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UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION M.TECH (BIOCHEMICAL ENGINEERING)

FIRST SEMESTER EXAMINATION

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**NOTE:** Students can select TWO electives either offered by the department mentioned above or from the list of offered electives from other departments.

*subject to availability of resource person
UNIT I:  
Thermodynamics and rate concept of biological systems; Bioreactor configurations - Batch, Continuous stirred- tank, Tubular, Plug flow, packed bed, Air lift, Fluidized bed, Continuous reactors with cell recycles and wall growth, Trickle bed Bioreactors, Fluidized bed Bioreactor, Upflow anaerobic sludge blanket bioreactor, other membrane bioreactors.

UNIT II:  
Kinetic expression; Monod’s equation and its generalization, Continuous (single and multistage), Continuous (single) cell recycle and fed batch cultures operations, kinetics Bioreactor design and optimum operations – Mixing characteristics; Residence time distribution (RTD) in bioreactors and non-ideality, Concentration distribution and Temperature distribution.

UNIT III:  
Introduction, General design information, Design of bioreactors, Basic function of a bioreactor Design, Mass and energy balance, Materials of construction for bioprocess plant, Mechanical design of process equipment, Utilities for biotechnology production plants.

UNIT IV:  
Basic concept of Scale-up of bioreactors and the Bioprocesses from upstream to downstream, Case Studies

Text Books:
2. Bioprocess Engineering; basic concepts, Michael L. Shuler and Fikret Kargi

References Books:
UNIT-I
10 (Hrs)

UNIT-II
12 (Hrs)
Enhanced distillation and supercritical extraction: Use of Triangular Graphs, Extractive distillation, Salt distillation, Pressure –swing distillation, Homogeneous Azeoptropic distillation, Heterogeneous Azeoptropic distillation, Supercritical-fluid extraction.

UNIT-III
12 (Hrs)
Solid Phase separation Process: Industrial examples, Sorbents, equilibrium considerations, kinetics and transport considerations, solid phase separation techniques, slurry and fixed bed adsorption system, continuous and countercurrent adsorption systems, chromatographic separation, electrophoresis.

UNIT-IV
8 (Hrs)
Mechanical separation of phases: Separation-device selection, Industrial particle-separator devices, design of particle separator, design of solid –liquid cake filtration devices based on pressure gradients, centrifuge devices for solid-liquid separations, wash cycle, mechanical separations in biotechnology.

Text Books:

Reference Books:
1. Douglas M, Ruthven, Principles of adsorption and adsorption process, John Wiley & Sons, 1984,
UNIT-I

Introduction to process engineering and optimization, Formulation of various process optimization problems and their classification, Basic concepts of optimization – convex and concave function, necessary and sufficient conditions for stationary points, optimization of one dimensional problems.

UNIT-II

Unconstrained multi variable optimization – direct search methods, indirect first and second order methods; linear programming and its application: Simplex, Big M & Two Phase methods.

UNIT-III

Constrained multi level optimization – necessary and sufficient for constrained optimum, quadratic programming (Wolfe’s Method and Beale’s Method), Generalized Reduced gradient method, optimization of stage and discrete processes, Dynamics Programming, Integer and Mixed Integer Programming (Gomory’s algorithm and Branch & Bound technique)

UNIT-IV


Books & Reference:

4. Bart Kosko, “Neural Network and Fuzzy systems”, PHI

Nomography: Introduction. Logarithmic charts. Equations of the form F1(x)+F2(y)=F3(z), F1(x)+F2(y)=F3(z), 1/ F1(x)+1/F2(y)=1/F3(z) and line coordinate charts.

Statistical Analysis: Tests for Fluctuations in process variables. Test for deviation of the variables from standard conditions. Selection of theoretical model to fit the data.


Books & Reference:

2. Stephan G.N., Ariela Sofer; Linear & nonlinear programming, McGraw Hill.
UNIT I: 8 (Hrs)
Enzyme Introduction and Scope, regulation and control of enzyme in microorganisms.

UNIT II: 8 (Hrs)

UNIT III: 8 (Hrs)
Large scale production and purification of enzyme; Cofactors and their role in enzyme activity; Immobilization of enzyme and whole cells, External and diffusional mass transfer limitation, Effectiveness factor and modulus.

