2007-2008

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

B.TECH. CHEMICAL ENGINEERING

III YEAR II SEMESTER
COURSE STRUCTURE

Subject	T	P	C
Management Science	4+1*	0	4
Chemical Technology	4+1*	0	4
Mass Transfer Operations – II	4+1*	0	4
Chemical Reaction Engineering-II	4+1*	0	4
Process Dynamics and Control	4+1*	0	4
Biochemical Engineering	4+1*	0	4
Chemical Reaction Engineering Lab	0	3	2
Mass Transfer Operations Lab	0	3	2
Total	30	6	28

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III Year B.Tech. Ch.E. II Sem

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4+1*	0	4

MANAGEMENT SCIENCE

Unit I: ***Introduction to Management*****:** Concepts of Management and organization- Nature and Importance of Management, Functions of Management, Taylor's Scientific Management Theory, Fayol's Principles of Management, Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation, Systems Approach to Management, Leadership Styles, Social responsibilities of Management.

Unit II: ***Designing Organisational Structures*****:** Basic concepts related to Organisation - Departmentation and Decentralisation, Types of mechanistic and organic structures of organisation (Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organisation, Cellular Organisation, team structure, boundaryless organization, inverted pyramid structure, lean and flat organization structure) and their merits, demerits and suitability.

Unit III: ***Operations Management*****:** Principles and Types of Plant Layout-Methods of production (Job, batch and Mass Production), Work Study -Basic procedure involved in Method Study and Work Measurement-Statistical Quality Control: $\overline{X}$ chart, R chart, *c* chart, *p* chart, (simple Problems), Acceptance Sampling, Deming's contribution to quality.

Unit IV: ***A) Materials Management*****:** Objectives, Need for Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Stores Records - Supply Chain Management

B) Marketing**:** Functions of Marketing, Marketing Mix, Marketing Strategies based on Product Life Cycle., Channels of distribution.

Unit V: ***Human Resources Management (HRM):*** Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs. PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Placement, Wage and Salary Administration, Promotion, Transfer, Separation, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating.

Unit VI: ***Project Management (PERT/CPM)*****:** Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing. (simple problems)

Unit VII: ***Strategic Management*****:** Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives.

Unit VIII: ***Contemporary Management Practices*****:** Basic concepts of Just-In-Time (JIT) System, Total Quality Management (TQM), Six sigma and Capability Maturity Model (CMM) Levels, Value Chain Analysis,Enterprise Resource Planning (ERP), Performance Management, Business Process outsourcing (BPO), Business Process Re-engineering and Bench Marking, Balanced Score Card.

Text Book:

1. Aryasri: *Management Science*, TMH, New Delhi.

Reference Books:

1. Kotler Philip & Keller Kevin Lane: Marketing Mangement 12/e, PHI, 2007
2. Koontz & Weihrich: *Essentials of Management*, 6/e, TMH, 2007
1. Thomas N.Duening & John M.Ivancevich *Management—Principles and Guidelines,* Biztantra,2007.
2. Kanishka Bedi, *Production and Operations Management*, Oxford University Press, 2007.
3. Memoria & S.V.Ganker, *Personnel Management*, Himalaya, 25/e, 2007
4. Schermerhorn: *Management*, Wiley, 2007.
5. Parnell: Strategic Management, Biztantra,20073.
6. L.S.Srinath: PERT/CPM,Affiliated East-West Press, 2007.

Pre-requisites: Managerial Economics

***Objective*:** To familiarize with the process of management and to provide basic insights into select contemporary management practices.

Codes/Tables: Normal Distribution Function Table need to be permitted into the examination Hall.

Question Paper Pattern: 5 Questions to be answered out of 8 questions.
Each question should not have more than 3 bits.
Unit VIII will have only short questions, not essay questions.

2007-08

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	4+1*	**0**	**4**

CHEMICAL TECHNOLOGY

UNIT I
Soda ash, caustic soda and chlorine, Glass: manufacture of special glasses

Unit – II
Industrial gases: carbon dioxide, hydrogen and oxygen – products of water gas, producer gas. Nitrogen industries: synthetic ammonia, urea, nitric acid (ammonium nitrate), ammonium chloride, ammonium phosphate and complex fertilizers

Unit – III
Sulphur and sulphuric acid, manufacture of sulphuric acids, hydrochloric acid and some other chemicals –Aluminum sulphate and alum, barium salts rare earth compounds.

Unit – IV
Cement manufacture, special cements, miscellaneous calcium compounds, magnesium compounds.

Unit – V:
Manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol- formaldehyde resin and polyvinyl chloride polymer, SBR.

Unit – VI:
Oils: Definition, constitution, extraction and expression of vegetable oils, refining and hydrogenation of oils.

UNIT-VII:
Soaps and detergents: Definitions, continuous process for the production of fatty acids, glycerin and soap, production of detergents.

Unit – VIII:
Pulp and paper industry: methods of pulping, production of sulphate and sulphite Pulp, production of paper –wet process

TEXT BOOKS:
1. Shreve's Chemical Process Industries edited by Austin, McGraw-Hill.5th ed.1985.
2. Dryden's Outlines of Chemical Technology, edited by M.Gopal Rao and M.Sittig, 2nd ed. 1973.

