stability requirement for binary vapor-liquid equilibrium; VLE of systems of limited liquid phase miscibility.

Unit 4.
Applications of equations of state; thermodynamic property calculations for fluid mixtures using the generalized correlation's based on the viral equation of state; properties of fluid mixtures using Redlich-Kwong equation of state and Pitzer's correlation's; VLE and flash calculations using the Redilich – Kwong equation of state.

Unit 5.
Chemical reaction equilibrium; reaction co-ordinate; equilibrium criteria for chemical reactions; equilibrium constant and the effect of temperature; temperature and pressure effects on conversion; calculation of equilibrium conversion for single reactions in homogenous and heterogeneous systems; Duhem's theorem for reacting systems; simple examples of multi-reaction equilibrium.

General Instructions
The term work will comprise of at least eight weekly take-home assignments designed to assess the students' ability to apply concepts learned in the classroom to solve numerical problems.

Nature of the Question Paper

One question from each unit with internal choice.

Text Book

"Introduction to Chemical engineering Thermodynamics," J.M.Smith and H.C. VanNess, Mc Graw Hill book company, Fifth Edition, 1999.

Reference Books

1. "Biological Thermodynamics," D. T. Haynie.

Cell Biology

Teaching Scheme Lectures: *4* hours/week
Examination Scheme
Theory: *100* marks, *3* hours.
Practical: *50* marks.
Term Work: *25* marks.

Unit I Cell Structure and function

Diversity of cell size and shape, cell theory, structure of prokaryotic and Eukaryotic cells, organization and functions of Sub cellular organelles of bacteria, yeast, plant and animal cells.

Unit II Cell Division

Cell division, Molecular control of cell division-leading to tumor, cell cycle regulation, cellular mechanism of development: Cell Differentiation and cell memory, morphogenesis and cell differentiation in prokaryotic cells.

Unit III Biomembranes

Structure and function of biomembranes i.e. plasma membranes, E.R. membranes, mitochondrial and chloroplast membranes and membranes in nitrobacter sp.

Transport across membranes: Types of membrane transport, role of carrier protein, ion channels and membranes potential in membrane transport. Sodium and calcium pump in prokaryotes and Eukarotes, Prepration and application of liposomes.

Unit IV Cellular interaction

Cell – cell interaction: Nerve cell-muscle cell interaction, rhizobium-legume interaction, cell-cell interaction observed in myxobacteria. Siderophores producing microbes and Its Application

Unit V Cell Signaling

Overview of Intracellular Signaling: mechanism, concept of receptor, receptor-ligand interaction, endocrine, autocrine, paracrine transmission, coupling of receptors of different signal transducing machinery, G-proteins, structure, fution, adynylate cyclase system, cAMP, protein kinase and CREB proteins, calcium channels and secondary messengers

List of Experiments

1. Transport across membranes
2. Effect of detergent on membrane permeability
3. Isolation of cellular organelles (nucleus, mitochondria, lysozymes)
4. Study of marker enzyme from isolated organelles
5. Preparation of liposomes
6. Growth and assay of Siderophores.

7. Staining Nucleus by using basic dyes and Feulgen technique
8. Study of Meiosis stages.
9. Study of Mitosis stages in onion root tips

General Instructions

For the term work, class tests will be conducted upon completion of each unit.

Practical Exam

The students will be expected to perform one of the above experiments, followed by an oral examination. The students will also maintain a journal to record their practical work throughout the semester.

Nature of the Question Paper

One question from each unit with internal choice.

Text Book

1. "Molecular Biology of the Cell," Alberts B et al., Garland Publishing House Inc.
2. "Molecular Cell Biology," Lodish et al.
3. "Molecular Cell Biology," Karp

Reference Books

1. "Molecular Cell Biology," Cloudish et al., Freeman and co. New York 1999
2. "Biomembranes – Molecular Structure and Functions," Gennish R B, Springer
3. "Mechanism Receptor regulation," G. Fossil, S.T. Crooke (Eds), Plenum press,1985
4. "Reproduction in eukaryotic cells," D M Proscot, Academic Press
5. "Developmental Biology," S F Gilbert, Sinauer.Inc.
6. "Cell and Molecular Biology," Shheler.
7. "Cell Biology," Sadava and Smith.

