GITAM INSTITUTE OF TECHNOLOGY
GITAM UNIVERSITY

(Declared as deemed-to-be-University u/s 3 of UGC Act, 1956)
Rushikonda, Visakhapatnam-530 045(AP)
Accredited by NAAC with 'A'Grade

DEPARTMENT OF BIOTECHNOLOGY

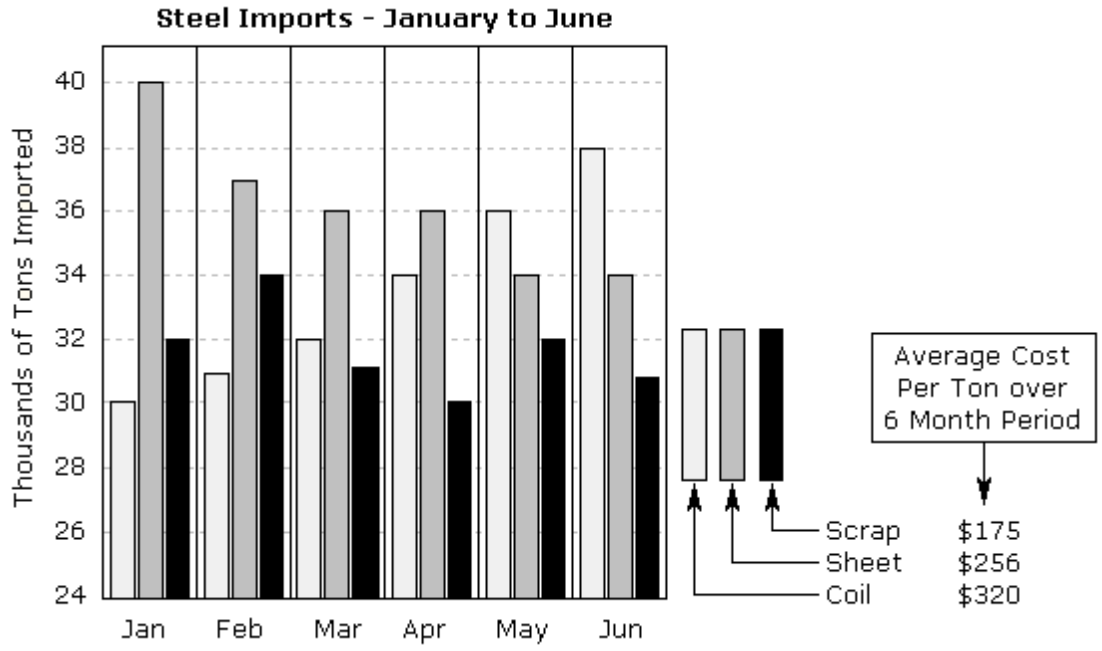
Model Question Paper for Ph.D. Entrance Examination (2012-13)

Note: **1. Answer all questions** **2. All questions carry equal marks.**

Maximum Marks: 60 **Time: 2hrs.**

1. What is the significance of Bibliography

2.

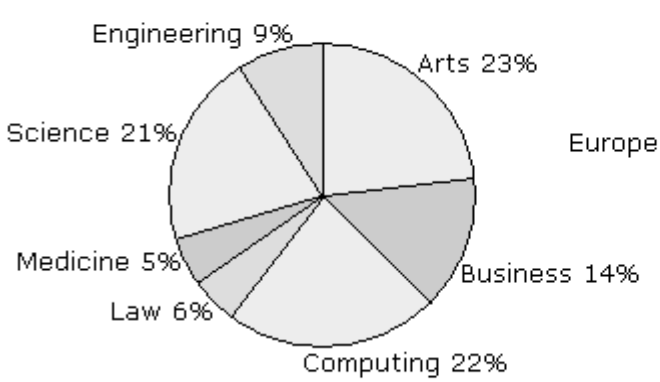


The figure above shows imports for three types of steel over a six month period. Use this information to answer the following questions.

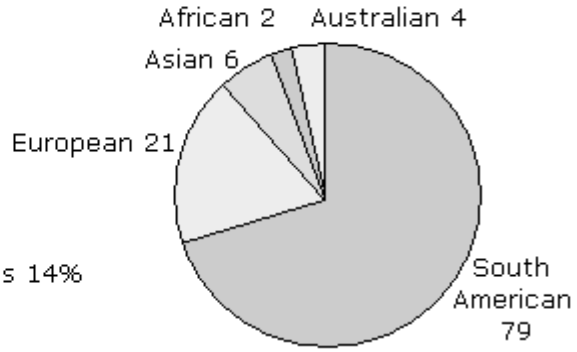
a) Which month showed the largest decrease in total imports over the previous month?

b) What was the percentage of scrap steel imported in the 6 month & period?

3.



Students by Faculty



Arts Students (Non-US)

The pie charts above show the percentage of students in each faculty at North West University and the number of non-US students in the Arts faculty. These percentages have been rounded to the nearest whole number. There are a total of 1049 students in the Arts faculty. Use this information to answer the following questions.

a) How many students are there in the Engineering faculty?

b) If six percent of Science students are Asian. How many Asian students are there studying Science?

