NORTH MAHARASHTRA UNIVERSITY,

JALGAON (M.S.)

THIRD YEAR ENGINEERING(T.E.)

BIOTECHNOLOGY

TERM – I & II

W.E.F. 2008-2009

NORTH MAHARASHTRA UNIVERSITY, JALGAON

STRUCTURE OF TEACHING & EVALUATION

T.E. (BIOTECHNOLOGY) **W.E.F.2008-2009**

First Term

Sr. No.	Subject	Teaching Scheme Hours/Week		Examination Scheme				
		Lectures	Practical	Paper Duration Hours	Paper	TW	PR	OR
1	Bio Process Principles	04	--	03	100	25	--	--
2	Chemical Reaction Engineering	04	04	03	100	25	--	50
3	Mass Transfer-I	04	04	03	100	25	50	--
4	Molecular Biology & Genetic Engineering	04	04	03	100	25	--	25
5	Enzyme Engineering	04	--	03	100	25	--	--
		20	12		500	125	50	75
	Grand Total	32			750			

Second Term

Sr. No.	Subject	Teaching Scheme Hours/Week		Examination Scheme				
		Lectures	Practical	Paper Duration Hours	Paper	TW	PR	OR
1	Instrumentation & Process Control	04	02	03	100	25	--	25
2	Biological Thermodynamics	04	02	03	100	25	--	--
3	Mass Transfer-II	04	04	03	100	25	50	--
4	Biotechnology of Waste Treatment	04	04	03	100	25	--	25
5	Fermentation Biotechnology- I	04	--	03	100	25	--	--
6	Practical Training/Mini Project/Special Study	--	--	--	--	25	--	--
		20	12		500	150	50	50
	Grand Total	32			750			

T.E. BIOTECH TERM I

1. BIOPROCESS PRINCIPLES

Teaching Scheme:
Lecturers: 4Hrs/week.

Examination Scheme
Paper: 100 marks (3Hrs)
Term work: 25 marks

Unit: I
Introduction: Bioprocess development, Material balance: Procedure for material balance calculations, material balances – worked examples, Material balance with recycle, By pass and purge systems, Growth stoichiometry and elemental balance. Biomass yield, Theoretical O_2 demand, worked out examples on above**,** Energy Balance: Procedure for energy balance calculations without and with reaction, worked out examples, Energy balance equation for cell culture, Fermentation energy balance, worked out examples, Unsteady state material and energy balance (USMEB): Unsteady state material balance equations, unsteady state energy balance equations and worked examples on USMEB.

(10 Hrs, 20 Marks)

Unit: II
Heat transfer in Bioprocess: Design equation for heat transfer process, Energy balance, Logarithmic and arithmetic mean temperature difference, Calculation for heat transfer coefficient for flow outside tubes, without phase change and for stirred liquids, Applications of design equations, Relationship in between heat transfer, cell concentrations and stirring conditions, Numerical based examples on above.
Mass transfer in Bioprocess: Role of diffusion in bioprocessing, Different equations in mass transfer (liquid-solid, liquid-liquid and gas-liquid) , Oxygen uptake in cell culture: Factors affecting cellular oxygen demand, Oxygen transfer from gas bubble to cells, Oxygen transfer in fermenter, measuring dissolved oxygen concentrations, Measurement of K_La: Oxygen balance method, Gassing out techniques (static method of Gassing out and dynamic method of Gassing out) Sulphite oxidation, Factors affecting K_La, Oxygen transfer in large vessels, Numerical based examples on above.

(10 Hrs, 20 Marks)

Unit: III
Fermentation broth: Viscosity, Viscosity measurement, types of viscometers, uses of viscometer with fermentation broths, Rheological properties of fermentation broths, Factors affecting broth viscosity (Cell concentration, cell morphology, and osmotic pressure, product and substrate concentrations).
Mixing in Fermenters: Mechanism of mixing, Assessing mixing effectiveness, estimation of mixing time, Power requirement for mixing: Ungassed Newtonian fluids, ungassed non-Newtonian fluids, Gassed fluids, Calculation of power requirements, Scale up of mixing systems, Improving mixing in Fermenters, Effect of rheological properties on mixing, Role of shear in stirred fementers: Interaction between cells and turbulent eddies, Bubble shear, operating conditions for shear damage.

(10 Hrs, 20 Marks)

Unit: IV

Kinetics of Substrate utilization, product formation and biomass production in cell cultures, General reaction kinetics for biological systems: Zero order kinetics, First order kinetics, Numerical based examples on this, Yields in cell cultures: Overall and instantaneous yields, Theoretical and observed yields, Numerical based examples on this. Cell growth kinetics: Batch growth kinetics, kinetics of balanced growth, Monod growth kinetics, factors affecting growth kinetics with plasmid instability, kinetic implication of endogenous and maintenance metabolisms, transient growth kinetics, unstructured batch growth model, Growth of filamentous organisms, structured kinetic model, Product formation Kinetics: unstructured model, chemically structured product formation kinetics, model, product formation kinetics by filamentous organisms, segregated kinetics models of growth and product formation, Biomass production: Biomass yield from substrate, Kinetics of cell death, Numerical based examples on this.

