University School of Chemical Technology
Guru Gobind Singh Indraprastha University

Syllabus of Examination

M.Tech (Full Time) (Chemical Engineering)

(1st 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
15	**3**	**6**	**24**

FIRST SEMESTER EXAMINATION

Code No.	Paper	L	T	P	Credits
Theory Papers					
Core Courses					
CT-501	**Advanced Transport Phenomena**	**3**	**1**	**0**	**4**
CT-503	**Advanced Separation Technology**	**3**	**1**	**0**	**4**
CT-505	**Advanced System Engineering**	**3**	**1**	**0**	**4**
Elective Course					
CT-511	**Design of Experiment and Analysis of Engineering Data**	**3**	**0**	**0**	**3**
CT-513	**Environmental Engineering And Waste Management**	**3**	**0**	**0**	**3**
CT-515	**Powder Processing &Technology**	**3**	**0**	**0**	**3**
CT-517	**Chemical Process Quantitative Risk Analysis**	**3**	**0**	**0**	**3**
Practical/Viva Voce					
CT-553	**Advance Control Lab**	**0**	**0**	**6**	**3**
CT-555	**Advance Computational Lab**	**0**	**0**	**6**	**3**
	Total	**15**	**3**	**12**	**24**

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

CT-501 Advanced Transport Phenomena

L	T	P	Credits
3	1	0	4

PHILOSOPHY AND FUNDAMENTALS OF THREE TRANSPORT PHENOMENA : Importance of transport phenomena; analogous nature of transfer process; basic concepts, conservation laws. Molecular transport of momentum, Heat and mass, laws of molecular transport, Newton's law of viscosity, Fourier law of heat conduction, and Fick's law of diffusion. Transport coefficients – viscosity, thermal conductivity and mass diffusivity. Estimation of transport coefficients and temperature / pressure dependence.

ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) : Newtonian and non-Newtonian fluids, General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian fluids in pipes, for flow of Newtonian fluids in planes, slits and annulus, heat flux and temperature distribution for heat sources such as electrical, nuclear, viscous and chemical; forced and free convection; mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection.

EQUATIONS OF CHANGE AND THEIR APPLICATIONS : Conservation laws and equations of change; development of equations of continuity, motion and energy in single component systems in rectangular coordinates and the forms in curvilinear coordinates; simplified forms of equations for special cases, solutions of momentum, mass and heat transfer problems discussed under shell balance by applications of equation of change.

TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW : Introduction to turbulent flows, comparisons of laminar and turbulent flows in simple systems such as circular tube, flat plate. Concept of Boundary Layer Flow.

Books & Reference :

1. Transport Phenomena,R.B. Bird, W.E. Stewart and E.W. Lighfoot, 2nd Edition. John Wiley, 2002
2. Fundamentals of Momentum Heat and Mass Transfer, J.R. Wilty, R.W. Wilson, and C.W. Wicks, 4th Edition, John Wiley, New York, 2001
3. Transport Processes and Separation Process Principles, Christie J. Geankopolis, 4th Edition. Printice-Hall, 2003
4. "Transport Phenomena – A Unified Approach", R.S. Brodkey, and H.C. Hershey, McGraw Hill, 1988

CT-511 Design of Experiment and Analysis of Engineering Data

L	T	Credit
3	**0**	**3**

Graphical methods of model selection from experimental data. Two variable empirical equations. Liner, logarithmic and semi logarithmic plots. Modified linear, logarithmic and semilogarithmic plots. Reciprocal plots. Equations for lumped data. Elongated "s" curves. Three variables empirical equations. Sterns methods. Multivariable empirical equations. Dimensionless numbers. 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. Design of experiments: Factorial design of experiments. Detection of significant variables in the absence and in the presence of experimental errors. 2k factorial design. Fractional factorial design. Box-Wilson method. Estimation of quantitative significance of the variables. Response surface analysis: Interpretation of results. Reduction of equations to canonic form. Steepest ascent along response surface.

Books & Reference:

1. Mokhtar S. Bazara & C.M.Shetty; Non linear Programming, Theory & Algorithums; John Wiley & Sons.
2. Stephan G.N., Ariela Sofer; Linear & nonlinear programming, McGraw Hill.
3. T.F. Edgar and D.M.Himmelblan " Optimization of Chemical Processes", McGraw Hill International editions.
4. G.S.Beveridge and R.S.Schekhter " Optimization theory and practice, McGraw Hill, New York.
5. G.V. Rekhlaitis, A.Ravindran and K.M. Ragidell "Engineering Optimization Methods & applications, John Wiley, New York.

CT-513 Environmental Engineering and Waste Management

L	T	Credit
3	0	3

Ecology and Environment. Source of air, water and solid wastes. Air pollution. Micrometeorology and dispersion of pollutants in environment. Fate of pollutants. Air pollution control technologies, centrifugal collectors, electrostatics precipitator, bag filter and wet scrubbers. Design and efficiencies. Combustion generated pollution, vehicle emission control. Case studies. Water pollution: Water quality modeling for streams. Characterisation of effluents, effluent standards. Treatment methods. Primary methods: setting, pH control, chemical treatment. Secondary methods: Biological treatment. Tertiary treatments like ozonization, disinfection, etc. Solid waste collection, treatment and disposal. Waste recovery system.