4. If A = $\begin{pmatrix} 2 & 0 & 1 \\ 0 & 2 & 0 \\ 1 & 0 & 2 \end{pmatrix}$. Find eigen values of A and A^2.

5. Solve $(1+x)^2 \frac{d^2y}{dx^2} + (1+x)\frac{dy}{dx} + y = \sin(2\log(1+x))$.

6. Calculate the stoichiometric coefficient for CO2 for the following reaction :

C6H12O6 + a O2 + b NH3 -> c (C4.4H7.3M0.36O1.2) + dH2O +eCO2. Assume that 2/3 (wt/wt) of substrate carbon is converted to biomass.

7. State the assumptions used to derive the Langmuir adsorption isotherm and its range of validity.

8. Draw the schematic diagram for a high pass filter based on an op-amp whose non-inverting input is connected to the ground.

9. Describe the difference in assumptions between the Monod-Wyman-Changeaue and Koshland-Nemethy-Filmer models.

10. Write down the Navier-Stokes equation and explain meaning of all symbols used.

11. Describe the concept of NTU (number of transfer units) for gas-liquid contactors.

12. Define and describe concept of fouling factor (R_D, dirt factor).

13. Define and explain the concepts of a) transfer coefficient and b) gain.

14. Derive an expression for release of protein from passage of Bakers yeast cell suspension through a large pressure drop confined to a small volume treating N (number of passes) as a continuous variable, using a 1st order rate law.

15. A mold was grown on glucose (100 g/l) with an initial cell concentration of 1.25 g/l. After 40 hours, the cell concentration was 41 g/l and the glucose concentration was 0.625 g/l. What is expected maximum cell concentration with same inoculum and 150 g/l of glucose.

16. Discuss the use of dispersion numbers to characterize the nonideality of a Bioreactor.

17. Define Damkohler number and explain its significance.

18. What is power number. Describe one application involving fermenter design.

19. What are the total number of gapped alignments for a pair of sequences having 6 and 4 residues respectively.

20. The proton NMR spectrum of an amide with empirical formula C10H12NO2 shows the following signals. (1.3, triplet, A=3); (2.0, singlet, A=3); (4.0, quarted, A=2); (6.8, multiplet, A=2); (6.8, m, A=2); (7.4, multiplet, A=2); (8.7, singlet, A=1).

21. What is inverse PCR?

22. Describe the basic steps required for producing gene knockout mice.

23. Draw a schematic diagram of the MHC-TCR complex.

24. State the major uses of hyperthermophiles in biotechnology.

25. State advantages and disadvantages of solid state fermentation.

26. Draw a schematic diagram of the insulin receptor signaling pathway

27. Describe the basic principles of Terminator technology.

28. Describe the principles and results of the first gene therapy trials.

29. State the benefits and liabilities of somaclonal variation.

30. List the assumptions involved in Sanger's method of DNA sequencing.

SYLLABUS FOR Ph.D ENTRANCE EXAMINATION IN BIOTECHNOLOGY (2012-13)

GENERAL:

Basic elements of Research Paper and Thesis

Computer knowledge on development of graphs bar charts and pi charts

Linear differential equations of higher order with constant coefficients – Cauchy, Legendre's homogeneous equations – simultaneous linear differential equations. Rank of a matrix – eigen values and eigen vectors – Cayley Hamilton theorem – quadratic forms. Correlation – coefficient of correlation – lines of regression – rank correlation.

CHEMICAL PROCESS CALCULATIONS

Stoichiometric and composition relationships. Limiting reactant. Excess reactant. Degree of completion. Basis of calculation. Weight percent, volume percent and mole percent. Density and specific gravity. Composition of gases on dry basis and on wet basis.

Material balances. Tie substance. Yield. Conversion. Processes involving chemical reactions. Material balance calculations involving drying, dissolution and crystallization, Processes involving recycle, bypass and purge.

Vapor pressures. Effect of temperature on vapor pressure. Antoine equation. Reference substance vapor pressure plots. Vapor pressure of immiscible liquids. Ideal solutions and Raoult's law. Non-volatile solutes.

Humidity. Percentage saturation. Relative saturation or relative humidity. Dew point. Vaporization. Condensation. Wet and dry bulb temperatures. Adiabatic vaporization and adiabatic saturation temperature.

Heat capacities of gases and gaseous mixtures. Effect of temperature on heat capacity of gas. Mean heat capacity of gas. Kopp's rule. Latent heats. Heat of fusion. Heat of vaporization. Trouton's rule. Kistyakowsky equation for nonpolar liquids. Estimation of latent heat of vaporization using Clausius – Clapeyron equation. Enthalpy of humid air, and humid heat capacity.