(10 Hrs, 20 Marks)

Unit: V

Heterogeneous reactions in bioprocessing, Concentration gradient and reaction rates in solid catalyst: True and observed reaction rates, Interaction between mass transfer and reaction, Mass transfer and reaction: Steady state shell mass balance, first order kinetics and spherical geometry, zero order kinetics and spherical geometry, Michaelis-Menten Kinetics and spherical geometry, Prediction of observed reaction rates, The Thiele modulus and effectiveness factor: Zero order kinetics, First order kinetics, Michaelis-Menten Kinetics, The observable Thiele Modulus, Weiss's criteria, Minimum intracatalyst substrate concentration, External mass transfer, Liquid-solid mass transfer correlations: Free moving spherical particles, Spherical particles in packed bed, Minimizing mass transfer effect: Internal mass transfer and external mass transfer, Evaluation of true kinetic parameters, General comments on Heterogeneous reaction in bioprocessing.

(10 Hrs, 20 Marks)

References

1. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier.
2. James E. Bailey, David F. Ollis, Biochemical Engineering Fundamentals, Mc Graw-Hill Book Company.
3. Michael L. Shuler, Fikret Kargi, Bioprocess Engineering, Basic concepts, Prentice Hall India Pvt. Ltd., New Delhi.
4. J. F. Richardson and D. G. Peacock, Coulson and Richardson's Chemical Engineering (Vol: 3) Asian Books Pvt. Ltd., New Delhi.
5. Murray Moo-Young, Comprehensive Biotechnology (Vol: 1), Pergamon Press, An imprint of Elsevier.

Term Work shall be based on the following assignments:

1. Material and Energy balances in Bioprocesses
2. Unsteady state material and Energy balances and fermentation energy balances
3. Heat and Mass transfer in bioprocesses
4. Oxygen transfer in fermenter

5. Fermentation broth(Viscosity and Rheological properties)
6. Mixing in fermenter
7. Kinetics of Substrate utilization, product formation and biomass production in cell Cultures
8. Heterogeneous reactions in bioprocesing

2. CHEMICAL REACTION ENGINEERING

Teaching Scheme:	Examination Scheme:
Lectures: 4 Hrs. / Week	Paper: 100 Marks (3 Hrs)
Practical: 4 Hrs. / Week	Oral: 50 Marks
	Term Work: 25 Marks

Unit: I

Introduction to chemical reaction engineering: Review of chemical reaction equilibrium, Classification of chemical reaction, rate of reaction, order and molecularity of reaction, rate constant, Temperature dependent term of rate equation, comparison of theories, Activation energy and temperature dependency, rate of reaction predicted by theories, Reaction mechanism.

(10 Hrs, 20 Marks)

Unit: II

Collection and interpretation of kinetic data, Constant volume batch reactor, integral and differential method of analysis of data, Variable volume batch reactor, integral and differential method of analysis of data, The search for rate equation.

(10 Hrs, 20 Marks)

Unit: III

Ideal batch reactor, mixed flow reactor, plug flow reactor, space time and space velocity, holding time and space time for batch, mixed and plug flow reactors, comparison in mixed and plug flow reactors, Combined flow system, Recycle reactor, Autocatalytic reaction, Introduction to multiple reactions: Series and parallel reactions. Introduction to non-ideal flow.

(10 Hrs, 20 Marks)

Unit: IV

Introduction – Rate equations for heterogeneous systems, Contacting patterns in Two – Phase system, Introduction to fluid particle reaction non-catalytic reactions, unreacted core model for Spherical particle of unchanging size, Rate of reaction for shrinking spherical particles, Determination of rate controlling step, Various contacting patterns in fluid solid reactors for fluid-particle non-catalytic reactions

(10 Hrs, 20 Marks)

Unit: V

Introduction to solid catalyzed reactor, Rate equation for adsorption, desorption and surface reaction, Diffusion and reaction in spherical catalyst pellets, Internal effectiveness factor, Over all effectiveness factor, Estimation of diffusion and reaction limited regimes, Mass transfer and reaction in a packed bed, The determination of limiting situation from reaction data, Introduction to heterogeneous catalytic reactors with applications.

(10 Hrs, 20 Marks)

References

1. Octave Levenspiel, Chemical reaction engineering, John Wiley and sons.
2. J.M. Smith, Chemical engineering kinetics, McGraw Hill
3. S.D. Dawande, Principles of reaction engineering, Central Techno publication, Nagpur.
4. H.Scott Fogler, Elements of chemical reaction engineering, Prentice Hall New Jersy.
5. Lanny D. Schimdt , Chemical reaction engineering, Oxford University Press.

Practical and Term work shall consist of minimum eight experiments from list given below.

1. To determine the reaction rate constant {k} for given reaction.(CSTR / BATCH / SEMIBATCH / PFR)
2. To determine the effect of temperature on reaction rate constant. .(CSTR / BATCH / SEMIBATCH / PFR)
3. To determine the activation energy {E} for the given reaction. .(CSTR / BATCH / SEMIBATCH / PFR)
4. To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance { σ^2} and skew ness { S^3} for plug flow reactor.
5. To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance {σ^2} and skew ness {S^3} for packed Bed reactor.
6. To study the cascade CSTR.
7. To study the reaction of solid liquid system for an instantaneous reaction for benzoic acid, NaOH and calculate the enhancement factor.
8. To study the isothermal decomposition of ethyl alcohol in tubular reactor packed with activated alumina catalyst.
9. Adsorption: To study the adsorption of Acetic acid on charcoal.

