Scheme and Syllabus of M.Tech Chemical Engineering

(Part-Time)

Batch 2011 onwards

By
Department of Academics

Punjab Technical University

First Semester

Course Code	Course Name	Load Allocation			Marks Distribution		
		L	T	P	Internal Marks	External Marks	Total Marks
PGRM	Research Methodology	4	-	-	50	100	**150**
MTCH101	Advanced Fluid Mechanics	4	-	-	50	100	**150**
MTCH102	Advanced Mass Transfer	4	-	-	50	100	**150**
	Total	**12**	-	-	**150**	**300**	**450**

Second Semester

Course Code	Course Name	Load Allocation			Marks Distribution		
		L	T	P	Internal Marks	External Marks	Total Marks
MTCH201	Mathematical Methods in Chemical Engineering	4	-	-	50	100	**150**
MTCH202	Chemical Engineering Thermodynamics	4	-	-	50	100	**150**
	Total	**8**	-	-	**100**	**200**	**300**

Third Semester

Course Code	Course Name	Load Allocation			Marks Distribution		
		L	T	P	Internal Marks	External Marks	Total Marks
MTCH301	Advanced Heat Transfer	4	-	-	50	100	**150**
MTCH302	Chemical Reaction Engineering	4	-	-	50	100	**150**
MTCH	Elective-I	4	-	-	50	100	**150**
	Total	**12**	-	-	**150**	**300**	**450**

Fourth Semester

Course Code	Course Name	Load Allocation			Marks Distribution		
		L	T	P	Internal Marks	External Marks	Total Mark
MTCH401	Advanced Process Dynamics & Control	4	-	-	50	50	**100**
MTCH	Elective-II	4	-	-	50	100	**150**
	Total	**8**	-	-	**100**	**200**	**300**

Fifth Semester

Course Code	Course Name	Load Allocation			Marks Distribution		
		L	T	P	Internal Marks	External Marks	Total Marks
MTCH501	Environmental Engineering	4	-	-	50	50	100
MTCH502	Process Modelling & Simulation	4	-	-	50	50	100
MTCH503	Research Project Identification & Presentation	-	-	-	----	---	100

Sixth Semester

Course Code	Course Name	Load Allocation			Marks Distribution		
		L	T	P	Internal Marks	External Marks	Total Marks
MTCH601	Dissertation	---	--	---	---	Satisfactory / Non-Satisfactory	Satisfactory / Non-Satisfactory

LIST OF ELECTIVES

Elective – I		
Sr. No	Course Code	Course Name
1	MTCH311	Multi Component Distillation
2	MTCH312	Adsorption Engineering
3	MTCH313	Refrigeration Engineering
4	MTCH314	Advanced Polymer Science and Engineering

Elective – II		
Sr. No	Course Code	Course Name
1	MTCH411	Petrochemical Technology
2	MTCH412	Corrosion Engineering
3	MTCH413	Analytical Techniques
4	MTCH414	Advanced Energy Technology

PGRM Research Methodology

1. **Overview of Research** **(08)**
   Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial, response surfaces
2. **Methods of Data Collection** **(04)**
   Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules.
3. **Sampling Methods** **(08)**
   Probability sampling: simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgement sampling, quota sampling. Sampling distributions.
4. **Processing and analysis of Data** **(08)**
   Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses**:** Parametric (t, z and F) Chi Square, ANOVA, and non-parametric tests.
5. **Multivariate Analysis** **(06)**
   Multiple Regression, Factor Analysis, Discriminant Analysis, Cluster Analysis, multidimensional scaling
6. **Reliability and Validity** **(03)**
   Test-retest reliability, alternative-form reliability, internal-comparison reliability, and scorer reliability. Content validity, criterion-related validity, and construct validity.
7. **Essential of Report writing** **(03)**
   Note: Application and use of various software for case studies should be essential

Suggested Readings/ Books

1. Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.
2. Malhotra, N.K., Marketing Research An Applied Orientation, 4th Edition Pearson Education: New Delhi.
3. Zikmund, W.G., Business Research Methods, 7th Edition, Thomson South-Western.
4. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi.
5. Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 2nd edition

MTCH101 Advanced Fluid Mechanics

Objective: The course introduces the students to the principles of advanced fluid mechanics which are of fundamental importance to chemical engineers. The students are also acquainted with its applications to analysis of a given flow situation.

