2007-2008

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

B.TECH. CHEMICAL ENGINEERING

IV YEAR I SEMESTER
COURSE STRUCTURE

Subject	T	P	C
Transport Phenomena	4+1*	0	4
Chemical Engineering Plant Design and Economics	4+1*	0	4
Chemical Process Equipment Design	4+1*	0	4
Process Modeling and Simulation	4+1*	0	4
Elective - I	4+1*	0	4
Advanced Data Structures and Algorithms			
Polymer Technology			
Petroleum and Petro-Chemical Technology			
Fluidization Engineering			
Elective-II	4+1*	0	4
Membrane Technology			
Industrial Biotechnology			
Unix and Shell Programming			
Chemical Engineering Mathematics			
Process Dynamics and Control Lab	0	3	2
Simulation Lab	0	3	2
Total	30	6	28

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

TRANSPORT PHENOMENA

Unit-I:
Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity (molecular momentum transport), generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density, molecular theory of the viscosity of liquids.

Unit-II:
Thermal conductivity and the mechanisms of energy transport: Fourier's law of heat conduction (molecular energy transport), temperature and pressure dependence of thermal conductivity, and theory of thermal conductivity of gases at low density.

Unit -III
Diffusivity and the mechanisms of mass transport: Fick's law of binary diffusion (molecular mass transport), temperature and pressure dependence of diffusivities, theory of diffusion in gases at low density.

Unit-IV:
Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

Unit-V:
Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection, free convection.

Unit-VI:
Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction, diffusion with a homogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution), diffusion and chemical reaction inside a porous catalyst.

Unit-VII:
The equations of change for isothermal systems: the equation of continuity, the equation of motion, the equation of mechanical energy, the equation of angular momentum, the equations of change in terms of the substantial derivative, use of the equations of change to solve flow problems. Velocity distributions in turbulent flow: comparisons of laminar and turbulent flows, time- smoothed equations of change for incompressible fluids, the time- smoothed velocity profile near a wall.

Unit- VIII:
The equations of change for non- isothermal systems: the energy equation, special forms of the energy equation, the boussenis equation of motion for forced and free convection, use of the equations of change to solve steady state problems. The equations of change for multi component systems: the equations of continuity for a multi component mixture.

TEXT BOOK:
1. Transport phenomena by Bird R.B., Stewart W.C., Lightfoot F.N., 2nd ed. John Wiley & Sons Inc,U.S.A,1960.

REFERENCES:
1 Transport phenomena for engineers by L.Theodore, International text book company,U.S.A.1971.
2. Transport processes and unit operations, 3rd, Geankoplis, PHI, 1997.
3. Fundamental of heat, momentum and mass transfer, Welty, Wicks, Wilson, John Wiley.

2007-08

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

CHEMICAL ENGINEERING PLANT DESIGN AND ECONOMICS

Unit-I:
Introduction, Process Design development. General design considerations, Cost and asset accounting.

Unit-II:
Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment,

Unit-III:
Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing.

Unit - IV
Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

Unit-V:
Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self insurance.

Unit – VI
Depreciation : types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

Unit-VII:
Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period ,alternative investments, analysis with small investments, increments and replacements.

Unit- VIII:
Optimum design and design strategy, incremental cost, general procedure for determining optimum condition, comparison of graphical and analytical methods, optimum production rates, semi continuous cyclic operation, fluid dynamics, mass transfer strategy of linearization

TEXT BOOK
1. Plant Design and Economics for Chemical Engineering; by M.S. Peters and K.D.Timmerhaus, Mc Graw Hill,4th Ed.,1991
Reference:
1. Process Engineering Economics, Schweyer,

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

CHEMICAL PROCESS EQUIPMENT DESIGN

Uint-I
Introduction; development of flow diagrams from process description, material and energy balance, sizing of equipment, design preliminaries, design codes, MOC selection procedure, fabrication methods and testing methods.

Uint-II
Stresses in thin and thick walled shells, theories of failure, design of storage vessels.

Unit-III
Design of pressure vessels

Unit-IV
Design of shell and tube heat exchangers

Unit-V
Design of single effect evaporator.

Unit-VI
Design of distillation and absorption columns.

Unit-VII
Design of batch reactor, CSTR and PFR

Unit-VIII
Optimum pipe diameter.