3. MASS TRANSFER-I

Teaching Scheme:	Examination Scheme:
Lectures: 4 Hrs. / Week	Paper: 100 Marks (3 Hrs)
Practical: 4 Hrs. / Week	Practical: 50 Marks
	Term Work: 25 Marks

Unit: I

Introduction to mass transfer operations, Steady state molecular diffusion in fluid at rest, Multicomponent mixture diffusion, Maxwell's law of diffusion. Diffusion in solids, unsteady state diffusion

(10 Hrs, 20 Marks)

Unit: II

Eddy (turbulent) diffusion: Relation between mass transfer coefficients. Mass transfer coefficient in laminar and turbulent flow. Theories of mass transfer. Equipments for gas liquid operation

(10 Hrs, 20 Marks)

Unit: III

Equilibrium for mass transfer process: Local two phase mass transfer. Local overall mass transfer coefficient, Use of local overall coefficient. Material balances for steady state co current, countercurrent, cross flow cascade, counter flow cascade. Application of mass transfer processes.

(10 Hrs, 20 Marks)

Unit: IV

Introduction to Gas Absorption Operation: Equilibrium solubility of gases in liquids. Material balance for one component transferred in countercurrent flow and co current flow. Countercurrent multistage operation, one component transferred. Continuous contact equipment. Introduction to multi component system. Absorption with chemical reaction. Different absorption operation equipments (plate tower, packed tower, venturiscrubber) Operational difficulties like coning weeping, dumping, priming, flooding in plate and packed tower.

(10 Hrs, 20 Marks)

Unit: V

Introduction to Humidification: Vapour liquid equilibrium, Humidification terms. Determination of humidity, Humidification and dehumidification. Water cooling operation equipment. Introduction to Drying operation: Rate of drying, Mechanism of moisture movement during drying, Drying equipments, Different methods of drying

(10 Hrs, 20 Marks)

Practicals and term work shall be based on experiments mentioned below.

1. Diffusion in Still Air: To estimate mass transfer coefficient for given system at room temperature.
2. Liquid – Liquid Diffusion: To determine diffusion coefficient for given system as function of concentration.
3. Solid – Liquid Diffusion: To determine mass transfer coefficient for dissolution of benzoic acid without chemical reaction.
4. Wetted Wall Column: To determine mass transfer coefficient for air – water system.
5. Absorption in Packed Column: To find mass transfer coefficient of given system.
6. Cooling Tower: To determine volumetric mass transfer coefficient for air – water system.
7. Natural Drying (Batch): To obtain drying curve for batch drying operation.

8. Fluidized Bed Dryer: To determine the rate of drying and to obtain mass transfer coefficient for the given material.

References:

1. R.E.Treybal , Mass transfer operation ,McGraw Hill Publication
2. Coulson and Richardson Chemical Engineering (Vol. I and II), Pergamon Press
3. Christie J.Geankoplis ,Transport Processes and Unit Operations ,Prentice Hall inc
4. P. Chattopadhayay ,Unit operation in Chemical Engg. (Vol. I and II), Khanna Publications Delhi.

4. MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Teaching Scheme:
Lecturers: 4Hrs/week.
Term work: 4Hrs/week

Examination Scheme
Paper: 100 marks (3Hrs)
Oral: 25 marks
Term work: 25 marks

Unit: I
Introduction, Replication, DNA repair and DNA recombination:
C-value paradox, organization of genes (overlapping genes, antigens), central dogma, one gene – one polypeptide hypothesis. Replication: Enzymes and proteins involved in DNA replication: Structure and functions of DNA polymerase I,II,III, primase, polynucleotide ligase, endonuclease, helicase, single stranded binding proteins, topoisomerase. Types of DNA replication: Semi conservative method of replication, Meselson and Stahl experiment, bidirectional DNA replication, generalized model for the DNA replication, replication of E.Coli and eukaryotes chromosomes. DNA repair: Mismatch repair, base-excision repair, nucleotide excision repair, direct repair. DNA recombination: Homologous genetic recombination, site –specific recombination. Enzymes in DNA recombination

(10 Hrs, 20 Marks)

Unit: II
Gene expression
Transcription: RNA polymerase of prokaryotes and Eukaryotes (structure, types and function), transcription factors, Basal transcription factors, mechanism of transcription in eukaryotes and prokaryotes, Eukaryotic promoters, the enhancers.
RNA processing: Introduction, processing of the ribosomal RNA, transfer RNA, and the messenger RNA (eukaryotic),RNA splicing by group 1 and group 2 introns (mechanism).
Translation:-Genetic code; wobble hypothesis, ambiguity, degeneracy, universality of the genetic code. Protein synthesis:-Structure of Ribosome, t –RNA, messenger RNA. Steps in the protein synthesis: Activation of the amino acids, initiation (formation of amino acyl t –RNA), Elongation; termination and release, folding and post translational processing

(10 Hrs, 20 Marks)

Unit: III

Regulation of gene expression in prokaryotes and eukaryotes:

Introduction, levels of DNA regulation:-DNA replication in gene regulation, regulation of the transcription, Operon concepts (lac, tryptophan and arabinose operon) regulatory proteins, DNA binding proteins (zinc finger and helix –turn- helix), protein binding domains (leucine-Zipper and basic helix -loop-helix), Regulation of translation, regulation of genes expression in eukaryotes.

(10 Hrs, 20 Marks)

Unit: IV

Genetic engineering

Introduction, Brief outline of the genetic engineering (rDNA)

Properties of good vectors, vectors used in genetic engineering: plasmid vectors (PBR 322, PUC plasmids, M13 vectors), cosmids, bacteriophages, yeast artificial chromosomes, bacterial artificial chromosomes. Enzymes used in genetic engineering: Restriction endonuclease (type I, II and III), DNA ligase, DNA polymerase, Reverse transcriptase, polynucleotide kinase, terminal deoxynucleotidyl transferase, alkaline phosphatase. Integration of the DNA insert into the vector: Both ends of the cohesive and the compatible, Both ends cohesive and separately matched, Both ends cohesive and mismatched, both ends flush / blunt one end cohesive and compatible.

