Malaviya National Institute of Technology Jaipur

Curriculum of B.Tech. Chemical Engineering

B.Tech VII Semester Chemical Engineering

S.No.	Course Code	Course Title	Category	Type	Credit	L	T	P
1.	CHS-401	Training Seminar	PC	Theory	2	0	0	2
2.		Management	PC	Theory	3	3	0	0
3.		Program Elective-I	OE	Theory	3	3	0	0
4.		Program Elective-II	OE	Theory	3	3	0	0
5.		Open Elective-I	PE	Theory	3	3	0	0
6.		Open Elective-II	PE	Theory	3	3	0	0
Total					15	15	0	2

Program Elective-I			**Program Elective-II**	
CHT-403	Modelling and Simulation		CHT-411	Polymer Science and Technology
CHT-405	Introduction to Plastic Materials		CHT-413	Bioprocess Engineering
CHT-407	Nanotechnology		CHT-415	Non-Conventional Energy Sources
CHT-409	Operations Research		CHT-417	Mechanical Design of Process Equipment

Syllabus

SEMESTER – VII

Program Elective-I

UG Department: **Chemical Engineering**
Course Code: **CHT403** Course Name: **Modelling and Simulation**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Introduction and fundamentals of process modeling and simulation; industrial usage of process modeling and simulation; Macroscopic mass, energy and momentum balances; incorporation of fluid thermodynamics, chemical equilibrium, reaction kinetics and feed/ product property estimation in mathematical models.

Simulation of steady state lumped, modeling of chemical process equipments like reactors, distillation, absorption, extraction columns, evaporators, and heat exchangers.

Unsteady state lumped systems and dynamic simulation; Computer algorithms for numerical solution of steady state and unsteady state models.

Microscopic balances for steady state and dynamic simulation; process modeling with dispersion; axial mixing; diffusion, etc.

Modeling and simulation of complex industrial systems in petroleum, petrochemicals, polymer, basic chemical industries; Commercial steady state and dynamic simulators; Simulation of process flowsheets.

Introduction to application of artificial intelligence based modeling methods using Artificial Neural Networks, Fuzzy logic, etc.

Text/Reference Books

1. Luyben, W. L., "*Process Modeling, Simulation and Control for Chemical Engineers*," McGraw Hill.
2. Babu, B.V., "*Process Plant Simulation*," Oxford Unicversity Press, 2004.
3. Ramirez, W.F., "*Computational Methods for Process Simulation*," Butterworth-Heinemann, 1997.
4. Ingham, J., Dunn, I. J., Heinzle, E., Prenosil, J.E., Snape, J.B., "*Chemical Engineering Dynamics: An Introduction to Modelling and Computer Simulation*," 3rd ed., Wiley-VCH Verlag GmbH & Co. KGaA, 2007.
5. Holland, C. D., "*Fundamentals and Modeling of Separation Processes*", Prentice Hall, 1975.
6. Himmelblau, D. M., & Bischoff, K. B., "*Process analysis and simulation: Deterministic systems*," John Wiley, New York, 1968.
7. Aris, R. and Varma, A. (Editors), "*The Mathematical Understanding of Chemical Engineering Systems: Selected Papers of N. R. Amundson*," Pergamon Press, 1980.

UG Department: **Chemical Engineering**
Course Code: **CHT405** Course Name: **Introduction to Plastic Materials**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Additives for plastics: Stabilizers, fillers, plasticizers, lubricants, flame retarders, foaming agents, cross-linking agents, etc.

Manufacture, properties and applications of major thermoplastic: polyethylene, polypropylene, polyvinyl choloride, polystyrene and other styrenics, polyamides, polyesters.

Thermosetting polymers: phenolformaldehyde, urea and melamine - formaldehyde, unsaturated polyester, epoxy resins.