Standard heat of reaction. Standard heat of formation. Laws of thermochemistry. Standard heat of combustion. Calculation of heat of formation from heats of combustion. Calculation standard heat of reaction from heats of formation, and from heats of combustion. Standard integral heat of solution. Effect of temperature on heat of reaction. Kirchoff's equation. Adiabatic and non-adiabatic reactions. Theoretical and actual flame temperatures.

THERMODYNAMICS

The first law and other basic concepts: Joule's experiments – internal energy – The first law of thermodynamics – thermodynamic state functions – enthalpy – the steady state – steady flow process – equilibrium – the phase rule – the reversible process – constant V and constant P processes – Heat capacity.

The second law of thermodynamics: Statement of the second law – heat engines – thermodynamic temperature scales – thermodynamic temperature and ideal gas scale.

Entropy: entropy changes of an ideal gas – mathematical statement of the second law – the third law of thermodynamics.

Thermodynamic properties : PVT behavior, Thermodynamic property relations.

Solution thermodynamics : fundamental property relations – chemical potential and Phase equilibria, fugacity and fugacity coefficient, vapor/liquid equilibrium for pure species, fugacity of a pure liquid, fugacity and fugacity coefficient species in solution.

Chemical reaction equilibria: the reaction coordinate – application of equilibrium criteria to chemical reactions – the standard Gibbs energy change and the equilibrium constant – effect of temperature on the equilibrium constant – evaluation of equilibrium constants – relation of equilibrium constants to composition – equilibrium conversions for single reactions – phase rule and duhem's theorem for reacting systems – multireaction equilibria.

Factors affecting stability of double stranded DNA. Statistical thermodynamics of monomer-dimer equilibrium for DNA and brief discussion of implications for PCR primer design and DNA microarray design. The helix-coil transition theory of polypeptides. Ligand-receptor binding equilibria.

HEAT TRANSFER

Introduction: modes of heat transfer. Basic laws of heat transfer. Analogy between heat flow and electrical flow.

Conduction: The fourier heat conduction equation. Steady state and one dimensional heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces. Three dimensional heat conduction equation. Numerical problems on unsteady? state heat conduction through a semi-infinite slab; through an infinite slab, infinite cylinder, sphere. Critical insulation thickness.

Convection: the convective heat transfer coefficient. Introduction to thermal boundary layer. Dimensionless numbers in heat transfer and their significance. Dimensional analysis.

Forced convection: heat transfer by forced convection inside tubes and ducts in laminar transition and turbulent flow. Analogy between momentum and heat transfer. Reynolds, colburn and prandtl analogies.

Natural convection: natural convection from vertical and horizontal surfaces. Grashoff number.

Heat transfer with phase change: heat transfer from condensing vapors. Filmwise and dropwise condensation. Derivation and practical use of nusselt equations. Condensation of superheated vapors. Effect of non-condensable gases on rate of condensation.

Heat transfer by boiling liquids: boiling of saturated liquid. Maximum heat flux and critical temperature drop – minimum flux and film boiling.

Heat transfer by radiation: thermal radiation. Black body radiation. Kirchoff's law, emissivity, gray body. Laws of black body radiation. Geometric or shape factor. Radiation in enclosures with black and gray surfaces. Large parallel plates. Concentric cylinders and spheres. Combined heat transfer by conduction, convection and radiation.

Heat exchangers: types of heat exchangers. Log-mean temperature difference. Energy balances. Overall heat transfer coefficients. Heat exchanger effectiveness. Fouling factors. Design and description of heat transfer equipment. Heat exchangers, condensers, boilers, and kettles. Extended surface equipment.

MASS TRANSFER

Mass transfer Operations: molecular diffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state equimolal counter current diffusion, Stefan's diffusion, estimation of diffusivity of gases and liquids, application of molecular diffusion, theories of mass transfer, analogy between momentum, heat and mass transfer in laminar and turbulent flow, diffusion in solids.

Interphase mass transfer: concept of equilibrium, diffusion between phases, material balances in steady state co-current and counter-current stage processes.

Phase-Phase Operations:

Gas-Liquid (Absorption) : Solubilities of gases in liquids, two component system, multi-component system, ideal and non-ideal solutions, choice of solvent for absorption, single component absorption, material balance, counter current multistage operations, dilute gas mixtures, absorption and stripping factors, continuous contact equipment, HETP, HTU, NTU concepts for single component absorption, graphical construction for transfer units, absorption with chemical reaction.

Equipment for gas-liquid Operations : sparged vessels, mechanically agitated vessels for single phase liquids and gas – liquid mixtures. Description of tray towers & its components, Sieve tray towers, various tray efficiencies, Venturi scrubbers, spray towers and spray chambers, Description of packed towers, Comparison of tray tower and packed towers.

Vapor-Liquid (Distillation) : Principles of VLE for binary systems, phase diagrams, relative volatility, Ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, differential distillation (Rayleigh equation), steam distillation, continuous distillation, McCabe-Thiele method, azeotropic and extractive distillation.