(10 Hrs, 20 Marks)

Unit: V

Construction of the DNA libraries: Isolation and purification of nucleic acids, isolation of plasmids, construction of the genomic and cDNA libraries, methods of gene transfer: direct transformation (polyethylene glycol, Ca++, microinjection, nuclear transplantation), Using vectors (Ti plasmids in plants,SV40 vectors for animals), using viruses (cauliflower mosaic virus, Gemine virus, papilioma virus, retro virus), Gene transfer in bacteria (conjugation, transformation and transduction), analysis and expression of cloned gene ,Gene amplification ,PCR and its application: Basic PCR and inverse PCR, molecular probes and its application, Labeling of probes: radioactive and non radioactive probe labeling.

(10 Hrs, 20 Marks)

References:

1. B.D. Singh, Genetics –Rastogi publication
2. Lehninger , Principles of the biochemistry- Nelson MacMillan press
3. B.D. Singh Basic biotechnology , Kalyani Publisher.
4. Primrose S. B. Principles of gene manipulation- Blackwell scientific publication
5. Bruse Albertis , Molecular biology of the cell , Garland publication.

Practical and Term work shall consist of minimum eight experiments from list given below .

1. Isolation of genomic DNA from bacteria.
2. Isolation of RNA from yeast.
3. Isolation of total plasmid DNA from bacteria.
4. Restriction digestion of genomic DNA of bacteria.
5. Ligation of bacterial DNA.

6. Calculation of molecular weight by using DNA marker with agrose gel electrophoresis.
7. DNA extraction from Blood.
8. Plasmid preparation.
9. DNA fingerprinting (by RFLP)
10. To study Bacterial transduction.

References:

1. S. Harisha. An Introduction to Practical Biotechnology. Laxmi Publications (P) Ltd. New Delhi.
2. Aneja K.R.(2nd Edn., 1996). Experiments in Microbiology, Plant pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan, New Age International (P) Ltd.
3. Plummer David T. “An Introduction to Practical Biochemistry”, Tata McGraw-Hill Pubblishing Co. Ltd., New Delhi.
4. Jayraman J. A Laboratory Manual in Biochemistry. New Age International Publishers

5. ENZYME ENGINEERING

Teaching Scheme:
Lecturers: 4Hrs/week.

Examination Scheme
Paper: 100 marks (3Hrs)
Term work: 25 marks

Unit: I
Introduction, Nomenclature and classification of enzyme, Chemical nature and properties of enzymes: General basis of catalysis (Activation energy), Thermodynamic definition of enzyme catalysis, Binding energy, Transition state, Specificity (Substrate Specificity , Stereo specificity and Geometric specificity), Active site, allosteric site. Structure and Function of some cofactor and coenzymes. Factors effecting enzymes activity, Models of enzyme activity: Lock and key model, Induced fit, Substrate Strain model. Isoenzyme, with example and its application.

(10 Hrs, 20 Marks)

Unit: II
Kinetics of enzyme:
Enzyme kinetics, rate equation, Rate of reaction, First order and second order reaction, Michaelis – menten equation (Steady state kinetics) and Haldane relationship, Significance of Km, Lineweaver – Burk or Double – reciprocal plot, Eadie-Hofstee plot, Hanes plot, Turnover number, Specificity constant, Bisubstrate reaction, Inhibition kinetics : Reversible inhibition (Competitive, uncompetitive and Mixed inhibition) with kinetics, Irreversible inhibition, Application of enzyme inhibition, Regulation of enzyme activity (coarse control and fine control) and it’s types, Allosteric enzymes, Kinetic properties of Allosteric enzymes , models for allosteric behaviors (MWC model and KNF model), Feedback inhibition, Cascade system (Genetic regulation) ,Numerical on above kinetics.

(10 Hrs, 20 Marks)

Unit: III

Enzymatic catalysis**:**

Catalytic mechanism : Acid-base catalysis, Covalent catalysis, Metal ion catalysis, Electrostatic catalysis, Proximity and Orientation effects, preferential binding of the transition state complex, Mechanism and action of some enzymes: chymotrypsin, RnaseA, Lysozyme, Hexokinase, Enolase, Lactate dehydrogenase, Alcohol dehydrogenase, Glutathione reductase, Pyruvate dehydrogenase.

Bisubstrate or Multisubstrate reaction: Ping – Pong mechanism, sequential mechanism, (Compulsory ordered and Random ordered), Enzyme model
(Host guest complexation chemistry).

(10 Hrs, 20 Marks)

Unit: IV

Immobilization of enzymes**:**

Techniques of enzyme Immobilization : Adsorption, Covalent linkage, Matrix entrapment, Encapsulation with example, Kinetics of immobilized enzyme, effect of solute Partition and diffusion on the kinetics of immobilized enzymes, Immobilized enzyme in bioconversion process (Production of L-amino acid from racemic mixture), Bioreactors using immobilized enzymes.

Enzyme Purification –

Introduction, objective in enzyme Purification, Steps involved in enzyme purification: Choice of source, Method of homogenization, Methods of separation: Depends on size or mass (Centrifugation, Gel filtration), Method depend on Polarity (Ion-exchange, electrophoresis, Iso-electric focusing), depends on changes in solubility (change in pH, ionic strength, Dielectric constant), Based on specific binding (Affinity chromatography)
Example of purification procedure (Adenylate kinase, RNA polymerase).