REFERENCES:
1. Industrial Chemistry by B.K.Sharma
2. Hand book of industrial chemistry Vol 1&II K.H.Davis & F.S. Berner Edited by S.C. Bhatia, CBS publishers

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III Year B.Tech. Ch.E. II Sem	**T**	**P**	**C**
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MASS TRANSFER OPERATIONS-II

UNIT-I

Distillation: Fields of applications, VLE for miscible liquids, immiscible liquids, steam distillation, Positive and negative deviations from ideality, enthalpy-concentration diagrams, flash vaporization and differential distillation for binary and multi component mixtures.

UNIT-II

Continuous rectification-binary systems, multistage tray towers –method of Mc Cabe and Thiele, enriching section, exhausting section, feed introduction, total reflux, minimum and optimum reflux ratios, use of steam, condensers, partial condensers, cold reflux, multiple feeds , tray efficiencies, continuous-contact equipment (packed towers)

UNIT- III

Multistage (tray) towers –the method of Ponchon and Savarit, the enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios, reboilers, use of open steam, condenser and reflux accumulators, Azeotropic distillation, extractive distillation, comparison of Azeotropic and extractive distillation.

UNIT- IV

Liquid-Liquid operations: fields of usefulness, liquid-liquid equilibrium, equilateral triangular co-ordinates, choice of solvent, stage wise contact, multistage cross-current extraction, Multi stage counter current without reflux

UNIT- V

Multi stage counter current with reflux, Differential (continuous contact) extractors, spray towers, packed towers, mechanically agitated counter-current extractors, centrifugal extractors, dilute solutions, super critical fluid extraction, fractional extraction.

UNIT-VI

Leaching: Fields of applications, preparation of solid for leaching, types of leaching, leaching equilibrium, single stage and multi stage leaching calculations, constant under flow conditions, equipment for leaching operation.

UNIT-VII

Adsorption: Adsorption, types of adsorption, nature of adsorbents, adsorption equilibrium, single gases and vapors, Adsorption Hysteresis, effect of temperature, Heat of adsorption, vapor and gas mixtures: One component adsorbed, Effect of change of temperature or pressure. Liquids, Adsorption of solute from dilute solution, The Freundlich equation, Adsorption from concentrated solutions, adsorption operations, stage wise operation, application of Freundlich equation to single and Multistage adsorption (cross current & counter current).

UNIT -VIII

Adsorption of vapor from a gas, fluidized bed, continuous contact, steady state moving bed adsorbers, unsteady state–fixed bed adsorbers, adsorption wave, elution, adsorption-desorption operations- thermal desorption of gases, activated carbon solvent recovery, pressure swing and vacuum swing adsorption (qualitative treatment), regeneration with purge and desorbent, ion-exchange: principles of ion exchange, techniques and applications, ion-movement theory, ion exclusion.

Text Book:

1. Mass transfer operations by R.E. Tryebal, 3rd ed. Mc Graw Hill, 1980.

Reference:

1. Diffusion: mass transfer in fluid system by E. L. Cussler.
2. Transport processes and unit operations by Christie J. Geankoplis
3. Principles of mass transfer and separation processes, B.K. Dutta, PHI, India

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III Year B.Tech. Ch.E. II Sem	**T**	**P**	**C**
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CHEMICAL REACTION ENGINEERING – II

UNIT I
Basics of non-ideal flow- **E**, the age distribution of fluid, the RTD, Conversion in Non-ideal flow reactors, Diagonizing reactors ills (qualitative discussion only)

Unit–II
The dispersion model-axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

Unit–III
The tanks in series model- pulse response experiments and the RTD, chemical conversion. The convection model for laminar flow- the convective model and its RTD, chemical conversion in laminar flow reactors

Unit–IV
Earliness of mixing, segregation and RTD- self-mixing of a single fluid, mixing of two miscible fluids.

Unit–V
Catalysis and Catalytic reactors- catalysts, steps in a catalytic reactions, synthesizing a rate law, mechanism and rate limiting step. (From chapter 6 Fogler)

Unit–VI
Heterogeneous reactions -Introduction.
Solid catalyzed reactions- The rate equation for Surface Kinetics- Pore diffusion resistance combined with surface kinetics, Porous catalyst particles, Heat effects during reaction, Performance equations for reactors containing porous catalyst particles.

Unit–VII
Solid catalyzed reactions- Experimental methods for finding rates. Deactivating catalysts- mechanisms of catalyst deactivation, the rate and performance equations.

Unit–VIII
Fluid-fluid reactions: kinetics- the rate equation.
Fluid-particle reactions: kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling step.

TEXT BOOK:

1. Chemical Reaction Engineering by Octave Levenspiel 3rd ed. Wiley Eastern Ltd.

REFERENCES:

1. Elements of chemical reaction engineering by H.S. Fogler, 3rd ed. PHI, 1999.
2. Chemical engineering kinetics by J.M.Smith, 3rd ed. Mc Graw Hill, 1981.

