University School of Chemical Technology
Guru Gobind Singh Indraprastha University

Syllabus of Examination

M.Tech (Full Time) (Chemical Engineering)

(2nd Semester)

(w.e.f. August 2006 Batch)

W.e.f – August 2006 Batch
Modified_11.08.2006
Approved By Academic Council_28.08.06

SCHEME OF EXAMINATION
M.Tech (Full Time)

L	T	P	Credits
14	**2**	**8**	**24**

SECOND SEMESTER EXAMINATION

Code No.	Paper	L	T	P	Credits
Theory Papers					
Core Courses					
CT-502	**Computer Aided Process Design**	**3**	**1**	**0**	**4**
CT-504	**Advanced Chemical Engineering Thermodynamics**	**2**	**1**	**0**	**3**
Elective Courses					
CT-512	**Alternative Energy Sources**	**3**	**0**	**0**	**3**
CT-514	**Process plant Utilities**	**3**	**0**	**0**	**3**
CT-516	**Catalysis and Reactor Design**	**3**	**0**	**0**	**3**
CT-518	**Membrane Science &Technology**	**3**	**0**	**0**	**3**
CT-520	**Design & Analysis of Bio-Reactors**	**3**	**0**	**0**	**3**
Practical/Viva Voce					
CT-554	**Minor Project**	**0**	**0**	**16**	**8**
	Total	**14**	**2**	**16**	**24**

Note: Student can select three electives either offered by the department from the above list or from the list of intradepartmental electives.

CT-502 Computer Aided Process Design

L	T	P	Credits
3	1	0	4

Process and cost models, Role & application of mathematical models in process design and optimization, Process synthesis, modelling and development. **(8 Hrs)**

Process flow sheeting. Dynamic modelling and simulation of chemical process with / without recycle. Use of generic software for steady unsteady state material, momentum & energy balance flow sheet simulation, software development for design of process equipment & flowsheet. **(8 Hrs)**

Introduction to design of Separation network, Reactor-Separator network, Flow sheet optimisation. **(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. **(8 Hrs)**

Course Objectives :

- Train students for various process design problems in industries using computer tools available like ASPENTECH.
- 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,
2. Seider W.D. and Seader J.D., Process Design Principles, John wiley & sons, inc.
3. Rudd and Watson; strategy of process engineering, John wiley & sons, inc. Babu
4. B.V. Basu, Process Plant Simulation,
5. Oxford Luyben, W.L. Process Modelling, Simulation and Control, McGraw Hill Book Co., 1990.
6. Hussain Asgher, Chemical Process Simulation, wiley eastern Ltd., New Delhi, 1986.

CT-504 Advanced Chemical Engineering Thermodynamics

L	T	P	Credits
2	1	0	3

Fundamentals of Statistical Thermodynamics: Quantum energy levels and degeneracy, Boltzmann statistics, Maxwell statistics and thermodynamics properties, Thermodynamics equilibrium of process, Molecular theory of ideal gases, Dense gases and liquids, Phase transitions and phase equilibrium. **(14 Hrs)**

Irreversible Thermodynamics: Definition, Entropy production and flow, Thermodynamics forces, Onsager's reciprocal relation and application to chemical processes. **(6 Hrs)**

Molecular Simulation: Thermodynamics modeling and molecular simulation of equilibrium separation processes. **(8 Hrs)**

Course Objectives:

- To introduce the fundamentals of statistical thermodynamics and to give students a foundation for molecular simulation of chemical engineering processes.
- To train students to apply this fundamental body of knowledge in thermodynamics to the solution of practical problems.
- To understand the fundamentals concepts of chemical engineering thermodynamics and to explain these concepts to other chemical engineers. We will re-drive the essential conclusions of statistical thermodynamics so that students will comprehend the breadth as well as the limitations of thermodynamics.