Molecular Biology

Teaching Scheme Lectures: *4* hours/week
Examination Scheme
Theory: *100* marks, *3* hours.
Practical: *50* marks.
Term Work: *25* marks.

Unit I Genetic Material

Discovery of genetic material – Experimental evidence, Genome of bacteria, viruses and eukaryotic cells, C-value paradox, Cot value, repetitive and non-repetitive DNA, organelles Genome: mitochondria and chloroplast, Topological Manipulation of DNA

Nucleosomes: Nucleosomes as sub unit of chromatin, organization of histone, Octamer, modes of Epigenic inheritance.

Unit II DNA Replication :

Replication of DNA is semiconservative, semidiscontinuous and primed by RNA, Direction of Replication with experimental evidences, replicons.

Replication of bacteria and Structure of Pol III holoenzyme .

Mechanism of replication of chromosomal DNA, circular plasmids, Teleomers, ϕX174 and Organelle genome.

Replication of eukaryotes and DNA polymerase of eukaryotes, role of licensing factor of eukaryotes during replication, replication of leading and lagging strand. Constancy and Catalytic efficiency of polymerases.

Unit III Transcription

Prokaryotic transcription: Prokaryotic RNA polymerase and its sub units, Sigma factor and Specificity of binding to DNA ,structure of bacterial promoter and their consensus sequences.

Initiation of transcription, elongation and termination, rho dependent and rho independent termination of transcription and post transcriptional modification .

Eukaryotic transcription: RNA polymerase-types and sub units, promoter elements for RNA pol I, pol II and pol III, initiation of transcription by RNA pol I, pol II and pol III and transcription factors involved in initiation, ,elongation and termination of transcription.

chromatin structure and its effect on transcription: a) chromatin structure and gene activity, b) effects of histones on transcription of genes, c) histone acetylation d) histone deacetylation, e) chromatin remodeling and f) nucleosomes and transcription elongation.

Post-transcriptional modification of r-RNA, t-RNA and m-RNA, polyadenylation, intron splicing, role of snurps.

Unit IV Translation

Experiment on direction of protein synthesis, t-RNA as Adaptor, ribosomes and their organization in prokaryotes and eukarotes.

Bacterial translation: polycistronic RNA in bacteria ,initiation of translation in bacteria small sub unit ,its accessory factor ,SD sequences in bacteria ,initiator t-RNA, elongation of translation, translocation and termination mechanism.

Eukaryotic translation: initiation, elongation and termination. Role of ribosomal RNA in protein synthesis and summary of genetic code.

Post translational modification of proteins, protein folding, membrane localization, localization in organelles, co-translational transfer through ER, transport of proteins to nucleus, oligosaccharide addition to proteins.

Unit V Mutation and Repair

Mutation:

Types of mutation: point, frame shift, lethal, conditional lethal, inversion and deletion, null mutation, Reversion of mutation, intra and intergenic suppression. Enrichment of mutant of single type. Spontaneous and induced mutation: Physical and chemical mutagen

Repair of DNA:

Repair mechanism in prokaryotes: 1) Light dependant repair - photo reactivation. 2] Light independent repair: a) excision repair, b) mismatch repair, c) sos repair and d) recombination repair

Eukaryotic repair mechanism: 1) Excision repair in Eukaryotes – a] global genome – nucleotide excision repair (GG-NER) and b]transcription coupled - nucleotide excision repair [TC-NER], 2) Base excision repair (BER) and 3) Double strand break repair in eukaryotes.

List of Experiments

1. Spontaneous mutation in bacteria by Fluctuation test.
2. Induced mutation using chemical mutagens.
3. Induced mutation using physical mutagens
4. Auxotroph enrichment by ampicillin method.
5. Dark Repair mechanism in E.Coli.
6. Light repair mechanism in E.coli.
7. Repair mechanism in Yeast
8. Study of genotype and its conformation.
9. Isolation of Bacterial DNA.

General Instructions
For the term work, class tests will be conducted upon completion of each unit.

Practical Exam
The students will be expected to perform two of the above experiments (one major, one minor), followed by an oral examination based on subject matter covered during the semester. The students will also maintain a journal to record their practical work throughout the semester.

Nature of the Question Paper
There will be two sections worth 50 marks each. There will be four questions in each section; the students are expected to answer any three from each.

