Department of Chemical Engineering
Bachelor of Technology in Chemical Engineering

Basic Science Core (BSC)

MA110	Engg.Mathematics – I	(3-0-0) 3
PH110	Physics	(3-1-0) 4
PH111	Physics Lab	(0-0-2) 1
MA111	Engg.Mathematics – II	(3-0-0) 3
CY110	Chemistry	(3-0-0) 3
CY111	Chemistry Lab	(0-0-3) 2
CY205	Organic Chemistry	(3-0-0) 3
CY255	Technical Analysis Lab	(0-0-4) 2
CY305	Inorganic & Physical Chemistry	(3-0-0) 3

Engineering Science Core (ESC)

EE110	Elements of Electrical Engineering	(3-0-0) 3
ME110	Elements of Mechanical Engineering	(3-0-0) 3
CO110	Computer Programming	(3-1-0) 4
CO111	Computer Programming Lab	(0-0-2) 1
EC110	Elements of Electronics Engg.	(3-0-0) 3
AM110	Engineering Mechanics	(3-0-0) 3
ME111	Engineering Graphics	(1-0-3) 3
ME200	Workshop	(0-0-2) 1

Humanities and Social Science Core(HSC)

HU100	Professional Communication	(3-0-0) 3
HU300	Engineering Economics	(3-0-0) 3
HU302	Principles of Management	(3-0-0) 3

Programme Core (PC)

CH200	Process Calculations	(2-2-0) 4
CH201	Momentum Transfer	(3-1-0) 4
CH202	Particulate Technology	(3-1-0) 4
CH203	Transport Phenomena	(2-2-0) 4
CH250	Chemical Engg. Thermodynamics I	(2-1-0) 3
CH251	Heat Transfer	(3-1-0) 4
CH252	Mass Transfer-I	(3-1-0) 4
CH253	Chemical Reaction Engg.–I	(2-1-0) 3
CH254	Fluid & Fluid Particle Systems lab	(0-0-3) 2
CH 300	Chemical Engg. Thermodynamics II	(2-1-0) 3
CH301	Chemical Reaction Engineering – II	(3-1-0) 4
CH302	Mass Transfer – II	(3-1-0) 4
CH303	Heat Transfer Operations Lab	(0-0-3) 2
CH351	Process Dynamics & Control	(3-1-0) 4
CH352	Simultaneous Heat & Mass Transfer	(2-1-0) 3
CH354	Mass Transfer Operations Lab	(0-0-3) 2
CH355	Chemical Process Industries	(3-0-0) 3
CH402	Process Design of Chemical Equipments	(2-0-3) 4
CH403	C.R.E. & Process Control Lab	(0-0-3) 2

Programme Specific Electives (PSE)

CH211	Process Instrumentation	(3-0-0) 3
CH261	Energy Technology	(3-0-0) 3
CH311	Petroleum Engineering	(3-0-0) 3
CH312	Biochemical Engineering	(3-0-0) 3
CH361	Process Modeling & Simulation	(3-1-0) 4
CH362	Separation Processes	(3-1-0) 4
CH363	Fertilizer Technology	(3-0-0) 3
CH364	Risk and Safety Management in Process Industries	(3-0-0) 3
CH365	Introduction to Molecular Simulations	(2-0-2)3
CH366	Electrochemical Engg.	(3-0-0)3
CH367	Energy Conservation & Management in process Industries	(3-0-0)3
CH368	Fuel Cell Engineering	(3-0-0) 3
CH411	Fermentation Technology	(3-0-0) 3
CH412	Pollution Control & Safety in Process Industries	(3-0-0) 3

Project (MP)

CH449	Major Project - I	(0-0-3) 2
CH499	Major Project – II	(0-0-9) 6

Mandatory Learning Courses (MLC)

CV110	Environmental Studies	(1-0-0) 1
HU111	Professional Ethics and Human Value	(1-0-0) 1
CH440	Practical Training	(0--0-2)1
CH 448	Seminar	(0-0-3) 2

Open Electives (OE)

CH211	Process Instrumentation	(3-0-0) 3
CH261	Energy Technology	(3-0-0) 3
CH311	Petroleum Engineering	(3-0-0) 3
CH465	Air Pollution Control and Design of Equipments	(3-0-0) 3

Suggested Plan of Study:-

Semester →	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
1	CH200	CH250	CH300	CH351	CH 402	*CH499*
2	CH201	CH251	CH301	CH352	CH403	*Elective*
3	CH202	CH252	CH302	CH354	CH440	*Elective*
4	CH203	CH253	CH303	CH355	CH448	*Elective*
5	CY 205	CH254	CY305	HU300	CH449	*Elective*
6	ME 200	*CY255*	HU302	*Elective*	*Elective*	*Elective*
7	*Elective*	*Elective*	*Elective*	*Elective*	*Elective*	*Elective*
8	*Elective*	*Elective*	*Elective*	*Elective*	*Elective*	*Elective*

Degree Requirements:

Category of Courses	**Minimum Credits to be Earned**
Foundation Courses	
Basic Science Core (BSC)	24
Engineering Science Core (ESC)	21
Humanities and Social Sciences Core (HSC)	09
Programme Core (PC)	63
Elective (Ele)	40
Project (MP)	08
Mandatory Learning Courses (MLC)	05
Total	**170**

Department of Chemical Engineering

CH200 Process Calculations (2-2-0) 4

Introduction to Engineering Calculations.Physical and chemical properties of compounds and Mixtures.Techniques of problem solving.Concepts of unsteady state processes and material balance equation.Steady State Material Balances. Material balances involving Recycle by pass and purge calculations. Multiphase systems. Single component phase Equilibrium. Solutions of Solids in Liquids. Humidity charts and their uses. Energy and Energy balances.

D.M.Himmelblau, Basic Principles and calculations in Chemical Engg 5th Edition, Prentice Hall of India. 1992

R.M.Felder, R.W.Rlusseau, Elementary Principles of chemical processes 2nd Edition. John Wiley & Sons Inc. 1986

CH201 Momentum Transfer (3-1-0) 4

Properties of fluids.Fluid statics.Introduction to fluid flow. Basic equations of fluid flow. Laminar Flow.Turbulent flow.Fluid flow around immersed bodies - Boundary layer and friction drag.Motion of particles through fluids.Fluidization principles.Dimensional analysis Similitude.Mixing of liquids.Compressible flow. Flow measurement. Fluid transportation machinery

McCabe and Smith, Unit operations in Chemical Engineering, McGraw - Hill 5th Edition. 1993

Coulson and Richardson, Chemical Engineering Volume I ELBS, Pargamon 3rd Edition. 1977

CH202 Particulate Technology (3-1-0) 4

Particle Size Analysis.Industrial Screening.Storage and Conveyance of Solids.Size Reduction.Size Enlargement.Classification.Centrifugal Separation.Gas cleaning.Solid - Liquid Separation.Thickening. Froth Flotation. Magnetic separation.Electrical separation.Sorting (Separation of solids).Mixing and Agitation.

Richardson J.F and Coulson J.M, Chemical Engineering (SI Units) Vol 2; 1978.

McCabe W.L. and Smith J.C., Unit Operations in Chemical Engineering, McGraw Hill, New York, 5th edition.

CH203 Transport Phenomena (2-2-0) 4

Shell balances for momentum, energy and mass transfer. Introduction to general transport equations for momentum, energy and mass transfer in cartesian - cylindrical and spherical coordinates - simple solutions in one dimension. Simplification of general equations with time and spatial coordinates for momentum, energy, mass transport, boundary layer concepts of momentum energy and mass transport. Macroscopic balances for isothermal systems, nonisothermal systems and multi componant systems.

Robert S. Brodkey and Harey C. Hershey - Transport Phenomena - A Unified Approach, McGraw Hill Book Co., 1988.

R.B.Bird, W.E.Stewart and E.W.Lightfoot - Transport Phenomena, John Wiley &Topan, 1960.

Beek W.J. andMutzall K.M.K., - Transport Phenomena, John Willey and Sons Ltd., 1975.

CH211 Process Instrumentation (3-0-0)3

Introduction: Temperature measurement, Pressure measurement, Flow measurement, Level measurements Viscosity measurement, Moisture and humidity measurements. Conductivity meter- pH meter,
Analytical instruments – Liquid chromatography – HPLC – Mass spectroscopy - Computer aided analysis – process instruments and automatic analysis.