Books & Reference :

1. J M Prausnitz, R N Lichtenthaler, E G de Azevedo, Molecular Thermodynamics of Fluid Phase Equilibrium, 3rd Edition., Prentice-Hall, 1999.
2. V P Carey, Statistical Thermodynamics and Microscale Thermophysics, Cambridge University Press, 1999.
3. T L Hill, An Introduction to Statistical Thermodynamics, Dover Publications, New York.
4. J M Haile, Molecular Dynamics Simulations-Elementary Methods, J Wiley & Sons.
5. Introduction to Chemical Engineering Thermodynamics, Smith J.M, Van Ness H.C., Abbott M.M. The McGraw Hill Companies, Inc., USA, 5th Edition, 1996.
6. Chemical and Engineering Thermodynamics, Sandler S.I. John Wiley and Sons, Inc., New York, 3rd Edition, 1999.
7. Introductory Chemical Engineering Thermodynamics, Elliot J.R and Lira C.T., Prentice Hall, 1999.

CT-520 DESIGN & ANAYSIS OF BIOLOGICAL REACTORS

L	T	P	Credit
3	0	0	3

Ideal Bioreactors: Fed-Batch Reactor, Enzyme-catalysed reactions in CSTRs, CSTR reactors with recycle and wall growth, The ideal plug-flow tubular reactor.

Reactor Dynamics: Dynamics model, Stability

Reactors with non-ideal mixing: Mixing time in agitated tanks, Resident time distributions, Models for no-ideal reactors, Mixing-Bio reaction interactions.

Sterilization Reactors: Batch Sterilization, Continuous Sterilization

Immobilized Bio Catalysits: Formulation and characterization of immobilized cell bio catalysts, Application of immobilized cell bio catalysts

Multiphase Bio reactors: Conversion of heterogeneous substrates, Packed bed reactors, Bubble column Bio-reactors, Fluidised bed Bio-reactors, Trickle bed reactors

Fermentation Technology: Medium formulation, Design and operation of a typical aseptic, alrobic fermentation process, Alternate bio reactor configuration.

Animal & Plant Cell Reactor Technology: Environmental requirements for animal cell cultivation, Reactor for large-scale production using animal cells, Plant cell cultivation.

Books & References:

1. Biochemical Engineering Fundamentals by James E.Bailey & David F.Ollis, Publishers: McGrew-Hill.
2. Bioprocess Engineering by Shuler & Kargi, Prentice Hall
3. Encyclopedia of Chemical Engineering by Kirk & Othmer,

CT-516 Catalysis and Reactor Design

L	T	Credit
3	0	3

Catalysis and catalytic process , catalyst formation, adsorption on solid surfaces, physical - chemical adsorption model, multiplayer adsorption theory; catalytic reaction kinetic model, real and ideal surface models; various models for data analysis, adsorption enhancement, multi step rate control, significances of dual rate – determining step and non equilibrium kinetic model, catalyst deactivation, catalyst classification.

Fixed bed catalytic reactor; reactor and reaction parameter, chemical and physical dimensionless parameters, radial peclet, aspect and biot numbers, velocity variance, adiabatic and non adiabatic fixed bed reactor, design and modeling of fixed bed reactors

Fluidized bed catalytic reactor; character and quality of fluidization, fluid bed reactor modeling; Davidson Harrison model, Kunii - Levenspiel model, anatomy of overall rate coefficient, Olsons's fluid bed reactor analysis. Introduction and performance of catalytic gaze reactor, trickle bed reactor, catalyst deactivation in fixed bed, batch fluid bed, moving bed and continuous fluid bed reactors, comparison of fixed moving and fluid beds; reactor poisoning in terms of spm, thermal waves in fixed bed regeneration, optimization of regeneration cycles.

Books & References:

1. James J. Carberry: Chemical and catalytic reaction engineering McGraw Hill.
2. J.M.Smith, " Chemical Engineering Kinetics", McHill.
3. O.Levenspiel, "Chemical Reaction Engineering", Wiley Eastern, 2nd ed, 1972
4. Froment G.F., Bischoff K.B.; Chemical Reactor Analyser and design, John Wiley & Sons.
5. R.E.Hayes; Introduction to Chemical Reactor Analysis", Gordan and Breach science publishers.

CT-512 Alternative Energy Sources

L	T	Credit
3	0	3

Energy Scenario : Indian and global energy crisis, Classification of various energy sources, renewable and non renewable energy sources, remedial measures to energy crisis.