TEXT BOOK:
1. Chemical Engineering: Vol.6, Coulson J.M. and Richardson J.F., Pergamon Press 1983

REFERENCES:
1. Process Equipment Design, M.V. Joshi
2. Process Equipment Design-Vessel Design: Brownell L.E., Wiley Eastern Ltd.,(1986)
3. Introduction to Chemical Equipment Design-Mechanical Aspects: Bhattacharya B.C., CBS Publishers, 1991
4. Process Heat Transfer: Kern Q., McGraw Hill book Co. Inc.,1982
5. Mass Transfer Operations:Treybal R.E., MGH Book Co.Inc, 1982
6. Chemical Engineering Hand Book, Perry, 5th Ed.,

2007-08

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

PROCESS MODELING AND SIMULATION

UNIT-I
Mathematical models for chemical engineering systems, fundamentals, introduction to fundamental laws

UNIT -II
Examples of mathematical models of chemical engineering systems, constant volume CSTRS, two heated tanks, gas phase pressurized CSTR, non-isothermal CSTR.

UNIT -III
Examples of single component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.

UNIT -IV
Iterative methods, bisection, false position, Newton –Raphson, successive approximation methods, comparison of iterative methods, solution of linear simultaneous algebraic equations, Computation of Eigen values and Eigen vectors, Gauss elimination method, Gauss-Jordan and Gauss-Seidel's method.

UNIT -V
Numerical integration by Trapezoidal and Simpson's rules, numerical solution of differential equations, Euler method, Runge-Kutta fourth order method, Milne predictor corrector method.

UNIT -VI
Interpolation, Lagrange interpolation, forward difference, backward difference and central difference interpolation methods, least square approximation of functions, linear regression, polynomial regression.

UNIT -VII
Computer simulation, examples, gravity flow tank, three CSTRs in series, binary distillation column, batch reactor

UNIT -VIII
Simulation of Non-isothermal CSTR, VLE dew point, bubble point calculations, countercurrent heat exchanger

Textbooks:

1. Process modeling simulation and control for chemical engineers by W. L. Luyben, McGraw Hill, 2nd Ed.,
2. Numerical methods in engineering, S.K. Gupta, Tata McGraw Hill.

Reference:

1. Engineering Mathematics by B. S. Grewal
2. Modeling and analysis of Chemical Engineering processes by K.Balu and K.Padmanabhan, IK International private limited, 2007

2007-08

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

ADVANCED DATA STRUCTURES AND ALGORITHMS
(ELECTIVE – I)

Unit I:-
C++ Class Overview- Class Definition, Objects, Class Members, Access Control, Class Scope, Constructors and destructors, parameter passing methods, Inline functions, static class members, this pointer, friend functions, dynamic memory allocation and deallocation (new and delete), exception handling.

Unit II:-
Function Overloading, Operator Overloading, Generic Programming- Function and class templates, Inheritance basics, base and derived classes, inheritance types, base class access control, runtime polymorphism using virtual functions, abstract classes, streams I/O.

Unit III:-
Algorithms, performance analysis-time complexity and space complexity,O-notation, Omega notation and Theta notation, Review of basic data structures - the list ADT, stack ADT, queue ADT, implementation using template classes in C++, sparse matrix representation.

Unit IV:-
Dictionaries, linear list representation, skip list representation, operations- insertion, deletion and searching, hash table representation, hash functions, collision resolution-separate chaining, open addressing-linear probing, quadratic probing, double hashing, rehashing,extendible hashing, comparison of hashing and skip lists.

Unit V:-
Priority Queues – Definition, ADT, Realizing a Priority Queue using Heaps, Definition, insertion, Deletion, Application-Heap Sort, External Sorting- Model for external sorting, Multiway merge, Polyphase merge.

Unit VI:-
Search trees (part I) : Binary search trees, definition, ADT, implementation, operations-searching, insertion and deletion, Balanced search trees- AVL trees, definition, height of an AVL tree, representation, operations-insertion, deletion and searching.

Search trees (part II) : Introduction to Red –Black trees and Splay Trees, B-Trees-B-Tree of order m, height of a B-Tree, insertion, deletion and searching, Comparison of Search Trees.

Unit VII:-
Divide and Conquer- General method, applications – Binary search, merge sort, quick sort, Strassen's matrix multiplication
Efficient non recursive tree traversal algorithms, Biconnected components. Disjoint set operations, union and find algorithms.