Definition. Characteristics of engineering plastics. Important engineering thermoplastics such as acrylics, ABS, Polyesters, Polycarbonate, polyamides, polyphenylene oxide, polystyrene, polyphenylene sulfide, PEK .Processing and application of engineering plastics

Definition and characteristics of speciality polymers Important speciality polymers such as fluropolymer, silicone, liquid crystalline polymers, conducting polymers, polymeric hydrogels Processing and application of speciality polymers.

Books

1. J.A.Brydson, Plastics materials, Butterworth- Heinemann – Oxford, 6th Ed., 1995.
2. Irvin .I. Rubin, Hand Book of Plastic Materials and Technology, Wiley Interscience, NY, 1990.

UG Department: **Chemical Engineering**
Course Code: **CHT407** Course Name: **Nanotechnology**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

- Introduction

- Important concepts in nanoscience and nanotechnology

- Technology that enables science

- Current themes in nanoscale science and technology

- Commercial applications of nanotechnology

- The social dimensions of nanotechnology

- CMOS

- Si processing/fabrication

- Non-traditional nano-fabrication

- Carbon nanotube

- Self-organization and self-assembly

- Quantum dots and wires

- Mesoscopic transport

- Optical spectroscopy of nanostructures

- Scanning probe microscopy

Books

1. Poole, C. P. Jr. and Owens, F. J. Introduction to Nanotechnology, John Wiley, 2003
2. Plummer, J.D., Deal, M.D. and Griffin, P.B., Silicon VLSI Technology, Prentice Hall, 2000
3. Kittel, C., Introduction to Solid State Physics, a chapter about nanotechnology, John Wiley, 2004

UG Department: **Chemical Engineering**
Course Code: **CHT409** Course Name: **Operations Research**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Introduction: Nature and meaning of operations research, general methods for solving operations research problems, main characteristics of operations research in decision making, Role of computers in operations research.

Linear Programming Problem: Formulation of LP problem, graphical solution of LP problem, general formulation of LP problem, slack and surplus problem, standard form of LP problem, matrix form of LP problem, some important definitions, assumptions in LPP, limitations of LP, Applications of LP.

Simplex Method: Definition and notations, computational procedure, artificial variable technique- two phase method, Big-M method, disadvantages of Big M method over two phase method, degeneracy problem, method to resolve degeneracy, special cases- alternative solution, unbounded solutions, non-existing solution, solution of simultaneous equations by simplex method, flow chart of simplex method.

Duality in Linear Programming: Concept of duality, primal-dual problems, rules for converting any primal problem into its dual, duality theorems, primal and dual correspondence, duality and simplex method, shadow prices in LP, advantages of duality.

Dual Simplex Method: Computational procedure of dual simplex method, advantages of dual simplex over simplex method, different between simplex and dual simplex methods.

Assignment Problem: Introduction, mathematical formulation of assignment problem, fundamental theorems, Hungarian method, unbalanced assignment problem, variations of assignment problem- maximal assignment problem, restriction on assignment, traveling salesman problem- formulation and solution procedure.

Transportation Models: Introduction, mathematical formulation, feasible, basic feasible and optimum solutions, tubular representation, loops in table, IBFS to transportation problem, moving towards optimum solution, degeneracy in transportation problem, unbalanced transportation problem, time minimizing transportation problem, transshipment problem.

Network Scheduling by PERT/CPM: Introduction, Networks and basic components, Rules of network construction, Time calculations in networks, Critical Path Method (CPM), PERT, PERT calculations, Negative float and negative slack, Advantages of network.

Books

1. Taha, H.A., " Operations Research, an introduction", 6th edition, Prentice Hall, 1997.
2. Rao, S.S., “Engineering Optimization: Theory and Practice,” 3rd ed., New Age International, New Delhi, 2000.
3. Sharma, S.D., “Operations Research”.
4. Kanti Swaroop, “Operations Research”.