Instrumentation, Measurement and Analysis, B.C.Nakra and K.Chaudhry, Tata McGrow Hill Co., New Delhi, l985.

Encyclopadia of Instrumentation, Liptak B.G.,Vol.l, BG and supplement Chelton Book Co., New York, 1969.

Instrumental Methods of Analysis, Willard, Merru, Dean and Settle, C.B.S. publication, New Delhi,

1986 (Chapters 17, 18, 19, 30 & 31).
Mechanical and Industrial Measurements, R.K.Jain, Khanna Publishers, New Delhi, 1982.

CH250 Chemical Engg. Thermodynamics I (2-1-0) 3

Fundamental Concepts and Definitions. PVT relationships. First law of Thermodynamics. Application of law to different processes in closed systems. Second Law of Thermodynamics. Physical meaning of entropy. T-S diagrams. Relations among thermodynamic properties. Thermodynamic functions in terms of measurable properties. Construction of thermodynamic charts. Third Law of Thermodynamics. Thermodynamics of flow processes. Application of first law to flow processes. Power and Refrigeration Cycles.

Smith, J.M, and H.C. Van Ness -Introduction to Chemical Engineering Thermodynamics, 4th edition, McGraw - Hill.
Hougen, A., K.M. Watson and R.A. Ragatz - Chemical Process Principles, Vol. 2 (Thermodynamics), Asia Publishing House, 1960.

CH251 Heat Transfer (3-1-0) 4

Steady state conduction.Transient conduction. Insulation - critical thickness of insulation. Heat transfer with heat generation. Heat Transfer by convection. Heat Transfer with packed and fluidized beds. Heat Transfer in Jacketted vessels. Cryogenic heat transfer. Heat transfer in extended surfaces. Heat transfer with change of phase.Boiling Heat transfer.Radiation.

J.M.Coulson and J.F.Richardson - Chemical Enginering, Vol.1, 3rd ed., Pergamon and ELBS, 1977.
Krieth - Fundamentals of Heat Transfer, 4th Edition, Harper & Law, 1986.

CH252 Mass Transfer – I (3-1-0) 4

Introduction to Mass Transfer operations.Introduction to advanced separation techniques. Steady and unsteady state operations, stage wise and continuous contact operations. Diffusion Mass Transfer.Concept of Mass Transfer Coeficient. Theories of Mass transfer. Flow past solids - Analogies. Interphase Mass Transfer. Absorption and Desorption. Adsorption.

R.E.Treybal - Mass Transfer Operations. 2nd Edition, McGraw Hill, 1968.
W.L. McCabe and J.C. Smith - Unit Operations of Chemical Engineering.McGraw Hill, 1976.

CH253 Chemical Reaction Engineering – I (2-1-0) 3

Chemical Reaction Equilibrium.Kinetics of Homogeneous Reactions.Single Homogeneous Reactor Design.Multiple Reactor Systems.Multiple Reaction Systems.

Levenspiel, O. - Chemical Reaction Engineering, 3rd edition, Wiley Eastern Limited.
Scott Fogler, H. - Elements of Chemical Reaction Engineering, 3rd edition, Prentice Hall of India.

CH254 Fluid & Fluid Particle Systems Lab (0-0-3) 2

Experiments based on Momentum Transfer and Particulate Technology.

CH261 Energy Technology (3-0-0)3

Energy Scenario in India -Conventional/non-conventional renewable non renewable sources. Principles of efficient use of fuels, energy conservation and auditing. Solid liquid and Gaseous fuels. Combustion, Furnaces.Draught and chimney height. Nuclear Energy - Classification and Components. Unconventional fuels, renewable energy sources.

Sharma S.P.andChander Mohan -Fuels and Combustions- Tata McGraw Hill Book Co., 1982.
Shaha A.K. - Combustion Engineering and Fuel Technology, Oxford Press.
Gilchrist J.D. - Fuels, Furnaces and Refractors, Pergamon Press, 1977.
Ronald F. Probstein and Hicks R.E. - Synthetic Fuels - McGraw Hill Book Co., 1982.
Manon L Smith and Keri W Stinson - Fuels and Combustion - McGraw Hill Book Co., 1952.

CH 300 Chemical Engg. Thermodynamics II (2-1-0) 3

Single Component Systems. Multicomponent Systems. Phase Equilibria. Thermodynamics of Electrolytes. Statistical Thermodynamics.

Smith, J.M. and H.C. Van Ness - Introduction to Chemical Engineering Thermodynamics, 4rd edition, McGraw - Hill

Rao Y.V.C. - Introduction to Chemical Engineering Thermodynamics, Willey Eastern, 1994.

CH301 Chemical Reaction Engineering – II (3-1-0) 4

Non-ideal Flow Reactors. Non-isothermal Homogeneous Reactions. Non-catalytic heterogeneous Reaction Kinetics. Catalytic Heterogeneous Reaction Kinetics.

Smith, J.M. - Chemical Engineering Kinetics, 2nd edition, McGraw Hill, 1970.

Levenspiel, O. - Chemical Reaction Engineering, 3rd edition, Wiley Eastern.

Scott Fogler, H. - Elements of Chemical Reaction Engineering, 3rd edition, Prentice Hall of India.

CH302 Mass Transfer – II (3-1-0) 4

Concepts of Vapour - Liquid equilibria. Multi component systems.Principles of distillation.Continuous Rectification. Method of McCabe and Thiele.Liquid-Liquid Extraction, leaching.

R.E.Treybal - Mass Transfer Operations. 2nd Edition, McGraw Hill (1968).

W.L.McCabe and J.C.Smith - Unit Operations of Chemical Engineering, McGraw Hill (1976).

Badger and Banchero - Introduction to Chemical Engineering.

CH303 Heat Transfer Operations Lab. (0-0-3) 2

Experiments based on Heat Transfer course.

CH311 Petroleum Engineering (3-0-0)3

Introduction.Composition and evaluation of properties of crude oil and refinery products.
Refining of petroleum. Types of pipe still furnaces used in refineries and their design consideration.
Cracking processes. Rebuilding processes. Product treatment processes.

Robert A. Meyers, Hand Book of Petroleum Refining Processes, McGraw Hill Book Co., l986.

BhaskerRao B.K,.Modern Petroleum Refining Processes, Oxford & IBM Publishing Co., 1984.

CH312 Biochemical Engineering (3-0-0) 3

Introduction - Principles of microbiology. The kinetics of enzyme catalysed reactions. Metabolic Pathways and Energetic of the cell. Kinetics of substrate Utilisation. Biological reactors-applications, and design Fermentation Technology.

J.E.Balley, D.F.Ollis - Biochemical Engineering Fundamentals, McGraw Hill, NY, 1977

CH351 Process Dynamics & Control (3-1-0) 4

Introduction Dynamic Behaviour of Lumped Parameter Systems. Transient analysis of control systems. Frequency response analysis. Advanced control strategies - Feed forward control, cascade control, inferential control, ratio control, adaptive control, selective control, smith predictor dead time compensator, interaction and decoupling in multi input - multi output control system.

Process Systems Analysis and Control - D.R.Coughanowr, McGraw Hill, Second Edition, 1991.

Process Dynamics and Control, D.W.Seborg, T.F. Edger, D.A.Millichamp, John Wiley & Sons, 1988.

CH352 Simultaneous Heat & Mass Transfer (2-1-0) 3

Evaporation -Concept and applications. Humidification and Dehumidification.Crystallisation. Drying Operations.

J.M.Coulson and J.F.Richardson - Chemical Enginering, Vol.1, 3rd ed., Pergamon and ELBS, 1977.

W.L.McCabe and J.C.Smith - Unit Operations of Chemical Engineering, McGraw Hill (1976).

CH354 Mass Transfer Operations Lab (0-0-3) 2

Experiments based on Mass Transfer I & II.

CH355 Chemical Process Industries (3-0-0) 3

Chlor-alkali industries.Sulphur industries. Nitrogen industries.Phosphate industries.Potash industries. Manufacture of soaps, detergents and glycerine. Manufacture of paper pulp, paper and paperboard. Manufacture of industrial alcohol, acetone and butanol. Petroleum Refining.Petrochemicals.Synthetic fibres.

C.E.Dryden - Edited and Revised by M.GopalaRao - Outlines of Chemical Technology, Edition 2, Affiliated East West Press Pvt. Ltd., New Delhi, 1973,

Austin G. T. - Shreves Chemical Process Industries, McGraw Hill Book Co., 5th Edition, 1986.