Liquid-liquid (Extraction) : Liquid-liquid equilibria, choice of solvent for extraction, analytical and graphical solutions for single and multistage operations, continuous counter current operation. Equipment : Mixer settler cascades, Rotating disc contactor, Schiebel extractor, Pulsed column, Centrifugal extractor.

FLUID MECHANICS

Units and dimensions, dimensional analysis, similarity, types of fluids, hydrostatic pressure, pressure distribution in a static fluids, pressure measuring devices.

Introduction to fluids in motion, concept of stream lines, stream tubes, viscosity, types of fluids, flow in boundary layers, its formation and growth in tubes and on plates, basic equations of fluid flow continuity, momentum and Bernouli's equation.

Flow of incompressible fluids in pipes, relation between skin friction – wall shear, laminar flow in pipes, Hagen-Poiseulle equation, turbulent flow in pipes, velocity distribution equation, friction factor, friction from changes in velocity or direction, flow of compressible fluids, basic equations, flow through variable areas condutes, adiabatic and isothermal frictional flow.

Flow past immersed bodies, Drag, drag coefficient, friction in flow through beds of solids, motion of particles through fluids, its mechanics, terminal velocity, fluidization, mechanism of fluidization, pressure drop in fluidization, applications of fluidization.

Transportation and metering of fluids, pumps, fans, blowers and compressors, reciprocating, rotary and centrifugal pumps. Flow measuring devices, venturi meter, orifice, pitot tube, rotameter, notches and weirs.

MECHANICAL OPERATIONS

Characteristics of solid particles: shape-size differential and cumulative screen analysis – specific surface area – particle population – different mean diameters for a mixture of particles – storage of solids.

Principles of communition – laws of crushing (rittinger's, bond's, kick's laws) – work index – classification, description and working of size reduction equipment – jaw, gyratory and roll crushers – hammers – revolving mills – attrition mills – fluid energy mill – cutting machines – open and closed circuit grinding – wet and dry grinding – grindability index.

Size separation: screening – industrial screens – grizzly – gyratory and vibratory screens – revolving screens – trommels – capacity and effectiveness of screens – froth flotation.

Motion of particles through fluids: drag – free and hindered settling.

Settling velocities – classification – sink & float methods – differential setting.

Batch sedimentation – thickeners – flocculation – centrifugal sedimentation – gravity and centrifugal decanters.

5. Agitation of liquids – power consumption in agitated vessels – scale up of agitation equipment – mixing equipment for mixing of solids and pastes – mixing for dry powders – mixing index.

BIOCHEMISTRY

Structure and functions of Amino acids; **Peptides**: Solution and solid phase synthesis of peptides; **Proteins**: classification, purification and physicochemical characterization. **Protein structure**: Primary, secondary, tertiary and quaternary structure of proteins. Folding and functions of Hemoglobin, Myoglobin, and Chymotrypsin. Protein Seqrencing **Enzymes**: classification, factors effecting enzyme action, Coenzymes.

Enzyme Kinetics. Types of enzyme inhibition. Methods of immobilization, Kinetics of immobilized enzymes, external and internal mass transport resistance of immobilized systems.

Carbohydrates: Biochemical thermodynamics: energetics of metabolic pathways – energy coupling (ATP and NADH). Glycogenesis and glycogenolysis, glycolysis and TCA cycle, HMP shunt pathway, Electron transport chain and oxidative phosphorylation.

Lipids: Digestion and absorption of fats.

Nucleic acids: Structure, properties and functions of purines, pyrimidines, nucleotides and nucleic acids. Cellular localization, isolation and estimation of nucleic acids, Types of DNA and RNA.

Topological descriptors of Cyclic DNA & linking number.

MICROBIAL BIOTECHNOLOGY

Microbial taxonomy and diversity: Bacteria, Archea and their broad classification, molecular approaches to microbial taxonomy. Physiology of Archaebacteria - thermophiles, psychropiles, halopiles, methanogens.

Viruses: Morphology of viruses – size, shape and symmetry, replication of viruses – lytic and lysogenic cycle. Genetic diversity of infectious microbes and humans and domestic animals.

Yeasts and Molds: morphology, life cycle, economic importance of yeast and Aspergillus.

Bacteria: ultrastructure of bacteria, cell wall, cell membrane, flagella, pili, capsule, endospore, and cell inclusions, differences between prokaryotic and eukaryotic cell.

Microbial growth: bacterial growth batch, fed batch, continuous kinetics, synchronous growth and methods of growth estimation, fungal growth.

Control of microorganisms, sterilization and disinfection, effect of physical (moist and dry heat, radiation and filtration) and chemical agents, antibiotics: classification, mode of action and resistance. Microbial nutrition: Nutrition requirements, nutritional types of bacteria, uptake of nutrients by cell.

Methods in microbiology: culture media, synthetic and complex media, solidifying agents, types of media, isolation of pure cultures – spread plate, pour plate and streak plate, preservation of microorganisms, light(bright field only) and electron microscopy.