Energy Conservation: Laws of energy efficiencies, Ways of conserving energy in chemical and allied industries, viz, better house keeping, scope of improvements in design of equipments, waste heat recovery, concept of multiple effect and recycling etc. Energy audit.

Bioenergy, bio-gas plants and their operation, biomass and its conversion routes to gaseous and liquidfuels, its potential and generation by wind mills

Nuclear energy: status, nuclear raw materials , nuclear reactors and their classification, generation of nuclear power, nuclear installation in India and their capacity generation, limitation of nuclear energy, reprocessing of spent nuclear fuel.

Cogeneration of fuel and power, Energy from tidal and ocean thermal sources..

Books & Reference :

1. Brame J. S. S. and King J. G. Edward Arnold, " Fuel, solid, liquid and gases"
2. Sukhatme S.P., "Solar Energy"

CT-518 Membrane Science & Technology

L	T	Credit
3	0	3

Membrane development, preparation and characterization for RO, UF, NF and micro filtration, design of membrane support structure, membrane modules for industrial applications.

Membrane polymer/preparation : polymer selection, phase inversion membranes, thermodynamics; interfacial polymerization and membrane morphology

Catalytic membranes; non porous and porous inorganic membranes, design and use of membrane reactors for industrial applications.

Bio functional membranes: immobilized enzymes , covalent attachment methods, affinity chromatography, transport models, functionalized membranes, membrane based sensors.

Books & Reference:

1. Ho and Sirkar, Membrane Handbook, Chapman Hall, 1992
2. Mulder, M., Basic Principle of Membrane Technology, Kluwer Academic Publishers, 1996
3. Sourirajan, S. and Matsuura, T., Reverse Osmosis/Ultrafiltration Principle, National Research Council of Canada, Ottawa, Canada, 1985
4. Rauenbach, R. and Albrecht, R., Membrane Processes, John Wiley, 1989
5. Noble, R.D. and Stern, S.A., Membrane Separations Technology: Principles and Applications, Elservier, 1995
6. Howell, J.A., Sanchez, V., and Field, R.W. (EDITORS), Membranes in Bioprocessing, Chapman Hall, 1993
7. Kesting, R.E.Synthetic Polymeric Membranes: A Structural Perspective, John Wiley, 1985
8. Biofunctional Membrane (ed. By D.A.Butterfield), Plenum Press, 1996

CT-514 Process Plant Utilities

L	T	Credit
3	0	3

Various process utilities, their role and importance in chemical plants.

Water sources: sources of water, their characteristics, storage and distribution of water, water for boiler use, cooling purposes, drinking and process water treatment reuse and conservation of water, water resources management.

STEAM : Steam generation and its application in chemical process plants, distribution and utilization, design of efficient steam heating systems, steam economy, condensate utilization, steam traps, their characteristics, selection and application, waste heat utilization.

COMPRESSORS AND VACUUM PUMPS : Types of compressors and vacuum pumps and their performance characteristics. Methods of vacuum development and their limitations, materials handling under vacuum, piping systems, lubrication and oil removal in compressors in pumps.

REFRIGERATION SYSTEMS: Refrigeration system and their characteristics, load calculation and load calculation and humidification and de humidification equipments, drying and cooling tower, air blending, exhaust, ventilation, cryogenics, their characteristics and production of liquid N_2 and O_2

INSULATION: Importance of insulation for meeting for the process equipment, insulation material and their effect on various materials of equipment piping, fitting and valves, insulation for high, intermediate, low and sub zero temperatures including cryogenic insulation, determination of optimum insulation thickness.

INERT GASES: Introduction**,** properties of inert gases & their use, sources and methods of generation, comparison of nitro generation routes, general arrangement for inerting system, operational, maintenance and safety aspects.

Books & Reference:

1. Jack Broughton; Process utility systems; Institution of Chem. Engineers U.K.
2. Reid, Prausnitz poling; The properties of gases & liquids, IV ed. McGraw Hill international ed.
3. S.C.Arora & S.Domkumdwar; A course in refrigeration and air conditioning; Dhanpat Rai & Co.(P) ltd.

CT-554 Minor Project

L	T	P	C
0	0	16	8

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.