CH361 Process Modeling & Simulation (3-1-0) 4

Introduction.Numerical solutions of Mathematical equations. Lumped Parameter models: steady state and unsteady state. Distributed Parameter models: Steady state and unsteady state. Unsteady state distributed parameter models (one-dimension).

Computational Methods in Process Simulations, W.F.Ramirez, Butterworth Publishers, 1989.

Modelling and Simulation in Chemical Engineering, Boger E. Franks, John Wiley & Sons, 1972.

CH362 Separation Processes (3-1-0) 4

Adsorption separations. Membrane separation processes. Surfactant based separations. External field induced separations. Supercritical fluid extraction.

Hand Book of Separation Process Technology, R.W. Rousseau, 1987, John Wiley and Sons.

Hand Book of Industrial Membrane Technology, M.C.Porter, 1990, Noyes Publication, Park Ridge, New Jersey.

CH363 Fertilizer Technology (3-0-0) 3

Introduction.Production, transmission and storage of ammonia through various processes and raw materials; ammonia salts; nitric acid and nitrates.Production of Urea through various Processes.Phosphatic Fertilizers.Potash fertilizers.Compound fertilizers.

Fertilizer Manual, No. 13 - Development and Transfer of Technology series, United Nations Industrial Development Organisation, 1980.

CH364 Risk and Safety Management in Process Industries (3-0-0) 3

The concept of risk and safety management.Major disasters in chemical process industries. Hazard identification methods and risk quantification techniques. Fire and explosions.Hazards peculiar to various industries Safety education and training, safety management, legal aspects of industrial safety, safety audit.Concept of preparation of on-site and off-site emergency plan.

F.P.Lees - Loss Prevention in Process Industries, 2nd ed. 1996, Butterworth-Heinemann.

W. Handley - Industrial Safety Handbook, 2nd ed. 1977, McGraw Hill.

CH365 Introduction to Molecular Simulations (2-0-2) 3

Introduction and basics of molecular simulations – model systems, interaction potentials, periodic boundaries, minimum image convention, Equations of motion. Elementary statistical mechanics: ensembles, Boltzmann's distribution, and free energy. Measure and control of temperature and stress in molecular systems. Length and time scale limits of simulation methods. Molecular dynamics of simple model fluids such as hard spheres.Structure of a simulation program and introduction to programming methods. Applications in solids, liquids, and biomolecules. Demonstration using LAMMPS (Large-scale Atomic/Molecular Massively Parallel Simulator).

Allen, M.P., Tildesley, D.J. Computer Simulation of Liquids, Oxford University Press

Frenkel, D., Smit, B., Understanding Molecular Simulations: From algorithm to applications, Academic Press.
Rapport, D.C., The Art of Molecular Dynamics Simulation, Cambridge University Press.
Donald Allan McQuarrie, Statistical Mechanics, University Science Books.

CH 366 Electrochemical Engineering (3-0-0) 3
Introduction. Galvanic and electrolytic cell. Thermodynamics, electrochemical potential and Nernst equation. Double layer - structure of electrified interface, ionic cloud theory and adsorption. Electrodics - Butler Volmer equation and transport phenomena. Applications- corrosion, fuel cells and biosensors. Impedance spectroscopy. Reaction mechanism and equivalent circuits.
Bockris J.O.M. and Reddy A.K.N, Modern Electrochemistry, Vol.1,Vol2A and Vol 2B, Springer.
Bard A.J. and Faulkner L.R, Electrochemical Methods Fundamentals and Applications, John Wiley & Sons, 2001.
Newman. J and Thomas-Alyea K.E., Electrochemical Systems, John Wiley & Sons, 2004.

CH367 Energy Conservation and Management in Process industries (3-0-0)3
Energy Outlook, Energy conservation and its importance, Energy intensive industries, Global industrial energy efficiency benchmarking, Engineering fundamentals related to energy efficiency, Principles on energy management, Energy Audit, Detailed thermodynamic analyses of common unit operations, Opportunities and techniques/methods for energy conservation in equipment and utility systems in process industries, Process synthesis, Thermo-economics, Energy Management Information Systems (EMIS). Software tools for industrial energy efficiency and savings, Case studies on energy conservation and management in process industries
W.F. Kenney, Energy Conservation in the Process Industries. Academic Press Inc., 1984.
Vladimir S. Stepanov, Analysis of Energy Efficiency of Industrial Processes. 1st Edition, Springer-Verlag, 1993.
Jakob de Swaan Arons, Hedzer van der Kooi, Krishnan Sankaranarayanan, Efficiency and Sustainability in the Energy and Chemical Industries, 1st Edition, Marcel Dekker, Inc., 2004.

CH368 Fuel Cell Engineering (3-0-0)3
Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.
Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.
Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.
Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.
Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling
Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal , Using renewable fuels for SOFCs
Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, 2003.
Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.
F. Barbir, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, 2013.
Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications, 2003

CH402 Process Design of Chemical Equipment (2-0-3)4

Detailed Chemical Engineering Process Design of the following equipments is to be carried out. Mechanical aspects of the design are not included here. Heat Exchangers; Packed and Tray towers for Absorption and distillation.Design of equipments mentioned above using simulation software.

Donald Q Kern - Process Heat Transfer, McGraw Hill Book CO, 1950.
J.M.Coulson and J.F.Richardson - Chemical Engineering, Vol.6, Design, Second Edition, Pergaman Press, 1993.
Robert H. Perry and Don Green - Chemical Engineers' Hand Book, 6th Edition, McGraw Hill Book Co.
Douglas J.M., Conceptual design of Chemical Processes McGraw Hill, New York, 1988.
W.D. Seider, J.D. Seader and R.L. Daniel, Product and Process Design Principles, Wiley, 2004.

CH403 C.R.E. & Process Control Lab (0-0-3) 2

Experiments based on Reaction Engg. I & II and Process Control courses.

CH411 Fermentation Technology (3-0-0) 3

Introduction, fermentors-principles and design, Manufacture of alcohol, pencillin, vitamins and other products.

Fermentation Technology, Whitaker.
Biochemical Engineering Fundamentals, J .E .Bailey and D. F. Ollis, 1997, McGraw Hill.

CH412 Pollution Control & Safety in Process Industries (3-0-0) 3

Importance of environment for human kind, flora and fauna, Types of pollution damages due to environmental pollution (industrial gas, liquid and solid effluents). Legislations to environmental pollution problems.Indian standards waste recycling.Noise pollution and its control. Waste water treatment. Air Pollution.Pollution control of effluents from different industries.Scientific and Engineering aspects of safety in industry.

S.P.Mahajan - Pollution Control in Process Industries - Tata McGraw Hill, 1990.
C.S. Rao - Environmental Pollution Control Engineering, Wiley Eastern, 1992.

CH465 Air Pollution Control and Design of Equipments (3-0-0) 3

Introduction.Air pollution laws and standards.Meteorological aspects of air pollutant dispersion, the Gaussian plume model, design of stacks and chimneys Air pollution control methods and design of equipments- control of gaseous emissions, Air pollution control in specific industries

Martin Crawford -Pollution control theory, , 1976, McGraw Hill, NY.
Joe Ledbetter - Air Pollution Part A&B, 1972,Marcel Dekker, NY.
N.Cheremissinoff - Air Pollution Control, Design Hand Book, Part I and II,1977,Marcel Dekker, NY.

CH440 Practical Training (0-0-2)1

This course is a one credit course. A student may complete the training before the beginning of 7th semester (or as stipulated by DUGC) and register for it in 7th semester. The duration and details shall be decided by the faculty advisor, with approval from DUGC.

CH448 Seminar (0-0-3) 2

This course is two credit courses to be completed during 7th semester. The student will make presentations on topics of academic interest.

CH449 Major Project - I (0-0-3) 2

The Students jointly or individually will be assigned an experimental or theoretical problem, to be carried out under the supervision of a guide. The project has to be completed in the VII & VIII semester. The students should complete the preliminary literature survey and experimental set up in the VII semester. Their work will be reviewed and evaluated.

CH499 Major Project – II **(0-0-9) 6**

Extension and completion of Major project -I started in the previous semester (CH449).