UNIT IV: 16 (Hrs)
Process design and operation strategies for immobilized enzyme reactors; Stabilization of enzyme, synzymes, Immobilization of multiple enzyme system; Application of enzyme - Industrial, Analytical and Medical.

Text Books:
2. Enzyme Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer.

Reference Books:
1. Enzyme: A Practical Introduction to structure, Mechanism and data analysis, R.A. Copeland, John Wiley & Sons Inc.
UNIT I
Selection of industrially important cultures; Isolation of pure culture & genetic improvement of industrial microorganisms with applications.

UNIT II
Process technology for the production of primary metabolites, Baker’s yeast, Single Cell Protein, ethanol.

UNIT III
Biosynthesis and fermentative production of antibiotics – penicillin, semi-synthetic penicillin, streptomycin, tetracyclines, chloramphenicol; Microbial production of antifungal antibiotics; Metabolic regulations in industrial fermentation; microbial production of amino acids-lysine, glutamic acid, microbial transformation of steroids; microbial production of vitamin-β-carotene, vitamin B12, vitamin B6.

UNIT IV
Recombinant DNA Technology for production of protein (insulin), vaccine (hepatitis), monoclonal antibodies (Herceptine).

UNIT V
Microbial assay techniques for estimation of antibiotics and vitamins. Application of antibiotics in animal nutrition and food preservation, mycotoxins and microbial insecticides.

UNIT VI
Use of microbes in mineral beneficiation; Production of biodegradable polymers, biofertilizers, microbial exopolysaccharides – xanthan, gellan etc.

Text Books:

Reference Books:
1. Bioprocess Engineering: basic concepts, Michael L. Shuler and Fikret Kargi
1. Study on protein separation by iron oxide nanoparticles.
2. Study on antibacterial activities of iron oxide nanoparticles against Escherichia coli.
4. Determination the fermentation profile of a supplied microorganism. Computation of maximum specific growth rate, growth yield, generation time and maintenance coefficient.
5. Determination of thermal death point and Thermal death time of microorganism for design of an autoclave.
6. Comparative studies of ethanol production using different substrates in batch and Continuous culture/ fed batch culture.
8. Separation of protein from aqueous solution using ultrafiltration and prediction of permeate flux.
10. To separate and identify the amino acids in a mixture by thin layer chromatography
11. Adsorption of methylene blue on biomass.
12. Identify and separate the components of a given mixture of carbohydrates by paper chromatography and calculate the RF value for each component. Learning

Students will be required to do Exercises and to write computer program as well as gain experience in the use of commercially available software such as MATLAB or any simulation software for bioprocess.
# UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
## SCHEME OF EXAMINATION M.TECH (BIOCHEMICAL ENGINEERING)

### SECOND SEMESTER EXAMINATION

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**NOTE:** Students can select THREE electives either offered by the department mentioned above or from the list of offered electives by other departments

#Subject to availability of resource person
Process and cost models, Role & application of mathematical models in process design and optimization, Process synthesis, modelling and development.  

(8 Hrs)


(8 Hrs)

Introduction to design of Separation network, Reactor-Separator network, Flow sheet optimization.  

(8 Hrs)

**Process design under uncertainty:** Accommodating to future developments; Anticipating the future, Accommodating to linear demand forecast, Non zero initial demand, sizing new chemical plants in a dynamic, economy, Accounting for uncertainty in Data; engineering on safe side, The propagation of uncertainty through designs, Failure tolerance; introduction, Catastrophic results from minor events, preliminary flowsheet review, theory of reliability & its application, Engineering around variation; variability, effects of storage on pulsed supply, analysis of queing theory, intersystem variation, economically optimal utilization, adapting to a variable power supply.  

(12 Hrs)

Course Objectives:

- Train students for various process design problems in industries using computer tools available like ASPEN TECH.
- To make students capable for development of the software in process designing.