Applied Microbiology: Water, Food and Milk borne contamination and remedy. Basic microbial genetics - conjugation, transformation and transduction. Strain improvement of microbes of industrial importance.

Production of enzymes, selection of organisms, Industrial approach to enzyme production and comparison of cells and enzymes as Industrial catalysts. Enzyme reactor performance, operational strategies, carrier life and cycle time. Applications of enzymes in Pharmaceutical & Food Processing Industry.

FERMENTATION TECHNOLOGY

Introduction and scope of microbial processes. Sources of industrial cultures and maintenance. Alcoholic fermentation: Production of Industrial Alcohol – Fermentation mechanism. Recent developments, brewing and malting, manufacture of wine and other distilled liquors.

Microbial Foods – Food, Fodder and Bakers yeast, applications of the non-conventional raw materials (cellulosic material and hydrocarbons) Nutritional characteristics of food yeast, mushroom production. Vitamins- Vitamin B-2, Riboflavin, Soya-sauce & cheese production.

Organic acids: Production of acids, viz., citric, lactic and gluconic acid. Mechanism of each fermentation, their uses.

Production of Amino acids (Lysine and glutamic acid) and Antibiotics (Pencillin, Streptomycin and Tetracyclines) and its new Developments.

Production of Organic Acids (Acetic acid and vinegar) its spoilage and prevention.

ENVIRONMENTAL BIOTECHNOLOGY

Sources of wastewater, characteristics of wastewater; disposal standards; health hazard due to pollution. Conventional Physical, Chemical unit operations / unit processes, Screens, Grit chambers, Primary and Secondary clarifiers.

Aerobic Biological Treatment Processes: Attached and Suspended Film Growth processes, Trickling filter, Design, Types, Activated Sludge Process, Types, Design, RBC

Anaerobic Suspended / Attached Growth Processes, Anaerobic filter, Upward Anaerobic Sludge Blanket Reactor – Design.

Solid waste management, Sources of solid waste, characteristics of solid waste, waste disposal, landfilling, landfill gas generation, recovery, aerobic and anaerobic composting, Recovery and reuse, recycling.

BIOPROCESS ENGINEERING

Stoichiometry and energetic analysis of cell growth and product formation – degree of reduction concepts – oxygen consumption and heat evolution in aerobic cultures – thermodynamic efficiency of growth.

Principles and mechanism of media and air sterilization, batch and continuous sterilization of media, design of air filter.

Aeration and agitation in bioreactors: Oxygen transfer in microbial systems, oxygen demand mass transfer theories, measurement of volumetric mass transfer coefficient, power requirement in gassed and ungassed bioreactors, mixing and heat transfer in dispersed systems, bioreheology.

Microbial growth kinetics, substrate utilization and product formation kinetics for batch growth-unstructured non-segregated models, models for transient behavior in batch reactor.

Batch, Continuous and Fed-batch culture:

Growth in ideal chemostat, chemostat with recycle, multistage chemostat, fed-batch growth.

Kinetic relationships, parameters, variables and constraints in microbial, plant and animal cell cultures.

Simple problems on the topics.

Scale-up: Basic concepts, problems related to the scale-up of the microbial processes.

GENETICS AND MOLECULAR BIOLOGY

Mendelian and Non mendelian inheritance, linkage and crossing over, mapping of genes. Cytoplasmic inheritance.

Organization of the chromosome, euchromatin and heterochromatin; nucleosome: Cell division, cell cycle and its regulation: CDC mutants, protein kinases, cyclins.

DNA structure and topology; Replication in Prokaryotes and eukaryotes; Models of replication, nucleotide sequence composition; unique, middle and highly repetitive DNA, Redundant DNA; Genetic recombination, transposons- Molecular nature of mutations, DNA Repair mechanisms..

Principles of transcription: prokaryotic RNA polymerase, Mechanism of transcription in prokaryotes and eukaryotes, post transcriptional processing. Regulation of gene expression in E. coli. Operon concept; Biochemical control of gene expression in eukaryotes.

General features of Genetic code, Translation machinery in Prokaryotic and eukaryotic systems, Protein targeting and processing. Signal sequences, Signal Receptor Protein, signal hypothesis.

GENETIC ENGINEERING

Isolation and purification of nucleic acids. History and Scope of Enzymes involved in DNA manipulation. Isolation of gene using restriction endonucleases, mechanical shearing. Restriction mapping, strategies for DNA ligation.

Cloning vectors: structure and properties of plasmids, cosmids, Ti and Ri plasmids, expression vectors, YAC, BAC, PAC and phagemids and vectors used for cloning in mammalian cells. Cloning strategies: Construction of recombinant vectors; Gene transfer methods for bacteria, plants and animals: Biological delivery systems and artificial delivery systems.

Expression of cloned genes in bacteria, yeast, animal and plant cells, synthesis of cDNA, construction and Screening of Genomic DNA and cDNA Libraries. Isolation of cloned genes, identification of recombinants;

Molecular Techniques involved in detection and their expression of genes in host: Southern, Northern, Western, Dot and Slot blots, In-situ hybridization. Advanced Techniques in gene expression and analysis: PCR and RT-PCR, DNA finger printing, RAPD, RFLP and AFLP.