(10 Hrs, 20 Marks)

Unit: V

Enzyme engineering and Industrial uses of enzymes:

Design and construction of novel enzymes (protein engineering), Artificial Enzymes, Enzymes used in detergents, use of Proteases in food, Leather and wood industries, methods involved in production of Glucose syrup from starch, production of maltose and sucurose, glucose from cellulose, Use of Lactase in dairy industry, glucose oxidase and catalase in food industry, medical application of enzymes, Enzymes in biosensors.

(10 Hrs, 20 Marks)

References:

1. Lehninger, Nelson and cox. Principles of Biochemistry –Macmillan publishers.
2. Voet and Voet, Biochemistry, Wiley publisher.
3. Biotol series, Principles of Cell energetics , Butterworth- Heinemann Ltd,Jordan Hill, Oxford.

4. Biotol Series, Principles of enzymology and its application, Butterworth-Heinemann Ltd,Jordan Hill, Oxford.
5. Nicholascprice and Tewis stereous, Fundamentals of Enzymology, Oxford University press.
6. Palmer, Enzymes, Oxford University press.
7. Michael L. Shuler, Fikret Kargi, Bioprocess Engineering, Basic concepts, Prentice Hall India Pvt. Ltd., New Delhi.. .
8. J. F. Richardson and D. G. Peacock, Coulson and Richardson's Chemical Engineering (Vol: 3) Asian Books Pvt. Ltd., New Delhi
9. Murray moo-young, Comprehensive Biotechnology Pergemon Press(Vol 2)
10. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier.
11. James E. Bailey, David F. Ollis, Biochemical Engineering Fundamentals, Mc Graw-Hill Book Company.

Term work shall be based on following assignments:

1. Enzymes: Nomenclature, Classification and Properties.
2. Enzyme Kinetics: Michaelis – Menten Equation and evaluation of parameters of Michaelis – Menten Equation.
3. Inhibition kinetics of enzyme.
4. Enzymatic catalysis.
5. Bisubstrate or Multisubstrate reaction.
6. Immobilization of enzyme.
7. Enzyme purification.
8. Enzyme engineering and Industrial application of enzymes.

T.E. BIOTECH TERM II

1. INSTRUMENTATION AND PROCESS CONTROL

Teaching Scheme:	Examination Scheme:
Lectures: 4 Hrs. / Week	Paper: 100 Marks (3 Hrs)
Practical: 2 Hrs. / Week	Oral: 25 Marks
	Term Work: 25 Marks

Unit: I

Qualities of Measurement: The meaning of measurement, the elements of instruments, Static Characteristics, Dynamic characteristic. Expansion Thermometers: Introduction, Temperature scales, Constant volume gas thermometer, Bimetallic Thermometer, Industrial pressure spring thermometer, Response of Thermometer.

Thermoelectric Temperature Measurement: Introduction, Simple thermocouple circuit, Industrial thermocouples, Thermocouple lead wires, thermal wells, response of thermocouples. Resistance Thermometer: Introduction, Industrial resistance-thermometer bulbs, Resistance Thermometer element, Resistance thermometer circuit, RTD.

(10 Hrs, 20 Marks)

Unit: II

Pressure and Vacuum Measurement: Introduction, Indicating pressure gage, Bellows pressure element, Useful ranges of absolute pressure measuring gages, Mclead vacuum gage.

Measurement of Level: Float and tape liquid level gage, Float and shaft liquid level unit, Level measurement in pressure vessels, Gamma ray method, Ultrasonic method and resistive method.

Introduction, Theory, Instrumentation, advantages, and Application of: pH measurement, Refractrometry, Potentiometry, colourometry and Flame photometry.

(10 Hrs, 20 Marks)

Unit: III

Characteristics of Chemical Process Control, Mathematical Modeling of Chemical Processes, State Variables and State Equation for Chemical Processes. Input –Output Model, Linearization of non linear systems, Solution of Linear differential equation using Laplace Transform.

First order system and their transfer functions. Dynamic behavior of first order system , Pure capacity process, First order system with variable time constant and gain, Response of first order system in series :Interacting and Non-interacting.

(10 Hrs, 20 Marks)

Unit: IV

Second order system and their transfer function. Dynamic behavior of second order system: under damped and over damped and critically damped systems, Transportation lag. Higher order systems.

(10 Hrs, 20 Marks)

Unit: V

Introduction to feedback control, Controllers and final control elements. Control action block diagram of chemical reactant control systems.

Dynamic behavior of feedback control processes: P, PD, PI, and PID.

Stability analysis by Routh criteria, Root Locus Diagram

Frequency response analysis of linear processes: Bode's diagram, Nyquist plots.

(10 Hrs, 20 Marks)

Reference:

1. D.P.Eckman, Industrial Instrumentation, Willey Eastern Ltd., New Delhi.
2. Patranabis D. Industrial Instrumentation, Tata – Mcgraw Hill Publications, New Delhi.
3. Gurdeep Chatwal and Sham Anand, Instrumental methods of Chemical analysis, Himalaya publication House, Mumbai.
4. V.P. Kudesia and S.S. Sawhaney, Instrumental methods of chemical analysis Pragati Prakashan, P.O.Box No. 62, Begum Bridge,Meerut250001,U.P.
5. Nakra B.C. and K.K. Chaudhary, Instrumentation Measurement and Analysis, Tata – McGraw Hill, New Delhi.
6. B.K.Sharma.Goel, Instrumentation methods of chemical analysis, Publishing House,11,Shivaji Road, Meerut-250001,U.P.
7. George Stephanpolous, Chemical Process Control, Prentice Hall of India.
8. D.R. Coughnour, Process System Analysis and Control, McGraw-Hill.
9. R.P.Vyas, Process Control and Instrumentation {2^{nd} edition}. Central Techno publication, Nagpur.
10. K. Krishnaswamy, Process Control, New age International.