CH 263 Mineral Dressing Lab. **(0-0-3) 2**

Experiments based on Mineral dressing

Course Title : **Engineering Economics**
Course Code : **HU 300**
(L-T-P) : **(3-0-0)**
Credits : **3**
Category : **HSC**

Course description

The purpose of this course is to help students gain an understanding of the economic factors inherent in engineering design and decision-making. Any engineering project must be not only physically realizable but also economically feasible. The principal aim of this subject is to provide students with some basic techniques of economic analysis to understand the economic process.

Course objectives

The objectives of the course are to make students:

- Become acquainted with basic economic concepts such as demand and supply, price, competition, interest, taxes, profit, inflation, etc.
- Develop a significant understanding of the time value of money
- Develop the ability to apply various methods for economic analysis of alternatives
- Increase student's knowledge of the impact that interest, taxes, inflation have on economic and engineering decisions.
- Develop the ability to estimate project cash flows for design alternatives including tax implications.
- Understand the fundamentals of profit and loss analysis and benefit –cost analysis.
- Become familiar with basic accounting statements and concepts such as balance sheets, income statements, depreciation methods, etc.
- Develop the ability to make replacement decisions.
- Basic understanding of project risk and uncertainty using sensitivity and break-even analysis.

Course contents

Basic economic concepts and problems: Economic development and its impact on Science, Engineering Technology and Society (Environment), Resource constraints and welfare maximization, Physical and economic efficiency. Concepts of value and utility, Economic aspects of exchange, Theory of utility and consumers choice. Theories of demand, supply and Market equilibrium. Elasticity of demand and demand forecasting. Cost estimating and cost terminology.

Methods of economic analysis in Engineering: including time value of money, equivalence, Interest calculations. Bases for comparison of alternatives- Present worth, Annual equivalent, Future worth, Internal rate of return, Capitalized equivalent, Capital recovery with return. Selection among alternatives, Break-even analysis.

Evaluating replacement alternatives: Replacement analysis, the economic life of an asset, Retirement or abandonment decisions. Evaluating public activities: The nature of public activities, Benefit-cost analysis, Cost-effectiveness analysis.

Depreciation accounting: Basic depreciation methods. Basic terminology for Income taxes, Depreciation and Income taxes.

Estimating economic elements: Cost estimation methods, adjustment of cost data, Estimates and decision-making, allowances for uncertainty in estimates, Analysis of construction and production operation. Economic aspects of location, Economic aspects of Equipment.

Relevant Case Studies

Texts / References:

1. Thuesen G.J. and Fabrycky W.J., " Engineering Economy ", 9th ed., prentice_ Half of India, New Delhi, 2002.
2. Sullivan W.G., Bontadelli J.A. and Wicks E.M., "Engineering Economy ", 11th ed., Pearson Education Asia, New Delhi, 2001
3. Leland Blank P.E. and Anthony Tarquin P.E., "Engineering Economy", 4th ed., McGraw Hill, Singapore, 1998.
4. Newnan Donald G., Eschenbach Ted G., Lavelle Jerome P., Engineering Economic Analysis, Oxford University Press, 2004.
5. N.Gregory Mankiw, Principles of Economics, Thomson, 2002.

Pedagogy

The instructional tools consists of lectures, reading concurrent articles, case studies, problem solving and group discussions.

Weightage for Assessments

Mid – Semester exams of 1 hour 30 minutes (50 Marks)	25%
Continuous Assessment	25%
End-Semester exams of 3 hours (100 Marks) (Full syllabus)	50%
	100%

Assessment

Surprise tests, quizzes, tutorials, assignments, class participation and group interaction will be considered for continuous assessment.

Attendance

Any leave of absence has to conform to regulations printed in the Curriculum.

Course Code : **HU 302**
(L-T-P) : **(3-0-0)**
Credits : **3**
Course Title : **Principles of Management**
Semester:
Course Pre-requisite : **NIL**
Course Instructor : **Dr. Bijuna C Mohan**
bijunacm@gmail.com

Course Description

This course focuses on the foundation of management theory and provides an overview of management. Management is presented as a discipline and as a process. The course introduces the key issues of management from the essential skills to management ethics. Current trends in management theory and practice are examined, as well as the traditional functions of planning, organizing, leading and controlling. The course will involve an overview approach to covering the various concepts required for an overall understanding of management's role in the contemporary organization.

Course Objectives

This is an introductory course in management theory and practices. Its main objectives are:

1. To introduce and enable students to comprehend the fundamental management concepts and the issues important to business.
2. To promote an understanding of how these management concepts and issues are applied to real business problems that students will face in their future career situations.
3. To sharpen the student's ability to think, reason and to apply knowledge to solve real-life problems.
4. Enhance students' interpersonal and communication skills to meet the challenges facing today's management.
5. Encourage and support collaborative learning and teamwork as necessary management tools.

Course Contents

Management – Science, Theory and Practice,
Management and Society: External Environment, Social Responsibility and Ethics. Global, Comparative and Quality Management.
Planning: Principles, Process, MBO, Strategies, Policies, Planning Premises, Strategic Management, and Decision Making.

Organizing: Nature, Entrepreneuring, Reengineering, organization structure, Departmentation, Line Staff Authority, Power, Empowerment, Decentralization, Effective organizing and Organization culture.
Staffing: Human Resource Management, Recruitment and selection, Performance Appraisal, Career Strategy, Managing Change and Organization Development
Leading: Human Factors and Motivation, Leadership, Committees, Teams, Group Decision Making and Communication.
Controlling: system and Process of controlling, Controlled Techniques, Productivity, Operations Management and Total Quality Management.

References:

Harold Koontz and Heinz Weihrich, Essentials of Man*agement*, McGraw Hill Publication, 2012
Heinz Weihrich, Mark V, Cannice and Harold Koontz, Management, Tata McGraw Hill, 2012

Pedagogy

The instructional tools consist of lectures, reading concurrent articles, case studies and group discussions.

Assessment

Assignments, projects, group activities and involvement in class discussion will be considered for continuous assessment.

Weightage for Assessments

Mid – semester exams of 1 hour 30 minutes	25%
Continuous Assessment	25%
End – semester exams of 3 hours (Entire portions)	50%
	100%

Missing classes will hurt your participation grade. Note that the quality of your participation is what counts, not the amount you participate in each class. Switch off cell phones before you enter the class room.

Plagiarism, communicating with fellow students during an exam and other form of academic dishonesty will affect the grades.

Leave of Absence

Any leave of absence has to conform to regulations printed in Regulations in the curriculum.

Course Code : **CH 200**
Course title : **Chemical Process Calculations**
L-T-P : **2-2-0**
Credits : **4**
Category : **PC**
Teaching Department : **Chemical Engineering**

Course outcomes:

By the end of this course the student will be able to

- Mathematically represent the chemical reaction and transformations
- Interpret and analyze laws of conservation of energy and mass for the above.
- Perform material and energy balance on different unit operations of processes
- Extend the concept of material and energy balance for recycle, bypass, purge such complex systems.
- Thermo physics and thermo chemistry concepts and application of the same in energy balance calculations for different systems.
- Material and energy balance for various combustion processes.

Syllabus

Introduction to Engineering Calculations. Physical and chemical properties of compounds and Mixtures. Techniques of problem solving. Concepts of unsteady state processes and material balance equation. Steady State Material Balances. Material balances involving Recycle by pass and purge calculations. Multiphase systems. Single component phase Equilibrium. Solutions of Solids in Liquids. Humidity charts and their uses. Energy and Energy balances.

Course Coverage:

Contents	Approximate No. of Lecture Hours
Units and Dimensions	2
Mass relations (mole, weight, volume percentages and their application for various mixtures like solids, gases, liquids)	3
Concentration representations (density, equivalent weight, normality, molality and molarity etc for liquid mixtures)	3
Calculations involved in ideal gases and their mixtures	3
Material balance calculations using “Law of conservation of mass” for various unit operations at steady state and without chemical reactions (separation units)	5
Material balance calculations at steady state with chemical reactions	5
Material balance calculations involving recycling, bypassing and purging operations in the process units	5

Vapour pressure, partial pressure, saturation, and humidification concepts	5
Material balance calculations in combustion processes	3
Thermo physics and thermo chemistry concepts (for mixtures)	5
Energy balance with sensible and latent heat for different mixtures	3
Unsteady state operations (Mass balance)	3
Total	45

Reference Books:

D.M.Himmelblau, Basic Principles and calculations in Chemical Engg; 5th Edition, Prentice Hall of India. 1992

R.M.Felder, R.W.Rlusseau; Elementary Principles of chemical processes 2nd Edition. John Wiley & Sons Inc. 1986

Evaluation Plan

End semester Exam	:50 %
Mid semester Exam	: 25%
In-semester Evaluation:	
Total	: 25%
Assignments	: 5%
Tests/Quzzies	: 20 %
Seminars: Nil	

Course Code	**: CH 201**
Course Title	**: Momentum Transfer**
L T P	**: 3-1-0**
Credits	**: 04**
Category	**: PC**
Teaching Department	**: Chemical Engineering**

Course Outcome

At the end of this course the student is expected to have learnt the following.