**Books & Reference:**

1. Alexander C. Dimian, Integrated Design and Simulation of Chemical Processes, Elsevier,
3. Rudd and Watson; strategy of process engineering, John wiley & sons, inc. Babu
4. B.V. Basu, Process Plant Simulation,
UNIT I
Biochemical process variables and their measurements; Control principles and their application in bioreactors. On-line, in-line and off-line sensors in Bioreactor.

UNIT II
Physical And Chemical Parameters In Bioreactors ,Theory of electrode processes and their applications; Measurement and control of pH, temperature, dissolved oxygen, aeration and agitation, redox potential, foam, etc

UNIT III
Introduction to biosensors; Transduction principles used in biosensors; Characteristics of biosensors; Biosensors based on amperometric, potentiometric, thermistor FET, fiber optics and bioluminescence, Microbial biosensors

UNIT IV
Fundamentals of digital process control; Use of computer in control and optimization of microbiological processes. Computer Interfaces and peripheral devices; Data logging, Data analysis, Process control

Text Books:

Reference Books:
1. Principles of Fermentation Technology, Stanbury, Whitaker and Hall, Aditya Text Pvt. Ltd.
UNIT I
Overview of molecular biology and cellular metabolism, different models for cellular reactions, Metabolic regulation network at enzyme level and whole cell level. Basic concepts of Metabolic Engineering.

UNIT II
Modeling of metabolic networks- stoichiometry, kinetics, mass balance for steady state, mass balance for transient case.

UNIT III
Metabolic flux analysis- linear programming, cell capability analysis, Genome Scale Flux analysis. Methods for experimental determination of metabolic fluxes- isotope labeling.

UNIT IV
Metabolic control analysis- nonlinear programming.

UNIT V
Synthesis and design of metabolic networks - integer programming, mixed-integer nonlinear programming, Case studies – ethanol production, amino acid biosynthesis, other metabolisms in bacteria and yeast.

Text Books:

Reference Books:
Membrane processes: Microfiltration, Ultrafiltration, Nanofiltration and Reverse osmosis; Membrane configuration, Criterion of selection of suitable membrane; Factors affecting membrane fouling; Flux enhancement techniques; Cleaning protocol; Concept of integrated membrane process; Process design and energy requirement.  

Models predicting process throughput and permeate quality: Pore blocking model; surface-renewal model, concentration polarization model, gel layer model; osmotic pressure model and resistance in series model etc.  

Applications of membrane and above models: Purification and concentration of protein, enzymes etc.; Dairy industry; Sugar refining; Fruit juice processing; Treatment of plant extract; Alcoholic beverages etc.  

Affinity ultrafiltration and membrane bioreactor.  

References:
2. Membrane Processes, R. Rautenbach and R. Albrecht, John Wiley & Sons Ltd.
UNIT I 8 (Hrs)
Bioremediation/ Biotransformation processes and their developments, Current remediation processes in practices, Benefits of bioremediation

UNIT II 10 (Hrs)
The soil environment, Fate and Transport of contaminants in soils and water bodies

UNIT III 16 (Hrs)
Chemical Transformations, Microbial Ecology and Metabolism, Bioremediation of common chemical compounds, In-situ bioremediation process strategies.

UNIT IV 8 (Hrs)
Solid phase bioremediation, Slurry phase bioremediation, Vapour phase bioremediation, Natural attenuation with processes used

Text Books:
1. Eweis, Ergas, Chang and Schroeder, Bioremediation Principles, WCB Mc Graw Hill

Reference Book(s):
UNIT I 6 (Hrs)

UNIT II 12 (Hrs)
Genetic Advancements, Food Science and Food Process Technology Advancements, Microbiological Advancements, Future Bioprocess Technology Developments and their Risk, Bioprocess Lifecycle, Discovery and Development Phase –laboratory and Pilot Plant for Scaleup, Upstream and Downstream Inoculation, Seed and Production Biosafety, Containment and Production Risks, Fermentation and Cell culture.