Unit VIII:-
Greedy method and Dynamic programming : General method (Greedy), Minimum cost spanning trees, Job sequencing with deadlines, General method (Dynamic Programming), Optimal binary search trees, 0/1 knapsack problem, Ordering Matrix Multiplications

TEXT BOOKS :

1. Data Structures and Algorithm Analysis in C++, Mark Allen Weiss, Pearson Education, second edition.
2. Data structures, Algorithms and Applications in C++,S.Sahni,University press (India) pvt ltd, 2nd edition, Orient Longman pvt.ltd.

REFERENCE :

1. Data structures and Algorithms in C++, Michael T.Goodrich, R.Tamassia and D.Mount, Seventh Edition Wiley student edition, John Wiley and Sons.
2. Data Structures and Algorithms in C++, Third Edition, Adam Drozdek, Thomson
3. Problem solving with C++, The OOP, Fourth edition, W.Savitch, Pearson education.
4. C++, The Complete Reference, 4th Edition, Herbert Schildt, TMH.
5. Data structures using C and C++, Langsam, Augenstein and Tanenbaum, PHI/Pearson Education.

2007-2008

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

POLYMER TECHNOLOGY
(ELECTIVE - I)

Unit - I
Introduction; definitions: polymer& macro molecule , monomer, functionality, average functionality, co-polymer, polymer blend., plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index. Determination of average molecular weights: End group analysis, osmometry, light scattering techniques, viscometer, Gel permeation chromatography.

Unit-II
Natural polymers: brief study of i) Natural rubber ii) shellac iii) rosin iv) cellulose v) proteins.

Unit-III
Mechanism and kinetics of : Addition or chain polymerization
a) free radical addition polymerisation
b) Ionic addition polymerizations
c) Coordination polymerization.
d) Coordination or step growth or condensation polymerization.

Unit-IV
Methods of polymeisation: mass or Bulk polymerization process, solution polymeisation process, suspension polymeisation process and emulsion polymerisation method comparison of merits and demerits of these methods.Properties of polymers: crystalline and amorphous status, melting and glass transition temperatures and their determination, effect of polymer structure on mechanical, physical, chemical and thermal properties.

Unit-V
Degradation of polymers, Role of the following additives in the polymers: i) Fillers and reinforcing fillers ii) Plasticizers iii) Lubricants iv)Antioxidants and UV stabilizers v) Blowing agents vi)Coupling agents vii)Flame retardents viii) Inhibitors

Unit-VI
Brief description of manufacture, properties and uses of : i) Polyethylene (HDPE&LDPE), ii) Poly propylene iii) Polyvinylchloride iv) Polystyrene v) Polytetra fluoroethylene vi) Polymethyl mehacrylate
vii) Polyvinylacetate & Polyvinylalcohol.

Unit-VII
Brief description of manufacture, properties and uses of : i) Polyesters(Polyethylene terephalate polycarbonate and unsaturated polyesters) ii) Nylon(Nylon 66) iii) Phenol- Formaldehyde resins iv) Epoxy resins v) Polyurethane vi) Silicones

Unit-VIII
Compounding of polymer resins, brief description of : i) Compression and transfer moulding ii) Injection moulding iii) Extrusion iv) Blow moulding v) Calendaring vi) Laminating and pultrusion

TEXT BOOKS:
1. Plastic materials, J.A. Brydson, Newnes-Butterwarths (London) 1989.
2. Text book of polymer science, Bill meyer, F.W.Jr. (3rd ed.) John Wiely&sons 1984

REFERENCES:
1. Introduction to plastics, J.H. Brison and C.C. Gosselin, Newnes, London 1968.
2. Polymeric Materials, C.C.Winding and G.D.Hiatt Mc Graw Hill Book Co. 1961
3. Polymer Science by Gowarikar

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

PETROLEUM AND PETRO CHEMICAL TECHNOLOGY
(ELECTIVE - I)

UNIT I
Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry.

Unit-II:
Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods.

Unit-III:
Fractionation of petroleum: Dehydration and desalting of crudes, heating of crudepipe still heaters, distillation of petroleum, blending of gasoline.

Unit-IV:
Treatment techniques: fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

Unit-V:
Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylations processes, Isomerization process.

Unit-VI:
Petrochemical Industry – Feed stocks

Unit-VII:
Chemicals from methane: Introduction, production of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines.

Unit-VIII:
Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

TEXT BOOKS:
1. Petroleum refining Engineering ; WL Nelson Mc Graw Hill company IV addition.
2. Modern Petroleum Refining Processes, 4th ed.,, B.K.bhaskara Rao, Oxford & IBH Publishing,2002.