- Mathematically represent and analyze the basic laws governing fluid statics and dynamics
- Understand the significance of energy losses and their calculations in fluid flow systems
- Understand the basic issues related to fluid –solid systems
- Know various principles used for flow measurement and fluid transportation
- Develop semi empirical equations using dimensional analysis and understand their significance in the context of equipment design

Syllabus

Properties of fluids. Fluid statics. Introduction to fluid flow. Basic equations of fluid flow. Laminar Flow. Turbulent flow. Fluid flow around immersed bodies - Boundary layer and friction drag. Motion of particles through fluids. Fluidization principles. Dimensional analysis Similitude. Mixing of liquids. Compressible flow. Flow measurement. Fluid transportation machinery

Course Coverage:

1.	Properties of fluids	--- 05 hours
2.	Fluid statics	--- 08 hours
3.	Principles of fluid motion	--- 10 hours
4.	Laminar and turbulent flows	---12 hours
5.	Flow past immersed bodies	--- 06 hours
6.	Dimensional analysis	--- 05 hours
7.	Flow measurement	--- 02 hours
8.	Fluid transportation	--- 02 hours
	Total	--- 50 hours

Reference Books:

1. Christie J Geankoplis: Transport Processes and Separation Process Principles, Prentice Hall India, 4th Edition

2. Warren L McCabe, Julian C Smith and Peter Harroit: Unit Operation of Chemical Engineering, McGrahill, 5th Edition
3. J M Coulson, J H Richardson, J R Backhurst and J H Harker, Chemical Engineering, Vol.1,
Pergamon, 6th Edition

Evaluation Plan

End Semester Examination: 50% marks
Mid Semester Examination: 30% marks
In Semester Evaluation: Total- 20% marks
Assignments: 03
Test: 01
Seminars: None

Course : **Particulate Technology**
Code : **CH202**
L-T-P : **(3-1-0)**
Credits : **4**
Category : **PC**
Teaching Department : **Chemical Engineering**

Course Objective:

The main objective of the course is to introduce various upstream and downstream processes in chemical industries and to understand the fundamentals behind them, which is used to design them.

Course Outcome

By the end of this course the student will be able to:

- Understand the physical characteristics of solid particles in the context of size reduction and solid flow.
- Gain insight into relevant methods for the analysis of particle sizes
- Apply the science and engineering principles in the energy requirement for size reduction and understand the working principles of different size reducing equipments
- Acquire skills to select and apply the various principles in the design and application of various solid/liquid, solid/gas separation techniques in chemical process industries.

Syllabus

Particle Size Analysis. Industrial Screening. Storage and Conveyance of Solids. Size Reduction. Size Enlargement. Classification. Centrifugal Separation. Gas cleaning. Solid – Liquid Separation. Thickening. Froth Flotation. Magnetic separation. Electrical separation. Sorting (Separation of solids). Mixing and Agitation.

Solid and Solid Handling **(13hrs)**
Introduction
Particle Characterization: - *Density, specific gravity, shape, size, sphericity, etc.*
Size Analysis Technique: - *cumulative analysis, differential analysis.*
Industrial Screens: - *Types based on driving system and mechanism, Effectiveness.*
Size Reduction: - *Principles, Mohr circle, laws of size reduction.*
Size Reducing Equipments: - *Crushers, Grinders, Ultrafine Grinders, Cutting Machines.*
Solid-Liquid System **(13hrs)**
Introduction

Flow of solid through liquids, Terminal falling velocity, Raising velocity of light particles, Wall effect on particle dynamics, Bottom effect on particle dynamics, Effect of sphericity on particle dynamics, Added mass concept.

Separation of Solid-Liquid Mixtures **(12hrs)**

Sedimentation: - *Introduction, Batch and Continuous process, Kynch theory.*

Thickeners: - *Introduction, Types, Design of thickener.*

Centrifugal Separation: - *Introduction, Types, Theory of centrifuge.*

Flotation: - *Introduction, types.*

Filtration: - *Introduction, Types of Industrial filtration, Theory of Filtration.*

Mixing and Agitation **(4hrs)**

Introduction, Types, Impellers, Turbines, Baffles, theory of mixing.

Conveyors **(3hrs)**

Introduction, Types of conveyors.

References

Chemical Engineering, Coulson and Richardson's, vol2

Unit Operations Of Chemical Engineering, Warren Lee McCabe

Grading:

Assignment 1 or surprise test carries 10% weightage, mid sem carries 30% weightage, Assignment-II or surprise test-II carries 10% weightage, End sem Carries 50% weightage. Attendance will be strictly followed based on the institute norms (pls verify academic dairy).

Course code **: CH203**
Course title **: TRANSPORT PHENOMENA;**
L-T-P **: (2-2-0)**
Credits **:4**
Category **: PC**
Teaching Department **: Chemical Engineering**

Learning outcomes
Students will gain knowledge about momentum, heat and mass transfer, which constitutes a foundation for applied courses in chemical science and chemical engineering education.

After passing the course the students will be able to:

- Write shell balance equations for transfer of momentum, heat and mass in one dimension.
- Specify appropriate boundary conditions.
- Solve the balance equations analytically with acquired knowledge in mathematics.
- Develop thinking capability to model a given problem in Momentum, Heat and Mass Transfer.
- Introduce suitable simplifications and assess the effects of the simplifications on model applicability
- Identify and solve simple cases of problems involving more than one independent variable.

Textbooks: 1) Transport Phenomena, by R.B. Bird, W.E. Stewart and E.N. Lightfoot, Wiley International Edition 1960, 2002
2) Transport Phenomena A unified Approach by R. Brodkey and H. Hershey, McGraw-Hill International Edition 1988.

Syllabus

Shell balances for momentum, energy and mass transfer. Introduction to general transport equations for momentum, energy and mass transfer in cartesian - cylindrical and spherical coordinates – simple solutions in one dimension. Simplification of general equations with time and spatial coordinates for momentum, energy, mass transport, boundary layer concepts of momentum energy and mass transport. Macroscopic balances for isothermal systems, nonisothermal systems and multi componant systems.

Topics:

- Shell Momentum Balances and Velocity Distribution for Laminar Flow.
- The Equation of Change for Isothermal Systems.

- Velocity Distribution with more than One Independent Variable.
- The Conductivity and the Mechanism of Energy Transport.
- Shell Energy Balances and Temperature Distribution in Solids and Laminar Flow.
- The Equation of Change for Isothermal Systems.
- Temperature Distribution with More than One Independent Variable.
- Diffusivity and the Mechanisms of Mass Transfer.
- Concentration Distribution in Solids and Laminar Flow.
- Concentration Distribution with More than One Independent Variable.

Evaluation Policy:

Two Tests	10%
Midterm Exam	30%
Assignments	10%
Final Exam	50%
Total	100%

Course code **: CH 211**
Course title **: Process Instrumentation**
L-T-P **: 3-0-0**
Credits **: 3**
Category **: PSE**
Teaching department **: Chemical engineering**

Course outcomes:

By the end of this course the student will be able to

- Understand the significance of instrumentation in chemical processes and familiarize with scientific principles involved.
- Understand elements of a measurement system
- Realize the major engineering principles used in the measurement of flow, temperature, pressure, level etc.
- Understand the construction and operation of the process equipment and selection of suitable instrument

Syllabus

Introduction: Temperature measurement, Pressure measurement, Flow measurement, Level measurements Viscosity measurement, Moisture and humidity measurements. Conductivity meter- pH meter, Analytical instruments – Liquid chromatography – HPLC – Mass spectroscopy - Computer aided analysis– process instruments and automatic analysis.