Practical and term work shall consist of minimum eight experiments given below.

1. To study the response of bimetallic thermometer.
2. Calibration of thermocouple.
3. To measure the pH of given solution..
4. To determine concentration of given solution by colorimeter
5. Flame photometry
6. Abbey's refractometer
7. Dynamic behavior of first order system: Single tank system.
8. Dynamic behavior of first order system in series: Two tank non-interacting system.
9. Two tank interacting system.
10. Dynamic behavior of second order system: Mercury Manometer
11. Dynamic behavior of final control Element: Pneumatic control valve.
12. Study of Pneumatic controllers: Proportional Controller/ Proportional Derivative Controller/ Proportional Integral Controller/ Proportional Integral Derivative Controller

2. BIOLOGICAL THERMODYNAMICS

Teaching Scheme:
Lecturers: 4Hrs/week.
Term work: 2Hrs/week

Examination Scheme
Paper: 100 marks (3Hrs)
Term work: 25 marks

Unit: I
Introduction:
Distribution of energy, system boundary and surroundings, energy and biological world, energy flow (transformation), mass and energy recycling, energy conversions, energy (nutritional) requirements of living systems, cell structure and division of labor in cells, metabolism (anabolism, catabolism), energy relations between catabolic and anabolic pathways, intermediary metabolism, three types of non linear metabolic pathways, Energy production and consumption in metabolism, flow of electrons in organisms, energy coupling reactions, activation energy(enzyme reaction), living cells as self regulating chemical engines, assembly of information macro molecules .

(10 Hrs, 20 Marks)

Unit: II
Biological Thermodynamics Concepts:
Types of systems, biological thermodynamics, zeroth law and first law of thermodynamics, internal energy, enthalpy, Hess's law, entropy and second law of thermodynamics, entropy in biological world, Gibb's free energy, Gibb's and Helmholtz function(derivation), relation between Gibb's energy and equilibrium, standard free energy change in biochemical reactions, additive nature of standard free energy with examples, effect of pH and temperature on Gibb's function and equilibrium, third law of thermodynamics, thermodynamic aspects of protein folding, thermodynamics of renaturation and denaturation of DNA, Thermodynamics of transport systems through membranes.

(10 Hrs, 20 Marks)

Unit: III
Energy Currency:
Structure and properties of ATP, ADP and AMP, ATP-hydrolysis and free energy change, calculation of ultimate standard free energy change during ATP-hydrolysis, standard free energy of hydrolysis of phosphate containing compounds (4 examples), energy production by group transfer (ATP), ranking of biological phosphatic compounds in cell, nucleophilic displacement reaction of ATP, ATP and active transport system, ATP and muscle contraction, conditions affecting the standard free energy change of hydrolysis of ATP, dynamics of phosphate group turnovers in cell, Transphosphorylation between nucleotides, inorganic polyphosphate, requirement of ATP (energy currency) in signal transduction processes (Insulin receptor, Epinephrine cascade) and others.

(10 Hrs, 20 Marks)

Unit: IV
Oxidation – Reduction:
Thermodynamics and compartmentalization, biological oxidation and reductions, flow of electrons to do biological work, conjugate redox pair, electrochemical cell, electromotive force (emf), electrode potential, standard reduction potential measurement, standard

reduction potentials of some biological important half reactions, standard potentials and Gibbs free energy , standard reduction potential to calculate free energy change, effect of concentration, pH, temperature on redox potential, structure and function of electron carriers in cells: NADH, NADPH, FADH, FMN.

(10 Hrs, 20 Marks)

Unit: V

Oxidative Phosphorylation and photophosphorylation:

Structure of mitochondria, electron transport system through complex I, II, III and IV in detail with structure, proton gradient and proton-motive force, ATP synthesis (chemiosmotic model), structure of ATP synthetase, mechanism of ATP synthesis by ATPase, shuttle system (malate aspartate shuttle, glycerol 3-phosphate shuttle), regulation of oxidative phosphorylation .

Photosynthesis: Introduction, ultra-structure of chloroplast, primary and secondary photo-pigments, Hills reaction, light dependant reactions, cytochrome complex, Photo system I and II, ATP synthesis by photophosphorylation, stoichiometry of photophosphorylation, carbon fixation reaction or dark reaction.

(10 Hrs, 20 Marks)

Reference:

1. Lehninger, Nelson and cox. Principles of Biochemistry Macmillan publishers.
2. Voet and Voet, Biochemistry, wiley publisher.
3. Biotol series, Principles of Cell energetics , Butterworth- Heinemann Ltd,Jordan Hill, Oxford.
4. Robert K.Murray, Daryl K.Granner, Harpers Illustrated Biochemistry, Mc Graw Hill.
5. Lubert Strayer, Jeremy M.Berg, Biochemistry , W.H.Freeman and Company. Newyork.
6. K.V.Narayan, Chemical Engineering Thermodynamics, PHI.

Term work shall consist of any eight assignments from the following

1. Enthalpy and First law of thermodynamics.
2. Entropy and second law of thermodynamics.
3. Calculation of Standard Gibbs free energy in biological reaction.
4. Energy production during metabolism.
5. Study of Energy Currency in Living organism.
6. Biological oxidation-reduction reaction.
7. Calculation of Standard electrode potential in biological system.
8. Oxidative Phosphorylation
9. Photophosphorylation.