REFERENCES:
1. The Petroleum chemicals industry by R.F.Goldstine, e & fn London, 1967
2. Chemical technology of petroleum by W.S.Gruese and D.R. Stevens, Mcgraw‘ Hill, 1980
3. Fundamentals of petroleum chemical technology by P Below.
4 Petro Chemicals Volume 1 and 2 ; A Chauvel and Lefevrev ; Gulf Publishing company 1989

2007-2008

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

FLUIDIZATION ENGINEERING
(Elective-I)

Unit-I:
Introduction: The phenomenon of fluidization; liquid like behaviour of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds.

Unit-II:
Industrial applications of fluidized beds: Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization.

Unit-III:
Fluidization and mapping of regimes: Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems; Voidage diagram; Mapping of regimes of fluidization.

Unit-IV:
Bubbles in dense bed: Single rising bubbles; Davidson model for gas flow at bubbles; Evaluation of models for gas flow at bubbles.

Unit-V:
Bubbling Fluidized beds: Experimental findings; Estimation of bed porosities; Physical models: simple two phase model; K-L model.

Unit-VI:
High velocity Fluidization: Turbulent fluidized bed; Fast fluidization pressure drop in turbulent and fast fluidization.
Solids Movement, Mixing, Segregation and staging: Vertical movement of solids; Horizontal movement of solids; Staging of fluidized beds.

Unit-VII:
Gas Dispersion and Gas interchange in Bubbling Beds: Dispersion of gas in beds; Gas interchange between bubble and emulsion; Estimation of gas interchange coefficients.
Unit-VIII:
Particle to Gas Mass Transfer: Experimental interpolation of mass transfer coefficients; Heat transfer; Experimental heat transfer from the bubbling bed model.

TEXT BOOKS
1. Fluidization Engineering by Kunil, Diazo and Octave Levenspiel
2. Fluidization by Max Leva.

2007-08

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

MEMBRANE TECHNOLOGY
(Elective-II)

UNIT-I
Introduction: Separation process, Introduction to membrane processes, definition of a membrane, classifications membrane processes.

UNIT-II
Preparation of Syntheic membranes: Types of Membrane materials, preparation of Syntheic membranes, phase inversion membranes, preparation technique for immersion precipitation, preparation technique for composite membranes.

UNIT-III
Characterization of membranes; Introduction, membrane characterization, characterization of porous membranes, characterization of non-porous membranes.

UNIT-IV
Transport in membranes: introduction, driving forces, non equilibrium thermodynamics, transport through porous, non-porous, and ion exchange membranes.

UNIT-V
Membrane Processes: Introduction, osmosis, pressure driven membrane processes: Introduction, microfiltration, membranes for microfiltration, industrial applications, ultrafiltration: membranes for ultrafiltration, industrial applications, reverse Osmosis and nanofiltration: membranes for reverse osmosis and nanofiltration, industrial applications, Electrically Driven processes: Introduction, electrodialysis, Process parameters, membranes for electrodialysis, applications, Membrane electrolysis, Bioploar membranes, Fuel Cells

UNIT-VI
Concentration driven membrane processes: gas separation: gas separation in porous and non porous membranes, membranes for gas separation, applications, pervaporation, membranes for pervaporation, applications, dialysis: membranes for dialysis, applications, liquid membranes: aspects, liquid membrane development, choice of the organic solvent and carrier, applications, introduction to membrane reactors,

UNIT-VII
Polarization phenomenon and fouling: Introduction to concentration polarization, turbulence promoters, pressure drop, gel layer model, osmotic pressure model, boundary layer resistance model, concentration polarization in diffusive membrane separations and electro dialysis, membrane fouling, methods to reduce fouling, compaction.

UNIT-VIII
Module and process design: Introduction, plate and frame module, spiral wound module, tubular module, capillary module, hollow fiber module, comparison of module configurations.

Text Books:

1. M.H.V.Mulder, Membrane Separations, Springer Publications, 2007
2. R.Philip C.Wanket, Rate- Controlled Separations, Springer, 1994.

References:

1. S.P.Nunes, K.V.Peinemann, Membrane Technology in the chemical industry, Wiley-VCH
2. Rautanbach and R. Albrecht, Membrane Process, John Wiley & sons.
3. J.G.Crespo, K.W.Bodekes, Membrane Processes in separation and Purification, Kluwer Academic Publications.
4. Transport processes and Unit Operations by C.J. Geankoplis.