S.No.	**Content**	**Approximate No of lecture hours**
1	Introduction- Typical applications of instruments, functional elements, classification, microprocessor-based instrumentation, standards and calibration	6
2	Temperature measurement- Scales, measurement, Non electrical and electrical methods, pyrometry, Moisture measurement	4
3	Pressure measurement- Moderate, high pressure and vacuum, calibration and testing, level measurement- Radar, radiation, capacitive methods.	7
4	Flow measurement – Primary meters, positive displacement, Secondary meters, Special meters	5
5	Viscosity measurement- capillary tube viscometer, efflux type and variable area viscometer.	5
6	Conductivity meter and pH meter, Liquid chromatorgraphy- HPLC, Mass spectroscopy	6

7	Computer aided measurements, fiber optic transducers, microsensors, Data analysis	7
	Total	40

Reference books:

1. Instrumentation, Measurement and Analysis, B.C.Nakra and K.Chaudhry, Tata McGrow Hill Co., New Delhi, l985.
2. Instruments for engineering measurements, second edition, James W Dally, William F Riley and Kenneth G McConnell
3. Chemical Analysis, Modern Instrumentation Methods and Techniques, Francis Rouessac and Annick Rouessac
4. Principles of Industrial Instrumentation-D Patranabis, Second edition, Tata McGraw-Hill Education

Course Code : **CH250**
Course title : **Chemical Engineering Thermodynamics I**
L-T-P : **(2-1-0)**
Credits : **3**
Category : **PC**
Teaching Department : **Chemical Engineering**

Course outcome:

By the end of this course the student will be able to

- Understand the importance of various thermodynamic functions
- Apply the laws of Thermodynamics to analyze flow and non-flow processes
- Use thermodynamic data from tables, diagrams and generalized correlations for making calculations related to physical principles
- Understand and make calculations pertaining to energy conversion cycles, refrigeration cycles and cycles used for producing cryogenic temperatures

Syllabus

Fundamental Concepts and Definitions. PVT relationships. First law of Thermodynamics. Application of law to different processes in closed systems. Second Law of Thermodynamics. Physical meaning of entropy. T-S diagrams. Relations among thermodynamic properties. Thermodynamic functions in terms of measurable properties. Construction of thermodynamic charts. Third Law of Thermodynamics. Thermodynamics of flow processes. Application of first law to flow processes. Power and Refrigeration Cycles

Course Coverage:

Contents	**Approximate No. of Lecture Hours**
Laws of Thermodynamics	10
Auxilliary thermodynamic functions[1]; Spontaneous approach to equilibrium	5
Thermodynamic relations	3
Equations of state and generalised correlations for compressibility factor	5
Generalised correlations for thermodynamic functions	3
Phase equilibrium, Thermodynamic tables and diagrams for pure systems	4
Use of thermodynamic data for analysis of flow and non-flow processes [2]	7

Analysis of Energy conversion cycles	8
Analysis of refrigeration and cryogenic cycles	5
Total	50

[1] Including Availability function [2] Including an introduction to compressible flow

Reference Books:

1. Smith, J.M. and Van Ness, H.C., Chemical Engineering Thermodynamics, McGraw Hill
2. Denbigh, K. G., Principles of Chemical Equilibrium, Cambridge University Press
3. Kyle, B. G., Chemical and Process Thermodynamics, John Wiley (?)

Evaluation Plan:

End semester Exam : 50%
Mid semester Exam : 20%
Insemester Evaluation: 30%
Total : 100%

Assignments : 5 problem sets; no assignments
Class Tests : 3
Seminars : None

Course Code	**: CH251**
Course title	**: Heat transfer**
Semester	**: IV Sem. B Tech Chemical Engineering**
L-T-P	**: 3-1-0**
Credits	**: 4**
Category	**: PC**
Teaching Department	**: Chemical Engineering**

Course Outcomes

By the end of this course the student will be able to

- Differentiate the modes of heat transfer and apply mathematical equations governing the rate of heat transfer.
- Develop equations to describe steady and unsteady state heat conduction systems in one and multi-dimensions and to apply boundary conditions to solve the equations.
- Apply the science and engineering principles governing the heat transfer during the phase change.
- To understand principle of analogy of heat transfer to other transport processes.
- Apply fundamentals of heat transfer to design heat transfer equipments to satisfy the needs of the chemical engineering process applications.

Syllabus

Steady state conduction. Transient conduction. Insulation - critical thickness of insulation. Heat transfer with heat generation. Heat Transfer by convection. Heat Transfer with packed and fluidized beds. Heat Transfer in Jacketted vessels. Cryogenic heat transfer. Heat transfer in extended surfaces. Heat transfer with change of phase. Boiling Heat transfer. Radiation.

Reference Books

1. J.M.Coulson and J.F.Richardson- Chemical Engineering,Vol.1,3 rd ed., Pergamon and ELBS, 1977
2. Krietch- Fundamentals of heat transfer, Harper and Law, 1986, 4th Edition.
3. McCabe and Smith- Unit operations in chemical Engg. , McGraw Hill Co., 1967.
4. Mc Adams- Heat transmission, 3rd edition, McGraw Hill Co., 1954.
5. Kern D.Q., Process Heat Transfer, McGraw Hill Co.5, 1950.
6. Gupta and Prakash, Engg. Heat Transfer, nemchand, 1969.
7. M.Jacob- Heat transfer, Vol.2, John Wiley & Sons, 1957.

Evaluation Plan

End semester Exam-50%
Mid semester Exam-25%
In-semester Evaluation: Total : 25%

- Assignments : 10
- Tests/Quzzies : 15

Courses Contents:

Contents	Approximate No. of Lecture Hours
Introduction,	1
Modes of heat transfer, basic laws for conduction, convection and radiation, combined heat transfer processes	5
Steady state conduction-conduction through plane ,curved surfaces-derivations of relations-multilayer walls, problems various types – transient conduction with infinite K ,and finite K-insulation- critical thickness of insulation –heat transfer with heat generation.	10
Heat transfer by convection-types-factors influencing heat transfer coefficients-analogies- dimensional analysis. High temperature heat carriers- heat transfer with packed and fluidized beds- correlations. Heat transfer in jacketed vessels. Cryogenic heat transfer.	12
Heat transfer in extended surfaces –fins – relations for Heat Transfer for rectangular and cylindrical fins- fin efficiency, fin effectiveness, overall fin efficiency- heat exchangers- concept of logarithmic mean temperature difference-dirt factor. Heat exchanger effectiveness	6
Heat transfer with change of phase- conduction- condensation- Nusselt's equation derivation- boiling heat transfer- correlations radiation heat transfer type of radiation bodies- Kirchhoff's law – view factor calculation- radiation exchange between gray bodies- radiation shield- radiation from flames- gases temperature measurement and radiation errors.	8
Process design of heat exchangers like D.P.H.E, shell and tube heat exchanger and condensers .simple designs only.	5
Total	**47 Hours**

Course Code : **CH 252**
Course title : **Mass transfer - I**
L-T-P : **3-1-0**
Credits : **4**
Category : **PC**
Teaching Department : **Chemical Engineering**

Course outcomes:

By the end of this course the student will be able to

- Understand the principles involved in mass transfer and concepts of inter phase mass transfer.
- Derive and develop expressions for diffusive, convective mass flux and rate of mass transfer
- Understand the working of continuous and differential contactors for mass transfer operations
- Design tray tower and packed tower contactors for mass transfer.
- Understand the equilibrium characteristics, working principles, and application of absorption and adsorption processes.
- To determine the height of packed bed adsorber from the breakthrough curve

Course Coverage:

Contents	**Approximate No. of Lecture Hours**
Introduction to Mass Transfer operations and separation techniques	4
Mass transfer principles including equilibrium and non-equilibrium operation.	2
Diffusion mechanism	5
Convective mass transport and mass transfer coefficient	3
Analogis	3
Inter phase mass transport and overall mass transfer coefficient concept	5
Mass transfer theories (Film, penetration, surface renewal theories etc.)	5
Stage concepts and cascades including co-current, counter-current and cross current operation with equilibrium characteristics representation	5
HTU, HETP and NTU concepts for gas/liquid dispersing equipments	3
Classification and of Gas-liquid contactors and their working and design principles	2
Equilibrium characteristics, working principles, and application of Absorption and desorption processes	7
Equilibrium characteristics, working principles, and application of Adsorption processes	4

Total	51

Reference Books:

R.E. Treybal - Mass Transfer Operations. 2nd Edition, McGraw Hill, 1968.
W.L. McCabe and J.C. Smith - Unit Operations of Chemical Engineering. McGraw Hill, 1976
Dutta B.K- Principles of Mass Transfer and Separation Processes, Prentice-Hall of India Private Ltd. (2007).
Geankoplis C J, Hersel A H,Lepek D H -Transport Processes and Separation Process Principles.Fifth Edition, Prentice Hall(2018)

Evaluation Plan:

End semester Exam-:50 %, Mid semester Exam: 25%, In-semester Evaluation: Total : 25 %

(Assignments: 5 %, Tests/Quzzies : 20 %, seminars: Nil)

Course code	**: CH 253**
Course Title	**: CHEMICAL REACTION ENGINEERING -I**
L-T-P	**: (2-1-0)**
Credits	**: 3**
Category	**: PC**
Teaching Department	**: Chemical Engineering**

Learning outcomes

Students will gain knowledge about the importance of chemical kinetics, interpreting kinetic data and understand how to design Ideal reactors under isothermal conditions for various reactions, which is essential in chemical engineering education.