3. MASS TRANSFER-II

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 4 Hrs. / Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Practical: 50 Marks
Term Work: 25 Marks

Unit: I

Introduction to distillation process, Vapor liquid equilibrium, The methods of distillation (Binary mixture), The fractionating column, Condition for varying overflow in non-ideal system(Binary), Batch distillation, Multi component mixture, Azeotropic, extractive and steam distillation, Introduction to distillation equipments.

(10 Hrs, 20 Marks)

Unit: II

Introduction to extraction process, Liquid equilibria, Material balances for stage wise contact methods, Extraction with reflux, Fractional extraction, Stage contact and continuous contact type extractors.

(10 Hrs, 20 Marks)

Unit: III

Introduction to crystallization, Growth and properties of crystals, Effect of impurities in crystallization, Effect of temperature on solubility, Fractional crystallization, Caking and yield of crystals, Different type of crystallizers.

(10 Hrs, 20 Marks)

Unit: IV

Introduction to adsorption operation, Type of adsorption operation, Nature of adsorbents, Adsorption equilibria, Adsorption of vapor, gas mixture and liquids, Material balances for stage wise for operation, Continues contact process for adsorption, Unsteady state fixed bed adsorption, Principle of ion exchange operation, Equilibria for ion exchange operation, Rate of ion exchange operation, Application of ion exchange operation.

(10 Hrs, 20 Marks)

Unit: V

Introduction to leaching operation, Mass Transfer in leaching operation, Calculation of stages for different processes, Graphical method for calculation of no. of stages ,counter current washing process, Equipments for leaching operation, Introduction to membrane separation process, Different Types of membrane separation process, (Ultrafilteration , Reverse Osmosis, Dialysis, Electro Dialysis, Pervaporation), General membrane equation, Liquid membrane

(10 Hrs, 20 Marks)

Practical and Term Work shall consists of any eight experiments from the following

1. Simple Distillation: To verify Rayleigh's equation for simple distillation
2. Ternary Diagram: To construct ternary diagram for acetic acid –water – benzene
3. Tie Lines

4. Liquid – Liquid Extraction: To study and determine the efficiency of cross current liquid- liquid extraction.
5. Leaching
6. Crystallization
7. Adsorption: To study adsorption of acidic acid on activated charcoal
8. Determination of HTU, HETP and NTU
9. Spray Column
10. Ion Exchange
11. Bubble Cap Distillation
12. Study of Mass Transfer Equipments

Reference:

1. Coulson and Richardson, Chemical Engineering (Vol. II), Pergamon Press
2. R. E. Tryebal, Mass Transfer Operation, McGraw hill.
3. Christie J. Geankoplis ,Transport Processes and Unit Operations ,Prentice Hall inc
4. P. Chattopadhyay, Unit operations in Chemical Engg. Vol. I and II, Khanna Publication,New Delhi.

4. BIOTECHNOLOGY OF WASTE TREATMENT

Teaching Scheme:	Examination Scheme
Lecturers: 4Hrs/week.	Paper: 100 marks (3Hrs)
Term work: 4Hrs/week	Oral: 25 marks
	Term work: 25 marks

Unit: I

Introduction:

Introduction to waste treatment, site surveys for waste treatment programme, strengths of fermentation waste, disposal of effluents, treatment process(physical, chemical and biological),introduction to microorganisms,bacterial growth and factors affecting growth kinetics, introduction to stoichiometry and kinetics of waste treatment, important biological reactions: Aerobic heterotrophic reaction, nitrification, denitrification, anaerobic digestion.

(10 Hrs, 20 Marks)

Unit: II

Biochemistry of Waste Treatment:

Introduction, oxygen uptake, dissolved oxygen, enzymes, inhibition, nitrogen metabolism, phosphorus and sulphur, elements and growth factors, fate of individual chemicals, structure-activity relationships, multisubstrates and species interactions, biochemical indicators, precipitation in waste treatment, coagulation in waste treatment, ecology of polluted water (physical, chemical and biotic effects) in brief. Problems on measurement of dissolved oxygen.

(10 Hrs, 20 Marks)

Unit: III

Waste Treatment Processes:

Characteristics of activated sludge, theory of activated sludge process, design, operation and control, operation and design features of trickling filters , rotating biological contractor, aerated lagoons, anaerobic digestion, packed beds, land farming.

(10 Hrs, 20 Marks)

Unit: IV

Nitrification and Denitrification and Anaerobic Treatment:

Introduction, forms of nitrogen, nitrifying and denitrifying bacteria, stoichiometry of nitrification and denitrification, process variables in nitrification and denitrification process, Nitrification processes: plug flow v\s complete mix, single stage v\s two stage systems, biofilm nitrification, denitrification using methanol, organic matter and thiosulfate and sulfide. Anaerobic treatment by methanogenic method, anaerobic reactor system.

(10 Hrs, 20 Marks)

Unit: V

Biological Degradation:

Introduction, determination of biological degradability, Pilot studies: PCB (polychlorinated biphenols) biodegradation, methyl ethyl ketone, Aerobic biodegradation: TCE (trichloro ethane) degradation, polycyclic aromatic hydrocarbon degradation, oil degradation, phenanthrene degradation, Treatment scheme of some industrial waste: dairy, paper, tannery distillation, and sugar. Biodegradation of waste by fungi, anaerobic biodegradation, engineering strategies for bioremediation.