2007-08

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

INDUSTRIAL BIOTECHNOLOGY
(Elective-II)

Unit-I
Fundamentals of biochemical engineering sciences ; Biotechnology – ancient and modern.

Unit-II
Exploitation of microbes – Large scale process, commercial exploitation, microgravity biotechnology (space biotechnology);

Unit-III
Animal biotechnology – application of animal cell culture, monoclonal antibodies, transgenic animal and gene therapy;

Unit-IV
Plant biotechnology – plant cell, tissue and organ culture processes – engineering perspectives;

Unit-V
Large scale separation processes- ATPS, gradient elution and affinity interaction;

Unit-VI
Technoeconomics of biotechnology industries;

Unit-VII
Legal, social and ethical aspects of biotechnology;

Unit-VIII
Biotechnology and the third world.

TEXT BOOK :
1. Text book of Biotechnology ; HK Das, Wiely Dremtechs Publications
2. Concepts in Biotechnology by Balasubramayam, 2nd ed., University Press,2004.

REFERENCES :
1. Molecular biotechnology; Glick and Pasternack,
2. Fundamentals of biochemical engineering ; Baily Ollis
3. Introduction to Biotechnology ; Ray V.Herran, Thomsam publications-2005

2007-08

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

Unix and Shell Programming
(ELECTIVE - II)

Unit I:-
Introduction to Unix:- Architecture of Unix, Features of Unix , Unix Commands – PATH, man, echo, printf, script, passwd, uname, who, date, stty, pwd, cd, mkdir, rmdir, ls, cp, mv, rm, cat, more, wc, lp, od, tar, gzip.

Unit II:-
Unix Utilities:- Introduction to unix file system, vi editor, file handling utilities, security by file permissions, process utilities, disk utilities, networking commands, unlink, du, df, mount, umount, find, unmask, ulimit, ps, w, finger, arp, ftp, telnet, rlogin.

Text processing utilities and backup utilities , detailed commands to be covered are tail, head , sort, nl, uniq, grep, egrep,fgrep, cut, paste, join, tee, pg, comm, cmp, diff, tr, awk, cpio

Unit III:-

Introduction to Shells:-
Unix Session, Standard Streams, Redirection, Pipes, Tee Command, Command Execution, Command-Line Editing, Quotes, Command Substitution, Job Control, Aliases, Variables, Predefined Variables, Options, Shell/Environment Customization.
Filters:-
Filters and Pipes, Concatenating files, Display Beginning and End of files, Cut and Paste, Sorting, Translating Characters, Files with Duplicate Lines, Count characters, Words or Lines, Comparing Files.

Unit IV:-
grep:-
Operation, grep Family, Searching for File Content.
sed:-
Scripts, Operation, Addresses, commands, Applications, grep and sed.

Unit V:-
awk:-
Execution, Fields and Records, Scripts, Operations, Patterns, Actions, Associative Arrays, String Functions, String Functions, Mathematical Functions, User – Defined Functions, Using System commands in awk, Applications, awk and grep, sed and awk.

Unit VI-

Interactive Korn Shell:-
Korn Shell Features, Two Special Files, Variables, Output, Input, Exit Status of a Command, eval Command, Environmental Variables, Options, Startup Scripts, Command History, Command Execution Process.

Korn Shell Programming:-
Basic Script concepts, Expressions, Decisions: Making Selections, Repetition, special Parameters and Variables, changing Positional Parameters, Argument Validation, Debugging Scripts, Script Examples.

Unit VII-

Interactive C Shell:-
C shell features, Two Special Files, Variables, Output, Input, Exit Status of a Command, eval Command, Environmental Variables, On-Off Variables, Startup and Shutdown Scripts, Command History, Command Execution Scripts.

C Shell Programming:-
Basic Script concepts, Expressions, Decisions: Making Selections, Repetition, special Parameters and Variables, changing Positional Parameters, Argument Validation, Debugging Scripts, Script Examples.

Unit VIII-
File Management:-
File Structures, System Calls for File Management – create, open, close, read, write, lseek, link, symlink, unlink, stat, fstat, lstat, chmod, chown, Directory API – opendir, readdir, closedir, mkdir, rmdir, umask.

TEXT BOOKS :

1. Unix and shell Programming Behrouz A. Forouzan, Richard F. Gilberg.
2. Unix the ultimate guide, Sumitabha Das, TMH. 2nd Edition.

REFERENCES :

1. Unix programming environment, Kernighan and Pike, PHI. / Pearson Education
2. Unix for programmers and users, 3rd edition, Graham Glass, King Ables, Pearson Education.