After completing the course the students will be able to:
Interpret experimental kinetic data and find out the rate equation for the given reaction.

- Interpret experimental kinetic data and mathematically represent the rate equation for homogeneous chemical reactions
- Develop design equations for ideal reactors. h reactor, CSTR or PFR for isothermal conditions.
- Analyse a given reaction system and be able to use multiple reactors where appropriate.
- Able to design appropriate reactor system for multiple reactions to maximize product yield.

Syllabus

Chemical Reaction Equilibrium. Kinetics of Homogeneous Reactions. Single Homogeneous Reactor Design. Multiple Reactor Systems. Multiple Reaction Systems

Textbooks: 1) *Chemical Reaction Engineering,*by Levenspiel, O., 3rd edition, Wiley Eastern, 1998
2) *Elements of Chemical Reaction Engineering,* by Scott Fogler, H. –4th edition, Prentice Hall of India, 2007.

Topics:

Thermodynamics and Reaction Kinetics
Interpretation of Batch Reactor data
Flow Reactors: CSTR & PFR
Multiple Reactors
Multiple Reactions

Evaluation Policy:

Two Tests	10%
Midterm Exam	30%
Assignments	10%

Final Exam	50%
Total	100%

Course Code **: CH 254**
Course title **: Fluid and Fluid Particles Systems Lab**
L-T-P **: (0-0-3)**
Credits **: 2**
Category **: PC**
Teaching Department **: Chemical Engineering**

Course outcomes

By the end of this course the student will be able to

- To apply the momentum transfer fundamentals to plan and conduct the experiments
- To gain hands on experience and visualization of the working principles of pumps, flow meters, valves and pipe fittings.
- To gain the experience into the relevant methods for the size reduction, separation and size analysis of particulate systems.
- To plan and conduct experiments on laboratory scale systems generate, analyze and interpret the experimental data
- To acquire skills for technical report preparation with relevant conclusions
- To demonstrate skills to work in a team

Syllabus

Experiments based on Momentum Transfer and Particulate Technology

Course Coverage:

Contents	**Approximate No. of Laboratory Hours**
Flow through pipes and fittings	03
Flow through orificemeter & Flow through Rotameter	03
Flow through packed bed	03
Flow through fluidized bed	03
Characteristics of a centrifugal pump	03
Screen effectiveness & Air permeability	03
Jaw crusher	03
Air elutriation	03
Batch sedimentation	03
Leaf filter	03
Total	30

Reference Books:

1. Unit operations in Chemical Engineering by McCabe and Smith, McGraw Hill.
2. Chemical Engineering by Richardson and Coulson, Butterworth-Heinmann Ltd.

Evaluation Plan:

End semester Exam: 30 %
Mid semester Exam: Nil
In semester Evaluation: Total: 70 % (Assignments: Nil, Tests/Quzzies : Nil,
Records & experimental result analysis: 60 %
Conducting the experiment: 10 %)

Course code : **CH 261**
Course title : **Energy Technology**
L-T-P : **3-0-0**
Credits : **3**
Category : **OE**
Teaching department : **Chemical engineering**

Course outcomes:

By the end of this course the student will be able to

- Acquire knowledge of current energy scenario and influence of policies on society, environment and public health.
- Familiarize with the scientific principles in energy conversion.
- Understand engineering principles involved in harnessing energy from renewable and fossil fuel energy sources.
- Understand various technologies and issues in energy conversion.
- Identify and select appropriate technologies for a given location.

Syllabus

Energy Scenario in India -Conventional/non-conventional renewable non-renewable sources. Principles of efficient use of fuels, energy conservation and auditing. Solid liquid and Gaseous fuels. Combustion, Furnaces. Draught and chimney height. Nuclear Energy - Classification and Components. Unconventional fuels, renewable energy sources.

Course coverage:

S.No	Contents	Approximate No. of lecture hours
1	Conventional energy – Solid fuels- biomass, charcoal formation, coal- types of coal, composition and analysis of coal- ultimate and proximate analysis; properties of coal- high and low CV, caking index, swelling index, coal carbonization – low and high temperature reactors, coal gasification- producer gas, water gas reactions and zones	8
2	Liquid fuels- petroleum, fractionation, and refinery processes- cracking- FCC, purification, acid treating, hydrogenation, isomerization, polymerization; properties of liquid fuels; storage.	5
3	Gaseous fuel- LPG, bio gas, Combustion fundamentals, Excess air, flue gas calculations, chimney height and draught, adiabatic	9

	flame temperature calculations, fluidized bed combustion, furnaces	
4	Efficient energy utilization, waste as fuel steam and gas cycles, recuperative heat exchangers, selection of energy recovery methods, energy auditing, pinch technology-basics.	9
5	Renewable energy sources- Solar energy- solar collectors, types of collectors, concentration ratio calculation; Wind mills- types, efficiency calculation	9
	Total	40

Reference books:

1. Energy efficiency for engineers and technologists- T.D.Eastop and D.R. Croft, Published by Longman Pub Group, 1990
2. Fuels and combustion- Samir sarkar, Gyan books pvt Ltd.
3. Fuels, furnaces and refractories – J.D. Gilchrist, Pergamon press.
4. Renewable energy sources and emerging technologies - D P Kothari, K.C.Singal, Rakesh Ranjan, PHI learning Pvt. Ltd.
5. Energy management – W.R Murphy and G.A. McKay Butterworth-Heinemann Ltd

Course Code : **CH300**
Course title : **Chemical Engineering Thermodynamics II**
L-T-P : **2-1-0**
Credits : **3**
Category : **PC**
Teaching Department : **Chemical Engineering**

Course outcomes

By the end of this course the student will be able to understand

- Concepts related to non-ideal systems and apply them to chemical engineering problems
- Concepts related to Phase equilibrium and apply them to single and multi-component systems.
- To generate vapor liquid equilibrium data and evaluate the consistency of the data.
- The macroscopic properties of thermodynamics systems through microscopic analysis of the components.
- The basic concepts of statistical thermodynamics and their usefulness.

Syllabus

Single Component Systems. Multicomponent Systems. Phase Equilibria. Thermodynamics of Electrolytes. Statistical Thermodynamics

Course Coverage:

Contents	**Approximate No. of Lecture Hours**
Fugacity, Fugacity coefficient, Activity, Activity Coefficient, Chemical Potential	10
Solution Properties: Partial Molar Properties, Property Change of Mixing, Excess Properties	15
Phase Equilibria: Phase equilibria, criterion of stability, Phase rule, Phase equilibria in single and multicomponent systems, Vapor – liquid equilibrium for binary systems, phase diagrams,	15
Statistical thermodynamics: Macroscopic and micropsopic properties of thermodynamics, probability theory, quantum mechanics and kinetics theory of particles statistical analysis of particles, degeneracy, Bose Einstein theory, Maxwell Botlzman and Fermi Dirac distribution of particles.	15
Total	55

Reference Books:

1. Introduction to Chemical Engineering Thermodynamics, 7th ed. by Smith J. M., H.C. van Ness and M. M. Abott., McGraw Hill, New York 1996.
2. Introduction to Chemical Engineering Thermodynamics, Gopinath Halder, Easter Economy Edition, PHI Learning Pvt Ltd. New Delhi 2009.
3. A Textbook of Chemical Engineering Thermodynamics, K V Narayanan, Easter Economy Edition, PHI Learning Pvt Ltd. New Delhi 2008.
4. Engineering Thermodynamics, P K Nag, 3rd ed., Tata McGraw Hill, New Delhi, 2005.
5. Chemical Engineering Thermodynamics, Y. V. C. Rao, University Press (India) 2005.