RNA silencing: siRNA and anti sense RNA their design and applications, Applications of genetic engineering in medicine, agriculture, animal husbandry, environmental management and industry, Achievements, limitation and negative aspects of genetic engineering.

BIOANALYTICAL TECHNIQUES

Radioisotope techniques: Principles, measurement and applications of radioactivity.

Chromatography: General Principles. Modes of chromatography. Types of chromatography.

Electrophoresis: Polyacrylamide and agarose gel electrophoresis. Isoelectric focusing. 2DGE. Pulse field gel electrophoresis. Capillary electrophoresis. Methods of Sequencing of DNA and RNA, Preparation of labeled probes and primers.

UV-Visible Spectroscopy. Turbidimetry and Nephelometry. Infrared and Raman Spectroscopy.

Spectrofluorimetry: Intensity, wavelength dependence, quantum yield, lifetime, polarization and rate of resonance energy transfer with emphasis on DNA sequencing, Fluorescence Immunoassays, and Molecular beacons.

Mass spectrometry: Basic Principles. Ionization techniques with emphasis on EI, FAB, Electrospray and MALDI. Analyzers with emphasis on Magnetic sector, quadrupole and TOF. FTICRMS.

Applications of MS– determination of relative molecular mass, empirical formula, small molecule structural analysis, peptide sequencing and protein identification for proteomic studies.

NMR spectroscopy: Principles of magnetic resonance. Use of NMR for structural elucidation. Nuclear Overhauser effect. Principles of FTNMR and 2D-NMR. Introduction to Protein structure determination by NMR. Principles of MRI and MR-spectroscopy.

Electrochemical methods: Principles of potentiometry. Clark's oxygen electrode.

Biosensors: Principles and applications of electrochemical, thermometric, optical and piezoelectric biosensors. Glucose biosensors.

Microarrays: Basic principles. Methods of manufacture. Applications.

BIOINFORMATICS

Fragment assembly. Gene prediction - Statistical and similarity based approaches. Gene annotation.

Sequence analysis: introduction. Similarity matrices. PAM and BLOSUM.

Searching databases using BLAST. Description of the BLAST algorithm.

Pairwise sequence alignment using dynamic programming. Needleman & Wunsch algorithm for global alignment. Smith-Waterman algorithm for local alignment. Dynamic programming for sequence alignment with affine gap penalties. Searching for repeats and partial overlaps using dynamic programming.

Phylogenetic analysis. Distance based methods: UPGMA and Neighbor joining. Classical parsimony and weighted parsimony methods. Branch and bound.

Multiple sequence alignment. Multidimensional dynamic programming. Progressive alignment and profile alignment. Sankoff and Cedergren method for Simultaneous alignment and phylogeny. Hidden Markov Models.

Prediction of secondary structure from protein sequence – Chou-Fasman rules, neural networks.

Prediction of transmembrane helices.

Prediction of protein conformation from protein sequence. Information theoretical methods: Homology and threading. Methods using Force fields - Energy minimization, molecular dynamics and simulated annealing.

Principles of ligand based drug design: SAR, QSAR and 3D-QSAR. Receptor based drug design: Principles of receptor based de novo ligand design. Rigid body molecular Docking.

PHARMACEUTICAL BIOTECHNOLOGY

Therapeutic agents, their uses, economics and regulatory aspects.

Drug Metabolism: Factors effecting drug metabolism. Models to study drug metabolism. Dose effect relationships. Pharmacokinetic effects on humans (including fetus).

Drug reactions: Adverse drug reactions and drug interactions. Toxic reactions, allergic reactions, idiosyncracy. Acute poisoning and its treatment.

Screening : Screening principles, correlations between various animal models and human situations.Correlation between in-vitro and in-vivo Screens

Biocatalysis for the synthesis of some Antibiotic products

Manufacturing principles: compressed tablets –coating of tablets – capsules – sustained action dosage forms – parenteral solutions, oral liquids, ointments – topical . Packaging techniques.

Quality control: GMP. Purity determination as per ICH guidelines; use of different biochemical, molecular biology techniques.

MEDICAL BIOTECHNOLOGY

Types of immunity: Innate and adaptive. Cells and organs of the immune system. B cell, T cell and macrophages, Antigens, Structure of antibody, antibody classification, antigen-antibody reactions.

Hybridoma technology: Monoclonal antibody production and applications, Major Histocompatability Complex (MHC); Humoral and cell mediated immunity. Cytokines, Complement components and biological consequences of complement activation.

Immunological memory, Immunoregulation, Adjuvants and Immunological tolerance, hyper sensitivity, autoimmunity, Transplantation immunology: graft versus host reaction, immuno deficiency and immuno proliferative diseases. Vaccines: types of vaccines, development.