(10 Hrs, 20 Marks)

Reference:

1. Bruce E Rittmann, Rurry L.Mc carty, Environmental Biotechnology:Principles and applications (Mcgraw Hill international)
2. A.K.Chatterji, Introduction to environmental biotechnology (Eastern Economy edition)
3. Nicholas P.Cheremisinoff, Biotechnology for waste water treatment (Eastern Economy edition)
4. Murray Moo - Young, Comprehensive biotechnology, vol 4- (Pergamon Press)
5. P. F. Stanbury, A. Whitaker and S. J. Hall, Principles of fermentation technology (Aditya book private limited)

Term Work shall consists of any eight experiments from the following

1. To determine alkalinity and pH of given sample.
2. To determine total solids and suspended solids of given sample.
3. To determine dissolved oxygen of given sample.
4. To determine initial oxygen demand.
5. To determine B.O.D. of the given sample.
6. To determine C.O.D. of the given sample.
7. To determine sludge volume index of the sample.
8. To determine M.P.N test of the given water sample.
9. To study Microorganisms of the given water sample.
10. Estimation of inorganic ion in water.

11. Evaluation of the effect of process, variables in the performance of activated sludge process (DEMO) / Study of activated sludge process
12. Evaluation of performance of anaerobic digestor (DEMO)/ Study of anaerobic digester

5. FERMENTATION BIOTECHNOLOGY- I

Teaching Scheme:	Examination Scheme
Lecturers: 4Hrs/week.	Paper: 100 marks (3Hrs)
	Term work: 25 marks

Unit: I

An introduction to fermentation process, Isolation methods for Industrial microorganisms, Culture preservation and stability, the improvement of industrial microorganisms.

(10 Hrs, 20 Marks)

Unit: II

Media for Industrial fermentation, Introduction ,typical media, Medium fermentation: Water, Energy sources, Carbon sources, Nitrogen sources, Minerals, Growth factors, Nutrient recycle, Buffers, Precursors, Metabolic regulators, Oxygen requirement and antifoams, Medium optimization: Animal cell media, serum, serum free media, supplement, protein free media, trace element, osmality, pH, Non-nutritional media supplements.

(10 Hrs, 20 Marks)

Unit: III

Sterilization: Introduction, Medium sterilization, Design of Batch sterilization process: Calculation of Del factor during heating and cooling, Calculation of holding time at constant temperature, Richard's rapid method for the design of sterilization cycles, the scale up of batch sterilization processes, Method of batch sterilization, Design of continuous sterilization process, Sterilization of the fermenter, Sterilization of the feeds, Sterilization of liquid wastes, Filter sterilization: Filter sterilization of fermentation media, air and fermenter exhaust air, the theory and design of depth filters.

(10 Hrs, 20 Marks)

Unit: IV

The development of Inocula for industrial fermentation: Introduction, Criteria for the transfer of inoculums, The development of inocula for yeast processes, The development of inocula for bacterial processes, The development of inocula for mycelial processes, The aseptic inoculation of plant femeners, Solid state fermentation.

(10 Hrs, 20 Marks)

Unit: V

Ageing and Death in microbes, Basic principles: Ageing of microbes, Death of microbes, Viability among microbes, Survival and populations: Cryptic growth, Injury among microbes, Stress and survival: The physiological status of the population, overt and acheal stress, Starvation: Substrate accelerated death (SAD), Metabolic and substrate injury, Thymine – Len death, survival of slowly growing bacteria, Differentiation and survival, Effect of Environment on microbial activity: Introduction, mechanism of microorganism response to the environment, dissolved oxygen, redox potential, and response to CO_2, water activity, effects of pH, temperature and shear, General control strategies, Mixed culture and mixed substrate systems: Introduction, mixed cultures, mixed substrate, co metabolism.

(10 Hrs, 20 Marks)

References

1. P. F. Stanbury, A. Whitaker and S. J. Hall, Principle of Fermentation Technology, Aditya Books (P) Ltd, New Delhi.
2. Murray Moo-Young, Comprehensive Biotechnology (Vol: 1), Pergamon Press, An imprint of Elsevier.
3. L. E. Casida, Industrial Microbiology, New Age Industrial Publishers.
4. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier.

Term Work shall consist of any eight assignments from the following.

1. Isolation methods of industrial microorganisms
2. Maintenance and preservation of cultures
3. Media for industrial fermentation
4. Sterilization of media
5. Air sterilization
6. Inoculum development
7. Solid state fermentation
8. Ageing and death in microorganisms
9. Effect of environment on microbial activity

6. PRACTICAL TRAINING / MINI PROJECT / SPECIAL STUDY

Examination Scheme
Term work: 25 marks

• Every student has to undergo industrial/practical training for a minimum period of two weeks during summer vacation between (S.E Second Term) fourth and (T.E. First Term) fifth term or during winter vacation between fifth and sixth term (T.E. First Term and Second Term).

• The industry in which practical training is taken should be a medium or large scale industry.

• The paper bound report on training must be submitted by every student in the beginning of (T.E. Second Term) sixth term along with a certificate from the company where the student took training.

• The report on training should be detailed one.

• Maximum number of students allowed to take training in company should be five. Every student should write the report separately.

• In case if a student is not able to undergo practical training , then such students should be asked to prepare special study report on a recent topic from reported literature
Or
A mini project related to the Biotechnology.
Fields includes like Microbiology, Immunology, Molecular biology, Bioprocess, Biochemistry and on Enzyme technology.
Project report should be details of work, carried out by student.
• The practical training/special study/ mini project shall carry a term work of 25 marks.
Every student shall be required to present a seminar in the respective class in the presence of two teachers. These teachers (fixed by the head of department in consultation with the Principal) shall award marks based on the following:
(a) Report 10 marks
(b) Seminar presentation 10 marks
(c) Viva-voce at the time of Seminar presentation 05 marks

Total 25 marks

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