1. **Differential equations of fluid flow:** **(05)**
   Continuity equation for one dimensional and three dimensional flows. Derivation of momentum equation for three dimensional flow in Cartesian coordinates. Conversion of equations to spherical and cylindrical coordinates
2. **Flow of non-viscous fluids:** **(05)**
   Equation of motion (Euler equation) and its integration to obtain Bernoulli equation, velocity potential and irrotational flow. Streamlines and stream functions for two dimensional incompressible flow and two dimensional irrotational flow.
3. **Laminar flow of viscous fluids:** **(06)**
   Effects of viscosity on flow, pressure gradient in steady uniform flow, use of momentum equations in cylindrical coordinates, velocity profiles in isothermal and non-isothermal flow conditions in circular tubes and annuli, friction factor and shear stress relations. Flow between infinite parallel plates.
4. **Turbulent flow of viscous fluids:** **(06)**
   Prandtl's mixing length theory, Reynolds equation for incompressible turbulent flow. Reynolds stresses, statistical theory of turbulence, intensity of turbulence, scale of turbulence, techniques for measurement of turbulence, isotropic and homogeneous turbulence.
5. **Turbulent flow in closed conduits:** **(06)**
   Prandtl's power law of velocity distribution, logarithmic and universal velocity distribution equations for turbulent flow in smooth tubes. Friction factor for rough and smooth tubes, relationship of u^+ and y^+ to the friction factor and Reynolds number.
6. **Flow of incompressible fluids past immersed bodies:** **(05)**
   Von-Karman integral momentum equation, boundary layer on immersed bodies, equation of two dimensional flow in the boundary layer, local and total drag coefficients. Transition from laminar to turbulent flow on the flat plate and bluff body.
7. **Flow of compressible fluids:** **(06)**
   Mach number, acoustic velocity and their values for ideal gases, continuity equation, mechanical energy balance and total energy balance for steady state one-dimensional flow, asterisk condition

and stagnation temperature, velocity distribution, pressure ratio and effect of cross sectional area for isentropic flow of ideal gas in convergent-divergent nozzle, equations for adiabatic and isothermal frictional flow

8. **General topics:** **(02)**

High velocity measurement techniques for fluids. Scale up techniques.

Suggested Readings/ Books:

1. Knudsen & Katz, Fluid Dynamics and Heat Transfer, McGraw Hill Book Co., 1974.
2. McCabe, Warren L., Smith, Julian C. and Harriot, P., Unit Operations of Chemical Engg., 7th Ed., McGraw Hill, 2005
3. Gupta, Santosh K., Momentum Transfer Operations, Tata McGraw Hill, 1984.
4. Sissom, L. E. & Pitts, D.R., Elements of Transport Phenomenon, McGraw Hill, 1972.
5. Nevers Noel De., Fluid Mechanics for Chemical Engineering, 2nd Edition, McGraw Hill Inc., 1991.
6. Backhurst J.R., Harker J.H., Coulson J.F., Richardson J.M., Chemical Engineering – Volume 1, 6th Ed., Butterworth Heinemann, 1999

MTCH102 Advanced Mass Transfer

Objective: The objective of this course is to present the principles of mass transfer and its advanced applications. The concept and mathematical treatment of turbulent diffusion, analogies and mass transfer with chemical reaction is developed.

1. **Unsteady state diffusion: (12)**
   General methods of solution of problem in unsteady state molecular diffusion in isotropic media. Derivation of equations of unsteady-state diffusion for typical cases of mass transfer in infinite, semi-infinite and finite plane media and in spherical and cylindrical media.
2. **Interphase diffusional phenomena: (08)**
   Steady state and unsteady state theories of diffusion in two phase systems, significance of hydrodynamic factor in mass transfer between two phases in relative motion.
3. **Turbulent diffusion and analogies: (12)**
   Mechanism of turbulent diffusion in fluids. Application of the concept of the boundary layer theory and of analogies of momentum, heat and mass transfer to turbulent range diffusional phenomena. A theoretical treatment of inter relationship of mass transfer co-efficient and heat transfer – co-efficient.
4. **Mass transfer with chemical reactions: (08)**
   Diffusion reaction equations, slow reactions, fast reactions, transition from low to fast reaction, problems in practice.

Suggested Readings/Books:

1. Crank, J., The Mathematics of Diffusion, Oxford University Press, London, 1956.
2. Skelland, A. H. P., Diffusional Mass Transfer, John Wiley & Sons, 1974.
3. Sherwood, T. K., Pigford, R. L. & Wilke, C. R., Mass Transfer, McGraw Hill, Chemical Engineering Series, 1975.
4. Bird R.B., Stewart, W.E. and Lightfoot, E.N., Transport Phenomena, 2nd Ed., John Wiley& Sons, 2005.