Blood formation, Anaemias: Blood loss anaemia, Magaloblastic anaemia, Leukaemia, Necrosis & Apoptosis, Biochemistry of cancer, The Parts of Brain; Brain Tumours, Principles of Animal Tissue Culture, Types of animal cell cultures and Stem cells.

Stem cell, Bone marrow and kidney transplants. Molecular diagnostics: PCR and RT-PCR based and RFLP based techniques. Gene therapy: types and use of rDNA constructs for Gene therapy. Transgenic mice development.

PLANT BIOTECHNOLOGY

History , development and land marks in the development of plant tissue culture, sterilization methods, nutritional components of tissue culture media, plant growth regulators, regulation of cell differentiation, Regeneration of plants through organogenesis and somatic embryogenesis;

Clonal (Micro) propagation and its applications; Somaclonal variation, its genetic basis and application in crop improvement; callus/cell line selection for resistance to herbicide, stress and diseases.

Anther culture - methods of haploid production and their application in plant breeding; Protoplast technology - isolation, culture and plant regeneration, protoplast fusion, identification and characterization of somatic hybrids, cybrids applications of protoplast in gene transfer; indirect and direct methods, current status and limitations.

Bioreactor system and models for mass cultivation of plant cells. Production of secondary metabolites by plant cell cultures.

Cryopreservation of germplasm, methods of production of synthetic seeds and their applications. Automation in plant tissue culture, field techniques for propagation of regenerated plants, economics of tissue culture.

CHEMICAL REACTION ENGINEERING

Batch reactors: introduction and overview of the subject, kinetics of homogeneous reactions, nonelementary reactions; collision theory and transition-state theory, arrhenius relation, various methods of analysis of batch reactor data (including variable volume and variable pressure data). Isothermal batch reactor design.

Homogeneous flow reactors: design equation for plug flow reactor (PFR) and continuous stirred tank reactor (CSTR), data analysis in flow reactors. Design of PFR and CSTR. Cascade fo CSTRs and combination of PFR and CSTR. (design of autocatalytic reactions not included).

Multiple reactions: design for multiple reactions, parallel reactions, series reactions (omit reversible and series-parallel reactions).

Non-isothermal design: energy balance equations for batch, PFR and CSTR under non-isothermal conditions. Equilibrium conversion under adiabatic conditions. Design of homogeneous reactors under adiabatic conditions.

Non-ideal flow: residence time distribution curves E,F and C; interpretation of the response data for the dispersion and tanks-in-series models (omit multiparameter models).

Heterogeneous catalysis: catalyst properties, physical adsorption and chemisorption, adsorption isotherm, derivation of rate equations for various mechanisms (adsorption, surface reaction and desorption controlling etc.) data analysis for heterogeneous laboratory catalytic reactors. Isothermal packed bed (PFR) reactor design, effectiveness factor and internal pore diffusion. Criteria for internal pore diffusion.

BIOREACTOR DESIGN

Mass Transfer in Bioreactors: Importance of interfacial mass transfer in Biotechnology. Mass Transfer between phases – factors affecting mass transfer between phases. Mass Transfer in porous solids. Oxygen uptake in fermenters. Simple problems on topics.

Design of a Fermenter: Basic functions of a fermenter for microbial or animal cell culture. Aseptic operation, sterilization and containment, temperature control. Reactor body construction – construction material. Reactor Dynamics. Design calculation for stirred tank Bio-reactor. Simple problem on it.

Rheology, Aeration and Agitation in Animal Cell Bioreactors: Design, Operation and types of agitators and spargers, power and time requirements for agitation. Effects of agitation on mass transfer, Oxygen delivery system, foam control system, factors affecting antifoam requirements, Antifoam addition system.

Types of Reactors and Accessories: Description, working, advantages and limitations of stirred tank, Airlift, Bubble-driven, packed bed, fluidized bed, trickle bed and flocculated cell Bioreactors.

Description and functions of the following accessories for bioreactors: Pumps, filters, valves, steam traps.

ELECTRONICS AND INSTRUMENTATION

Basics of Electronics-I : Semi Conductors - Energy Banks, Intrinsic and extrinsic semiconductors Fermi level in semi conductors, semiconductors diode - P.N. Junction diode, Zener diode, Tunnel diode - diode rectifiers, Bipolar junction transistor.

Basics of Electronics-II: Field effect transistors : JFET and its characteristics, MOSFET - Enhancement and Depletion modes.

Special purpose diodes, LED, LCD, Thyristor as a switch - Operation amplifiers, introduction.

Thermoelectric temperature measurement: Thermoelectricity, Industrial Thermocouples, thermocouple lead wires, Thermal wells, response of thermocouples. The Millivoltmeter, the null potentiometer circuit, Industrial potentiometers.

Resistance thermometers: Thermal coefficient of Resistance, Industrial resistance thermometer bulbs, Resistance thermometer circuits, Null-Bridge resistance thermometers. Deflectional Resistance Thermometers.