Books & Reference:

1. L.Canter "Environment Impact Assessment", McGraw Hill..
2. E.P.Odum "Fundamentals of Ecology "V.B.Saunders and Co. 1974.
3. W.J.Weber "Physico-Chemical Process for water quality control, Wiley-international ed.
4. L.L.Gaccio Water and water pollution Handbook Marcel Dekkar, New York

CT-515 Powder Processing and Technology

L	T	Credit
3	**0**	**3**

Powder sampling: importance of sampling, sampling techniques for static powders and flowing powders. Sampling errors. Properties of powder: size and size distribution. Number, area and volume distributions and their significance. Interconversion of distributions. Size analysis in subsieve size range. Impaction, centrifugation, light scattering and light diffraction techniques. Shape characterization, shape factor, Heywood numbers and their significance. Fractal and Fourier techniques. Shape distribution by sieve cascadograph. Production of powder: review of classical laws of grinding. Definition, terms and concepts, analogy of reaction kinetics to mill grinding. The first order grinding hypothesis.

Experimental estimation of selection function (specific rate of breakage) and breakage distribution functions. The size mass balance equations. Analysis of batch grinding equation. Solution of equation for batch grinding circuits. Storage of solids: flow properties, segregation. Funnel and bulk flow of solids, arch formation. Stresses in bulk solids. Design of silo for reliable flow of the solids. Flow improving techniques. Dust explosion: condition for dust explosion for stored and flowing solids. Methods of measurement of dust explosion.

Book & Reference:

1. A.S.Foust et.al.; " Principles of Unit Operations"Woley, New York.
2. Geankoplis " Transport Processes and Unit Operations, Prantice Hall, India.
3. W.L.McCabe, J.Smith and P.Harriot " Unit Operations of Chemical Engineering.

CT-503 ADVANCED SEPARATION TECHNOLOGY

L	T	Credit
3	1	4

Rate –Based Models for Separation: Rate models, transport-rate expression, estimation of transport co-efficient.

Membrane separation: Introduction and classification, transport model, membrane modules, module flow patterns, membrane selection procedure, membrane processes like. RO, NF, UF, Pervaporation, Electrodialysis, liquid membrane, design consideration, selective separation by combination/individual membrane process, industrial application and economic consideration.

Enhanced and Hybrid Distillation: Salt distillation, Pressure swing-distillation, Heterogenous azeotropic distillation, reactive distillation-theory and design consideration, hybride separation process module and design consideration.

Supercritical fluid extraction: Theory, Process and Process Design; Molecular Sieve separation.

Books & Reference:

1. Seader J.D. and Henley J.E., Separation Process Principles, John Wiley & Sons1998
2. Taylor R and Krishna R., Multicomponent Mass Transfer, John Wiley & Sons, 1993
3. McHugh M. and Krukonis V., Supercritical Fluid Extraction-Principles and Practice, Butterworths-Heinman 1994.
4. Mulder, M., Basic Principle of Membrane Technology, Kluwer Academic Publishers, 1996
5. Rautenbach, R. and Albrecht, R., Membrane Processes, John Wiley, 198
6. Noble, R.D. and Stern, S.A., Membrane Separations Technology: Principles and Applications, Elservier, 1995

CT-505 Advanced System Engineering

L	T	P	Credits
3	1	0	4

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. **(05 Hrs)**

Unconstrained multi variable optimization – direct search methods, indirect first and second order methods; linear programming and its application: Simplex, Big M & Two Phase methods. **(8 Hrs)**

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) **(10 Hrs)**

Neural Network: Fundamentals of Neural Network, Back Propagation Network, Simulated annealing. Use of Neural networking in industries, Genetic Algorithm: Fundamentals of genetic algorithm, Genetic Modeling. **(07 Hrs)**

Course Objectives:

- Introduction of various optimization techniques for linear and non-linear problems to the students.
- Use of various emerging tools e.g. Neural Network in optimizing the problems in process industries.
- To make students capable for developing programs using MATLAB for optimization techniques.

Books & Reference :

1. T.F. Edgar and D.M. Himmelblau "Optimization of Chemical Proceses", McGraw Hill International editions.
2. Rao S S, "Engineering Optimization" New Age
3. Sharma JK. "Operations Research", Macmillian.
4. Bart Kosko, "Neural Network and Fuzzy systems", PHI
5. Rajasekaran R. and Vijaylakshmi GA, "Neural Networks, Fuzzy systems and Genetic algorithm", PHI.
6. G.S. Beveridge and R.S. Schekhter "Optimization theory and practice, McGraw Hill New York.
7. G.V. Rekhlaitis, A. Ravindran and K.M. Ragidell "Engineering Optimization Methods applications, John Wiley, New York.
8. James A Anderson, "An Introduction to Neural Networks", Eastern Economy Edition.
9. George J Klier, "Fuzzy sets and Fuzzy Logic", PHI.
10. James A Freeman and David maskapura, "Neural Network", Addison Wesley Longman inc.

CT – 517 Chemical Process Quantitative Risk Analysis

L	T	Credit
3	0	3

1. Introduction to CPQRA (Chemical Process Quantitative Risk Analysis): -

Techniques of CPQRA,
Scope of CPQRA Studies,
Management of incident lists,
Application of CPQRA,
Limitations of CPQRA,

2. Consequence Analysis: -

Source Models,
Explosion & Fires,
Effect Models,

3. Event Probability and Failure Frequency Analysis: -

Incident Frequencies from Historical Record,
Frequency Modeling Techniques,

4. Measurement, Calculation & Presentation of Risk Estimates: -

Risk Measures,
Risk Presentation,
Risk Calculations,
Risk Uncertainty, Sensitivity & Importance,

5. Creation of CPQRA Data Base: -

Historical Incident Data,
Process & Plant Data,
Chemical Data,
Environmental Data,
Equipment Reliability Data,

6. Case Studies: -

Chlorine Rail Tank Car Loading Facility,
Distillation Column,

Books & References

1. Guidelines for Chemical Process Quantitative Risk Analysis, CCPS of AIChE
2. Risk Analysis for Process Plant, Pipelines & Transport; J.R. Taylor