MTCH201 Mathematical Methods in Chemical Engineering

Objective: This course is aimed at providing the knowledge about the numerical solutions and other techniques to solve various mathematical expressions; which are not easily solvable by conventional techniques.

1. **Numerical solutions of simultaneous & higher order differential equations**: **(06)**
   Runge-Kutta method, Picard's method.
2. **Approximate methods for B.V. problems**: **(10)**
   Finite Difference Method. Approximate and numerical solutions of PDE's: Finite difference approximation to derivatives. Numerical solutions of elliptic equations (Laplace and Poisson's equations), Parabolic equations and Hyperbolic equations. Finite Volume Method of Approximation
3. **Integral functions**: **(08)**
   Gamma functions, Beta functions, Elliptic integrals and functions and error functions. Solution methods for linear difference equations, complementary solutions and particular solutions. Nonlinear equations (Riccatic equations).
4. **Z-Transforms**: **(08)**
   Introduction, some standard Z-transforms, linearity property damping rule, some standard results, shifting rules, initial and final value theorems, convolution theorem, evaluation of inverse transforms, applications to difference equations.
5. **Fourier transforms:** **(08)**
   Introduction, Fourier integrals, properties of Fourier transforms, convolution theorem, Parseval's identity for F-transform, relation between Fourier and Laplace transforms, Fourier transforms of the derivatives of a function. Applications to boundary value problems.

Suggested Readings/ Books:

1. Jain, R. K. & Iyengar, S., Advanced Engineering Mathematics, 2nd Edition, Narosa Publishing House, New Delhi, 2003.
2. Grewal, B. S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 41st Edition.
3. Kreyszig, Erwin, Advanced Engineering Mathematics, 8th Edition, Wiley Eastern, New Delhi, 2002.
4. Jain, R.K., Numerical Solution of Differential Equations, 2nd Edition, Prentice Hall, 1987.
5. Mickley, H.S., Sherwood, T.K. and Reed, C.E., Applied Mathematics in Chemical Engineering, McGraw Hill.
6. Sastry, S.S., Introductory Methods of Numerical Analysis, 4th Ed., PHI

MTCH202 Chemical Engineering Thermodynamics

Objective: This course covers the thermodynamic analysis of chemical engineering problems, using its principles to phase and chemical equilibrium with emphasis on vapor/liquid systems.

1. **Review & applications of basic concepts:** **(10)**
   Inter-relationship of properties, Equations of States, Law of corresponding states, Maxwell's relations, Jacobian Method. Equilibrium and Stability, Chemical potential, Gibbs Duhem equation & its applications, fugacity & activity, standard states, thermodynamic properties from volumetric data.
2. **Solution thermodynamics applications:** **(14)**
   Models for the Excess Gibbs Energy: Wilson equation, Van-Laar equations, NRTL equation, UNIQUAC equation
   The Phase Rule, The Gamma/ Phi Formulation of VLE, Dew point and Bubble point Calculations, Flash Calculations for binary systems
   Equilibrium adsorption of pure gas on solid: Gibb's, Langmuir and Freundlich adsorption isotherms, heat of adsorption
3. **Thermodynamic properties and VLE from equations of state**: **(08)**
   Properties of fluids from the various equations of state – viral equations, R-K equation, Lee / Kesler equation. VLE from cubic equations of state
4. **Chemical reaction equilibrium:** **(10)**
   Effect of Temperature on the Equilibrium Constant, Relation of equilibrium constants to composition, Equilibrium Conversions for single reactions
   Phase rule & Duhem's Theorem for reacting systems, multi-reaction equilibria, multi-phase reaction equilibria.

Suggested Readings/Books:

1. Smith J.M. and Van Ness, H.C, Introduction to Chemical Engineering Thermodynamics, 7th Ed., McGraw Hill Book Co., 2005
2. Narayanan, K. V., A Textbook of Chemical Engineering Thermodynamics, 2nd Edition, Prentice Hall India, 2001.
3. Balzhiser R., Samuels M., Eliassen J., Chemical Engineering Thermodynamics, Prentice Hall, 1972
4. Prausnitz, T.Z., Lichtonthaler R.N. and de Azevedro E.G., Molecular Dynamics of Fluid Phase Equilibria, Englewood Cliff, N.Z. Prentice Hall, 2nd Ed., 1986.
5. Kennethenbigh, The Principles of Chemical Equilibrium, Cambridge University press, 4th Edition,1981

6. Kyle, B. G., Chemical and Process Thermodynamics, 3rd Edition, Prentice Hall of India, 1999.

7. Chao,K.C.& Greenkorn, R.A., Thermodynamics of Fluids, Marcel Dekker, 1975