Radiation temperature measurement: Introduction, Black Body devices, Radiation receiving Elements, Radiation Pyrometers, Photoelectric Pyrometers, Optical Pyrometers.

Measurement of pressure and vacuum: Pressure, Vacuum and Head, Liquid column Manometers, Measuring elements for Gauge pressure and vacuum. Indicating elements for Pressure gauges, Measurement of absolute pressure, Measurement of pressure in Corrosive fluids, Static accuracy of pressure gauges.

Measurement of Head and Level: Density and Specific gravity, Direct measurement of liquid level, Pressure (Level) measurement in Open Vessels, Level measurement in pressure vessels, Density measurement, Level measurement by weighing.

Methods of Composition analysis: Gas analysis by thermal conductivity. Analysis of moisture in gases (Humidity), Psychrometer method, Hygrometer method, Dew-point method for moisture analysis in Gases, measurement of moisture in paper, textile and Lumber.

Flow metering: Flow of incompressible fluids in pipe, Orifice Installation. The Venturi tube, Pitot tube, Head flow meters, Area flow meters, Open channel meters, Velocity meters, Quantity meters.

PROCESS DYNAMICS AND CONTROL

Bioreactor operation, measurement and control: Aseptic operations, Biochemical process variables (pH, dissolved oxygen, viscosity, temperature, NADH) measurement and control, measurement of agitative power, foam control. Data acquisitions, analysis and computer control of bioreactors.

Linear Open-loop Systems: Response of First-Order Systems, Physical examples of First-Order systems, Response of First-Order Systems in series, Second-Order Systems, Transportation Lag. Linear Closed-Loop Systems: The control system, Controllers and Final Control elements, Block diagram of a Chemical-Reactor Control system. Closed-Loop transfer functions, Transient response of simple control systems, Stability, Root Locus.

Frequency Response: Introduction to frequency response. Control system design by frequency response.

Process Applications: Cascade control. Feed forward control, Ratio control, Dead time Compensation, Internal Model Control, Controller tuning and Process identification, Control valves, Theoretical analysis of complex process like, steam-jacketed kettle and Heat Exchanger.

Sampled-Data Control Systems: Sampling and Z-Transforms, Open-loop Response and Closed-loop response. Stability, Modified Z-Transforms, Sampled data control of a First-Order process with transport lag, Design of sampled data controllers.

DOWNSTREAM PROCESSING

Recovery of intracellular products: Cell disruption methods.

Separation of cells and other insolubles from fermented broth . Sedimentation,

Centrifugation (batch, continuous and basket). Centrifugal filtration. Top suspended batch centrifuge.

Filtration theory. Pretreatment. Filtration equipment: batch and continuous rotary filters. Microfiltration.

Isolation and purification: precipitation, leaching, adsorption and ultrafiltration.

Precipitation (ammonium sulphate, organic solvents, high MW polymers)

Leaching: preparation of solid, steady and unsteady state operation, equipment, analytical methods both theoretical and problematic approaches for single and multistage operations.

Liquid-liquid extraction methods in DSP.

Adsorption: Theory of adsorption. Industrial adsorbents, adsorption equilibria. Freundlich equation. Single and multi-stage operations. Unsteady stae adsorpton. Equipment for single stage and continuous contact. Ion-exchange. Column chromatography.

Ultrafiltration.

Product polishing: crystallization and drying. Crystallization: yields and material balances, heat effects and heat balances. Equipment for crystallization. Crystallization theory: Rate of nucleation and rate of crystal growth. Particle size distribution of crystals. Model for MSMPR.

Drying of bioproducts: methods of drying. Equipment for drying. Equilibrium moisture content of bioproducts. Rate of drying curves. Convection, radiation and conduction heat transfer in constant rate drying period. Falling rate drying period. Freeze drying. Effect of thermal processing on food constituents.

ENGINEERING ECONOMICS AND ENTREPRENEURSHIP

Introduction. Basic concepts of the following: Value of money, equation for economic studies, equivalence, types of interest, discrete, continuous. Continuous cash flow and interest compounding. Present of an annuity, perpetuities and capitalised costs. Bonds and debentures: value of a bond and yield rate. Definition and structure of entrepreneur. Definitions, kinds and importance of IPRs.

Depreciation: Types and various methods of calculating depreciation, depreciation accounting. Cost accounting: Basic relationship in accounting, balance sheet and income statement. Various ratios to study the balance sheet andincome statements.

Cost estimation: cash flow for industrial operations. Factors affecting investments and production costs – estimation of capital investment, cost indices. Methods of estimating capital investment.

Profitability: alternative investments and replacements. Mathematical methods ofr profitability evaluation. Economic production charts for plants operating below 100%, above 100% and under dumping conditions. General procedure for determining optimum conditions. Break-even chart of a production schedule and its significance for optimum analysis. Economic balance in cyclic operations and semicontinuous cyclic operations – simple examples.

Theories of entrepreneurship, institutes in aid of entrepreneurs, problems of entrepreneurship. Project report.

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