Text Book

1. "Gene VI," or "Gene VII," Benjaman Lewin,Oxford university press
2. "Essentials of Molecular Biology," David Friedfielder, Jonnes and Barlett Publication

Reference Books

1. "Molecular Biology," Weaver
2. "Encyclopedia of Molecular Biology," J.Kendrew-,Black Well Scientific Publication
3. "Molecular Biology of the Gene," J. D. Watson, N. H. Hopkins, J. W. Roberts, Benjamin Cummings Publ.co.inc.California
4. "Molecular Biology of the Cell," J.Darnell, et al (2nd edition), Garland publishing inc.
5. "Molecular Biology and Biotechnology," Meyers R A (ed), VCH Publisher NY inc
6. "Molecular Biology of the Cell," Alberts B, et al, Garland Publishing inc.
7. "Recombinant DNA," Watson J D.
8. "Essentials of Moleculars Biology," Malacimski
9. "Molecular Biology," Stansfield
10. "Molecular Biology and Biotechnology," Walker
11. "Essentials of Molecular Biology vols. 1 and II," Brown T A
12. "Molecular Genetics Of Bacteria," Dale

Numerical Methods and Computer Programming

Teaching Scheme
Lectures: 2 hours/week
Practical: 2 hours/week
Examination Scheme
Practical: *25* marks.
Term Work: *25* marks.

Unit 1

Solution of linear algebraic equations, Gauss-Jordan elimination.

Unit 2

Integration, classical formulas, elementary algorithms.

Unit 3

Root finding and nonlinear sets of equations

Unit 4

Minimization, golden section search in one dimension

Unit 5

Ordinary differential equations, Runge-Kutta methods.

General Instructions
Every week, students will be expected to write code in a programming language of their choice (recommended 'C') to obtain numerical solutions for problems discussed in the class. At least eight problems will be solved during the course of the semester.

Practical Exam
The students will provide an algorithm and write code to obtain a numerical solution for one problem based on the subject matter covered during the semester. This will be followed by an oral examination. The students will also maintain a journal to record their programming assignments throughout the semester.

Text Book

1. "Numerical Recipes in C," W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery.

Biochemical Reaction Engineering – I

Teaching Scheme Lectures: *4* hours/week
Examination Scheme

Theory: *100* marks, *3* hours.
Term Work: *25* marks.

Unit 1 *(3 hours)*
Overview of chemical reaction engineering, classification of reactions, rate of reaction and variables affecting it, speed of chemical reactions.

Unit 2 *(6 hours)*
Homogeneous reactions in ideal reactors, kinetics of homogeneous reactions, simple reactor types, the rate equation, single and multiple reactions, elementary and non-elementary reactions, molecularity and order of reaction, rate constant, temperature dependent term of a rate equation, reaction rate from theory.

Unit 3 *(7 hours)*
Interpretation of batch reactor data, constant volume batch reactor, varying volume batch reactor, temperature and reaction rate, rate equation.

Unit 4 *(8 hours)*
Introduction to reactor design, ideal reactors for a single reaction, ideal batch reactor, space-time and space-velocity, steady state mixed flow reactor, steady state plug flow reactor, holding time and space time for flow reactors.

Unit 6 *(8 hours)*
Design for single reactions, size comparison of single reactors, batch reactor, mixed versus plug-flow reactors, multiple reactor systems, recycle reactor, autocatalytic reactions

Unit 7 *(8 hours)*
Introduction to biochemical reaction systems, enzyme fermentation, Michaelis-Menten kinetics, batch fermentor, plug flow fermentor, mixed flow fermentor, inhibition by a foreign substance – competitive and noncompetitive inhibition.

General Instructions
The term work will comprise of at least eight weekly assignments designed to assess the students' ability to apply concepts learned in the classroom to solve numerical problems.

Nature of the Question Paper
There will be two sections worth *50* marks each. There will be five questions in each section. The students are expected to answer any three questions from each section. The focus will be on assessing the ability of students to apply fundamental principles learned during the semester to solve numerical problems.

Text Books

1. "Chemical Reaction Engineering," Octave Levenspiel, John Wiley and Sons.
2. "Elements of Chemical Reaction Engineering" H. Fogler.

10 copies.