2007-08

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	4+1*	**0**	**4**

CHEMICAL ENGINEERING MATHEMATICS
(ELECTIVE - II)

UNIT I

Mathematical formulation of the Physical Problems : (i) Application of the law of conservation of mass-Salt accumulation in a stirred tank- starting an equilibrium still-solvent extraction in two stages-Diffusion with chemical reaction. (ii) Application of the law of conservation of energy-Radial heat transfer through a cylindrical conductor-Heating a closed Kettle-Flow of heat from a fin.

UNIT II

Analytical (explicit) solution of Ordinary differential equation encountered in chemical engineering problems.

(i) First order differential equations-Method of separation of variables- Equations solved by Integration factors-certain examples involving Mass and Energy balances and Reaction Kinetics.

(ii) Second order differential equations-Non-linear equations-linear equations- Simultaneous Diffusion and Chemical reaction in a Tubular reactor- Continuous hydroloysis of Tallow in a spray column.

UNIT III

(i) Formulation of partial differential equations-Unsteady state heat conduction in one dimension-Mass transfer with axial symmetry-Continuity equations.
(ii). Boundary conditions-function specified-Derivative specified and Mixed conditions.

UNIT IV

(i) Iterative solution of algebraic equations.
(a) Jacobi's method (b) Gauss-Siedal Method.
(b) Successive order-relaxation (S.O.R) method.

Unit V

(i) The difference operator-Properties of the diffrerence operator-Difference tables and other difference operators.
(ii) Linear finite difference equations-the complimentary solution of the particular solution-Simultaneous linear differential equations.

UNIT VI

Non-linear finite difference equations-analytical solution. Solution of the following type of problems by finite difference method.
(a) Calculation of the number of plates required for an absorption column.
(b) Calculation of the number of theoretical plates required for distillation column.
(c) Number of steps required for a counter-current extraction and leaching operations.

UNIT VII

Application of Statistical Methods.
(i) Propagation of errors of experimental data.
(ii) Parameter estimation of alge braic equations encountered in Heat and Mass Transfer, Kinetics and Thermodynamics by
(a) The method of averages.
(b) Linear least squares and
(c) Weight linear least squares methods.

UNIT VIII

Design of experiments, Fractional factorial methods.

TEXT BOOK :

1. "Mathematical methods in chemical engineering" by Jenson, V.J. and G.V.Jeffereys, Academic Press. London and New York, 1977

REFERENCE :

1. "Applied Mathematics in Chemical Engineering" by H.S.Mickley, Thoms, K.,Sherwood and C.E.Reed, 2nd ed., Tata McGraw-Hill, Publications, 1975.
2. Applied Mathematical Methods for Chemical Engineers, Norman W. Loney, 2nd edition CRC press, 2007

2007-08

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
	0	**3**	**2**

PROCESS DYNAMICS AND CONTROL LAB

1. Calibration and determination of time lag of various first and second order instruments
   Major equipment - First order instrument like Mercury-in-Glass thermometer and Overall second order instrument like Mercury-in-Glass thermometer in a thermal well

2. Experiments with single and two capacity systems with and without interaction.
   Major equipment- Single tank system, Two-tank systems (Interacting and Non-Interacting)

3. Level control trainer
   Major equipment - Level control trainer set up with computer

4. Temperature control trainer
   Major equipment - Temperature control trainer with computer

5. Cascade control
   Major equipment - Cascade control apparatus with computer

6. Experiments on proportional, reset, rate mode of control etc.
   Major equipment – PID control apparatus

7. Control valve characteristics
   Major equipment – Control valve set up

8. Estimation of damping coefficient for U-tube manometer
   Major equipment - U-tube manometer

2007-08

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HYDERABAD

IV Year B.Tech. Ch.E. I Sem	**T**	**P**	**C**
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SIMULATION LAB

The following experiments have to be conducted using C/C++/Simulink using MATLAB

1. Gravity Flow tank.

2. Three CSTR's in series – open loop

3. Three CSTR's in series – Closed loop

4. Non isothermal CSTR

5. Binary Distillation column

6. Batch Reactor isothermal; Batch reactor non isothermal – closed loop

7. Isothermal batch reactor – open loop

8. Heat Exchanger

9. Interacting System- two tank liquid level

10. Non interacting system-two tank liquid level

11. Plug flow reactor

12. Bubble point calculations

13. Dew point calculations

Major requirements are Personnel Computer and MATLAB Software