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PROCESS DYNAMICS AND CONTROL

UNIT I
Introduction to process dynamics and control. Response of First Order Systems. Physical examples of first order systems

Unit-II:
Response of first order systems in series, Higher order systems: Second order and transportation lag

Unit-III:
Control systems Controllers and final control elements, Block diagram of a chemical rector control system

Unit-IV:
Closed loop transfer functions, Transient response of simple control systems

Unit-V:
Stability, Root locus

Unit-VI:
Transient response from root locus, Application of root locus to control systems Introduction to frequency response, Control systems design by frequency response

Unit-VII:
Advanced control strategies, Cascade control, Feed forward control, ratio control, Smith predictor, dead time compensation, internal model control.

Unit -VIII:
Controller tuning and process identification. Control valves

TEXT BOOK
1. Process systems analysis and control by D.R. Coughanowr, 2nd ed. Mc Graw Hill 1991

REFERENCE
1. Chemical process control by G. Stephanopolous, PHI,1998

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BIOCHEMICAL ENGINEERING

Unit-I:
Introduction to microbiology: Biophysics and the cell doctrine, the structure of cells, important cell types, from nucleotides to RNA and DNA, amino acids into proteins.

Unit-II:
Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, other patterns of substrate concentration dependence, modulation and regulation of enzyme activity, other influences on enzyme activity.

Unit-III:
Immobilized enzyme technology: enzyme immobilization, industrial processes, utilization and regeneration of cofactors. Immobilized enzyme kinetics: effect of external mass transfer resistance, analysis of intraparticle diffusion and reaction.

Unit-IV:
Kinetics of cellular growth in batch and continuous culture, models for cellular growth – unstructured, structured and cybernetic models. Thermal death kinetics of cells and spores

Unit-V:
Introduction to metabolic pathways, biosynthesis, transport across cell membranes, end products of metabolism, stoichiometry of cell growth and product formation.

Unit – VI:
Design and analysis of biological reactors: batch reactors, fed-batch reactors, enzyme catalyzed reactions in CSTR, CSTR reactors with recycle and cell growth, ideal plug flow reactors, sterilization reactors, sterilization of gases, packed bed reactors using immobilized catalysts. Fermentation technology: medium formulation, design and operation of a typical aseptic, aerobic fermentation process.

Unit – VII:
Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, overall k_La' estimates and power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

Unit – VIII:
Down stream processing: Strategies to recover and purify products; separation of insoluble products-filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra filtration and reverse osmosis), chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification – crystallization and drying.

TEXT BOOK:
1. Biochemical engineering fundamentals by J.E.Bailey and D.F.Ollis, 2nd ed,1986,McGraw Hill.
2. Bioprocess Engineering by Michael L. Shuler and Fikret Kargi, 2nd edition, Pearson education education

REFERENCE:
1. Biochemical engineering by James M.Lee – Prentice-Hall-1992.
2. Biochemical engineering by Aiba, Humphrey and Mells, academic press.
3. Bioprocess engineering principles, Pauline M. Doran, Academic Press.
4. Biochemical Engineering, H.W. Blanch and D.S. Clark, Marcel Dekker, 1997

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	0	**3**	**2**

CHEMICAL REACTION ENGINEERING LAB

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) differential method (b) integral method.
   Major equipment - Batch reactor

2. Determination of the activation energy of a reaction using a batch reactor
   Major equipment - Batch reactor

3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.
   Major equipment – CSTR apparatus

4. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor.
   Major equipment - Batch reactor

5. To determine the order of the reaction and the rate constant using a tubular reactor.
   Major equipment – PFR apparatus

6. CSTRs in series- comparison of experimental and theoretical values for space times and volumes of reactors.
   Major equipment - CSTRs in series setup
7. Mass transfer with chemical reaction (solid-liquid system) – determination of mass transfer coefficient.
   Major equipment – beaker, stirrer

8. Axial mixing in a packed bed. Determination of RTD and dispersion number for a packed-bed using a tracer
   Major equipment - Packed bed set up

9. Determination of RTD and dispersion number in a tubular reactor using a tracer.
   Major equipment - PFR set up

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MASS TRANSFER OPERATIONS LAB

1. Estimation of diffusivity coefficients
   Major equipment - Diffusivity apprartus

2. Distillation, a) Steam distillation b) Differential distillation
   Major equipment – a) Steam Distillation unit,
   b) Differential Distillation unit

3. Packed towers, HETP evaluation
   Major equipment - Packed column unit

4. Vapor Liquid Equilibria
   Major equipment - VLE apparatus

5. Batch Drying
   Major equipment - Tray Dryer

7. Evaluation of Mass transfer coefficients
   (a) Surface Evaporation (b) Wetted wall column
   Major equipment – a) Surface Evaporation unit
   b) Wetted wall column unit
8. (a) Liquid- Liquid Equilibria (Tie line data)
   (b) Ternary Liquid Equilibria (binodal curve)
   Major equipment – LLE setup