Program Elective-II

UG Department: **Chemical Engineering**
Course Code: **CHT411** Course Name: **Polymer Science and Technology**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Chemistry of Polymerization Reactions
Functionality, polymerization reactions, polycondensation, addition free radical and chain polymerization. Copolymerisation, block and graft polymerizations, stereospecific polymerization.

Polymerization Kinetics
Kinetics of radical, chain and ionic polymerization and co-polymerization systems.

Molecular Weight Estimation
Average molecular weight: number average and weight average. Theoretical distributions, methods for the estimation of molecular weight.

Polymerization Processes
Bulk, solution, emulsion and suspension polymerization.
Thermoplastic composites, fibre reinforcement fillers, surface treatment reinforced thermoset composites – Resins, Fibres, additives, fabrication methods.

Rheology
Simple Rheological response, simple linear viscoelastic models – Maxwell, Voigt, material response time, temperature dependence of viscosity, Rheological studies.

Books

1. Rodringuez, "*Principles of Polymer Systems*", Tata McGraw Hill,1970.
2. Billmayer Jr. and Fred. W., "*Textbook of Polymer Science*", Wiley Tappers, 1965.
3. David, J. W., "*Polymer Science and Engineering*", Prentice Hall, 1971.
4. Schmidt, A. K. and Marlies, G. A., "*High Polymers - Theory and Practice*", McGraw Hill, 1948.
5. McKelvey, J. M., "*Polymer Processing*," John Wiley, 1962.
6. Manoriffs, R. W., "*Man-made Fibres*," Wiley Inter Science.

UG Department: **Chemical Engineering**
Course Code: **CHT413** Course Name: **Bioprocess Engineering**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Interaction of chemical engineering principles with biological sciences. Life processes, unit of living system, microbiology, reaction in living systems, biocatalysts, model reactions. Fermentation mechanisms and kinetics : kinetic models of microbial growth and product formation. Fermenter types; Modeling of batch and continuous fermentor. Bioreactor design, mixing phenomena in bioreactors. Sterilization of media and air, sterilization equipment, batch and continuous sterilize design. Biochemical product recovery and separation. Membrane separation process: reverse osmosis, dialysis, ultrafiltration; Chromatographic methods: adsorption chromatography, gel filtration, affinity chromatography etc. Electro-kinetic separation: electro-dialysis, electrophoresis. Waste water treatment: activated sludge process, anaerobic digestion, trickling filter.

Books

1. Shuler, M.L. and Kargi, "Bioprocess Engineering Basic Concepts," 2nd ed, Prentice Hall of India, New Delhi, 2002.
2. Bailey & Ollis, Biochemical Engg. Fundamentals, McGraw Hill.
3. Dubey R.C., "A Textbook of Biotechnology", S. Chand and Co., New Delhi 2002.
4. Schugerl, K. and Bellgardt, K. V., Bioreaction Engineering: Modeling and Control, Springer Verlag, Heidelberg, 2000.
5. Blanch H. W. and Clark D. S., Biochemical Engineering, Dekker, NewYork, 1996.
6. Doran P., Bioprocess Engineering Principles, Academic Press, NewYork, 1995.
7. Aiba, S., Humphrey, J. Biochemical Engineering, Academic Press, 1973.

UG Department: **Chemical Engineering**
Course Code: **CHT415** Course Name: **Non-Conventional Energy Sources**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Introduction: Energy scene of supply and demand in India and the world, energy consumption in various sectors, potential of non-conventional energy resources. Detailed study of the following sources with particular reference to India.

Solar Energy: Solar radiation and its measurement, limitations in the applications of Solar Energy, Solar collectors – types, and constructional details. Solar water heating, applications of Solar Energy for heating, drying, space cooling, water desalination, solar concentrators, photovoltaic power generation using silicon cells.

Bio-Fuels: Importance, combustion, pyrolysis and other thermo chemical processes for biomass utilization. Alcoholic fermentation, anaerobic digestion for biogas production.