UNIT III 8 (Hrs)

UNIT IV 8 (Hrs)

UNIT V 8 (Hrs)

Text Book:
1. Guidelines for Process safety in Bioprocess Manufacturing, By CCPS, USA.
2. Biosafety in Microbiological and Biomedical Laboratories, 2009, 5th Edition, HHS Publication
The student should select an existing experimental rig from U.G. Labs. Analyze the existing experiment being performed. Suggest modification for better performance.
If required, update the existing manual.
Suggest new experiment that may be carried out on existing or modified set up or entirely new set up. Or small research project.
### THIRD SEMESTER EXAMINATION

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**NOTE:** Students can select TWO electives either offered by the department mentioned above or from the list of offered electives by other departments

#Subject to availability of resource person
UNIT-I

UNIT-II
Protein and DNA based Nanostructures- Protein based nanostructures building blocks and templates- Proteins are transducer and amplifiers of bimolecular recognition events – Nanobioelectronic devices and polymer nanocontainers- Microbial production of inorganic nanoparticles –Megnetosomes . DNA based nanostructure –Topographic and Electrostatic Properties of DNA and Proteins –Hybrid conjugates of Gold nanoparticles-DNA

UNIT III

UNIT-IV

UNIT –V
Nanotechnology in Agriculture and food technology – Insecticides developments using Nanotechnology and nanofertilizers. Nanotechnology in food Processing, food safety and bio security, toxin and contaminant detection, smart packaging .

UNIT-VI
UNIT I:  
10 (Hrs)

UNIT II:  
10 (Hrs)
Cells of immune system Hematopoeisis and differentiation, antigen processing and presentation, activation of B and T lymphocytes, cytokines and their role in immune regulation, T cell regulation and MHC restriction, immunological tolerance. Tumor immunology, Transplantation immunology, immunotherapy.

UNIT III:  
8 (Hrs)
Cell mediated toxicity, Hypersensitivity, Autoimmunity, Vaccine: General consideration, ideotype network hypothesis, synthetic vaccine.

UNIT IV:  
6 (Hrs)
Product of Hybridoma, Monoclonal antibody and Fab fragments

UNIT V:  
8 (Hrs)
Immuno diffusion, immuno-electrophoresis, ELISA, RIA, fluorescence activated cell sorter (FACS), Hybridoma Technology and its application.

Text Books:
1. Immunology by J. Kubey Fence Creek Publishing (Blackwell).
2. Immunology by Ivan Riott.

Reference Books:
2. Immunology, Roitt, Mosby- Yearbook Inc.
3. Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell).
GENOMICS

UNIT I: 7 (Hrs)
Introduction to Genome and Gene structure, Structural organization of prokaryotic and eukaryotic genome. Genome assembly and annotation, Basis of population genomics, Contents of genomes, Repetitive DNA. Bioinformatics for the analysis of sequence data.

UNIT II: 7 (Hrs)
Genome expression in Prokaryotes and Eukaryotes, Transcriptomics; RNA Contents, Gene variation and single nucleotide polymorphism, Genetic Markers; Microsatellite DNA markers, RAPD RFLP, DNA sequencing methods, PCR, Microarray: DNA micro array marker, random primers, and computational methods.

UNIT III: 7 (Hrs)

PROTEOMICS

UNIT IV: 8 (Hrs)

UNIT V: 6 (Hrs)
Fundamental methods used in proteomics, Relationship between protein structure and function. Post translational protein modification, Proteome analysis, Protein - protein interactions, Two hybrid interaction screening, Fundamental of system biology.

UNIT VI: 7 (Hrs)
Proteome databases, Use of computer simulations and knowledge-based methods in the protein design process. De-novo design; making use of databases of sequence and structure.

Text Books & References

The student should select any one of the topics offered from the department or select one, on his own, duly approved from the department. As part of the project work, candidate should give oral presentation of the work at least one in a semester (CT - 653). The candidate is required to submit the detailed synopsis of the work that he would complete in the part-II (CT - 652) along with the report of the work already completed.

Based on industrial training at the end of 1st year of 6-8 week duration, candidate should give oral presentation of the work or seminar on any contemporary research area through self-study.

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## FOURTH SEMESTER EXAMINATION

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Students has to continue the work of CT-651, Major Project Part-I, and complete the work and submit the thesis for evaluation after giving Project Seminar (BCT - 654).

As part of the project work, candidate should give oral presentation of the work atleast one in a semester

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