Wind Power: Principle of energy from wind, windmill construction and operational details and electricity generation and mechanical power production.

Tidal Power: Its meaning, causes of tides and their energy potential, enhancement of tides, power generation from tides and problems. Principles of ocean thermal energy conversion (OTEC) analysis and sizing of heat exchangers for OTEC.
Geothermal Energy: Geo technical wells and other resources dry rock and hot aquifer analysis , harnessing geothermal energy resources.
Energy Storage and Distribution: Importance, biochemical, chemical, thermal, electric storage. Fuel cells, distribution of energy.

Books

1. Rai, G.D., "*Non-Conventional Energy Sources,"* Khanna Publishers, New Delhi, 2001.
2. Sorenson, B, "Renewable Energy", 3rd ed., Elsevier Science, 2004.
3. Twiddle, J. Weir, T. "*Renewable Energy Resources*," Cambridge University Press, 1986.
4. Kreith, F. and Kreider, J. F., "*Principles of Solar Engineering*," McGraw Hill, 1978.
5. Duffie, J. A., Beckman, W. A., "*Solar Engineering of Thermal Processes*," John Wiley, 1980.
6. Veziroglu, N., "*Alternative Energy Sources*," Volume 5 & 6, McGraw-Hill, 1978.
7. Sukhatme, S. P., "*Solar Energy: Principles of Thermal Collection and Storage*," 2nd ed., Tata McGraw-Hill, 2001.
8. Garg, H.P. and Prakash, J., "*Solar Energy: Fundamentals and Applications*," Tata McGraw-Hill, 2001.

UG Department: **Chemical Engineering**
Course Code: **CHT417** Course Name: **Mechanical Design of Process Equipment**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Pressure Vessels: Introduction of codes for pressure vessel design; Classification of pressure vessels; Design of cylindrical and spherical shells under internal and external pressure; Selection and design of closures; Optimum length to diameter ratio of pressure vessel using common types of closures; Design of jacketed portion of vessels; Selection and design of nozzles; Elementary idea of compensation for openings; Selection of gaskets; Selection and design of flanges; Pipe thickness calculation under internal and external pressure; Introduction to inspection and non-destructive testing; Complete design calculations and shop drawing for at least one pressure vessel using heads and flanges as per code specifications.
Tall Tower Design: Design of shell, skirt, bearing plate and anchor bolts for tall tower used at high wind and seismic conditions.
Supports: Design of lug support and saddle support including bearing plates and anchor bolts.
Storage Tanks: Filling and breathing losses; Classification of storage tanks; Design of liquid and gas storage tanks.
Heat Exchange Equipment: Mechanical design and drawing of heat exchangers
Foundation and Supports: Foundation and supports for equipment/vessels, tall towers.

Books

1. Bhattacharya, B. C., "*Introduction to Chemical Equipment Design: Mechanical Aspects*," 5th ed., CBS Pub., Delhi., 1991.
2. Joshi, M. V. and Mahajani, V. V., "*Process Equipment Design*," 3rd ed., Macmillan, Delhi, 1996.
3. Sinnott, R.K., "Coulson and Richardson's *Chemical Engineering*," Vol. 6, 3rd ed., Butterworth Heinmann, New Delhi, 2002.
4. Brownell, L. E. and Young, H. E., "*Process Equipment Design*," John Wiley, 1959.
5. Dawande, S. D., "*Process Design of Equipments*," 2nd ed., Central Techno. Pub. Nagpur, 2000.
6. IS: 2825-1969, "*Code of Practice for Mechanical Design of Unfired Pressure Vessels*".
7. IS:803-1962, "*Code of Practice for Design, Fabrication and Erection of Mild Steel Cylindrical Welded Oil Storage Tanks*".
8. IS: 1239-1968, "*Specification of Mild Steel Tubes*".
9. IS: 4503-1967, "*Specifications for Shell and Tube Type Heat Exchanger*".
10. IS Code for Pipe Line.