Evaluation Plan:

End semester Exam	50%
Mid semester Exam	30%
Insemester Evaluation Total	20 %
Assignments	10 %
Tests/Quzzies	10 %
Seminars	--

Course Code	**: CH301**
Course tilte	**: CHEMICAL REACTION ENGINEERING -II**
L-T-P	**: (3-1-0)**
Credits	**: 4**
Category	**: PC**
Teaching Department	**: Chemical Engineering**

Learning outcomes

Students will gain knowledge about non ideal flow in reactors, thermal effects in reactors and also about heterogeneous reactions, which is essential in chemical engineering education.

By the end of this course the student will be able to:

- Understand the issues related to non-ideal flow and use them in the context of design of process vessels
- Understand the issues related to thermal design of reactors in the context of energy conservation and safely
- Develop kinetic rate equations for heterogeneous catalytic and non-catalytic reactions.
- Know various types of reactors used to carry heterogeneous reactions.

Syllabus

Non-ideal Flow Reactors. Non-isothermal Homogeneous Reactions. Non-catalytic heterogeneous Reaction Kinetics. Catalytic Heterogeneous Reaction Kinetics

Textbooks:

1) *Chemical Reaction Engineering*, by Levenspiel, O., 3rd edition, Wiley Eastern, 1998
2) *Elements of Chemical Reaction Engineering*, by Scott Fogler, H. – 4th edition, Prentice Hall of India, 2007.

Prerequisite: Understanding of Interpretation of kinetic data, Ideal Reactors, multiple reactors and multiple reactions.

Topics:

Non-Ideal Flow in Reactors.
Thermal effects in Batch, CSTR and Plug Flow Reactors.
Heterogeneous Reactions, Non-catalytic.
Heterogeneous Reactions, Catalytic

Evaluation Policy:

Two Tests	10%
Midterm Exam	30%
Assignments	10%
Final Exam	50%
Total	100%

Course Code : **CH 302**
Course title : **Mass Transfer II**
L-T-P : **3-1-0**
Credits : **4**
Category : **PC**
Teaching Department : **Chemical Engineering**

Course outcomes

By the end of this course the student will be able to

- Understand the principles and applications of distillation, leaching and extraction
- Understand and apply the concepts of multiphase equilibrium; acquire knowledge to generate and predict the equilibrium data
- Understand the application of scientific and engineering principles in the separation of components by different mass transfer operations
- Select and design suitable equipments for mass transfer operations.

Syllabus

Concepts of Vapour - Liquid equilibria. Multi component systems. Principles of distillation. Continuous Rectification. Method of McCabe and Thiele. Liquid-Liquid Extraction, leaching.

Course Coverage

Contents	**Approximate No. of Lecture Hours**
Introduction	1
Concepts of vapor –liquid equilibria,P-xy and T-xy diagrams,relative volatility,Raoult’s law applications,deviation from ideality, azeotropes – different types ,Enthalpy concentration diagrams,Multicomponent systems-calcultions,principles of distillation-single stage operations –flash vaporization-partial condensation-simple distillation-differential condensation,steam distillation	10
Continuous rectification-Binary system fractionation operations-equipments-Ponchon Savarit method-calculations for entire fractionator.Feed tray location-minimum reflux ratio-total reflux conditions-multiple feeds-side stream calculations	8
McCabe Thiele method-concepts of equimolal overflow and vaporization-calculation of ideal stages for different situation like total condenser-partial condenser-reflux at bubble point,subcooled etc,feed tray calculation, q-line concept, location of feed tray,minimum reflux ratio,calculations for total	10

reflux,open steam use and calculations for such situations,multiple feeds and side stream problems Rectification of azeotropic mixtures	
Tray efficiencies, packed bed distillation –introduction to transfer unit concept, Introduction to multicomponent distillation	4
Liquid extraction applications-equilibria-ternary systems.Triangular and other coordinates-choice of solvent-problems on single stage and multistage cross current and countercurrent contactor-extraction with reflux-problems on fractional extraction,equipments for liquid liquid extraction-mechanism and design criteria	10
Leaching-concepts and applications-solid preparation methodsof leaching operations-Shank's system-equipments for leaching operation ,equilibria,batch and multistage cross current and countercurrent leaching operations-problems	6
Total	49 Hrs

Reference Books:

1.R.E Treybal –Mass Transfer Operations –McGraw Hill
2.Robinson and Gilliland-Elements of fractional distillation- McGraw Hill
3.J.M.Coulson and J.F.Richardson-Chemical Engineering vol 2,Pergamon press
4.McCabe and Smith ,Unit operations in Chemical Engg.- McGraw Hill
5.Van Winkle ,Distillation, McGraw Hill

Evaluation Plan:

End semester Exam-50%
Mid semester Exam-25%
Insemester Evaluation: Total : 25%

- Assignments:10
- Tests/Quzzies : 15

Course Code : **CH303**
Course title : **Heat Transfer Operation Lab**
L-T-P : **0-0-3**
Credits : **2**
Category : **PC**
Teaching Department : **Chemical Engineering**

Course outcomes:

By the end of this course the student will be able to

- To apply the Heat Transfer fundamentals to plan and conduct the experiments
- To gain hands on experience and visualization of the working principles of Heat transfer equipments, auxiliary units and utilities.
- To plan and conduct experiments on laboratory scale systems generate, analyze and interpret the experimental data
- To acquire skills for technical report preparation with relevant conclusions
- To demonstrate skills to work in a team

List of Experiments

S.No	Experiment
1.	Thermal Conductivity Of Insulating Powder
2.	Thermal Conductivity Of Liquid (Guarded Plate Method)
3.	Transient Conduction With Constant Heat Flux
4.	Stefan Boltzmann Apparatus
5.	Natural And Forced Convection In Air
6.	Natural And Forced Convection In Water
7.	Heat Losses By Combined Convection And Radiation (For Cylinder And Sphere)
8.	Pool Boiling Apparatus
9.	Heat Transfer Through Coils
10.	Double Pipe Heat Exchanger
11.	Spiral Plate Heat Exchanger
12.	Packed Bed Heat Exchanger
13.	Vertical And Horizontal Condensor
14.	Shell and Tube Heat Exchanger

Evaluation Plan:

End semester Exam-:**40 %**; In-semester Evaluation: **60%** (Conducting Experiments: 20%; Calculation and interpretation of data : 20%; Record preparations: 20%)

Course Code : **CH 311**
Course title : **Petroleum Engineering**
L-T-P : **3-0-0**
Credits : **3**
Category : **OE**
Teaching Department : **Chemical Engineering**

Course outcomes:

By the end of this course the student will be able to

- Understand the basic principles and the development of energy policies for sustainable development
- Acquire knowledge on the scientific principles involved in fossil fuel formation and their characterization.
- Understand the various unit operations/processes involved in the pre-treatment and refining of petroleum.
- Familiarize with the design principles and operating conditions of important unit operations involved in refining of petroleum.
- Familiarize with the issues on risk and safety with respect to storage transport and handling of crude and petro products

Syllabus

Introduction. Composition and evaluation of properties of crude oil and refinery products. Refining of petroleum. Types of pipe still furnaces used in refineries and their design consideration. Cracking processes. Rebuilding processes. Product treatment processes.

Course Coverage:

Contents	**Approximate No. of Lecture Hours**
Crude oil occurrence, composition, classification, properties	5
Crude oil Evaluation	3
Impurities present in the crude and pre-treatment processes	3
Refinery products and their specifications	2
Crude oil Refining operations: ADU,VDU, Thermal cracking, Catalytic cracking, Hydro cracking, Vis-breaking, lube oil processing and related reactions.	10
Product treatment processes: polymerization, Isomerisation, Hydro treating processes and their reactions	6
Additives used in different petro-products and their functions	3

Crude and petro-products Storage and handling techniques	3
Total	35

Reference Books:

Robert A. Meyers, Hand Book of Petroleum Refining Processes, McGraw Hill Book Co., l986.
Bhasker Rao B.K,. Modern Petroleum Refining Processes, Oxford & IBM Publishing Co., 1984

Evaluation Plan:

End semester Exam-:50 %
Mid semester Exam: 25%
In-semester Evaluation: Total : 25 %
Assignments: 5 %
Tests/Quzzies : 20 %

Course Code	**: CH312**
Course title	**: Biochemical Engineering**
L-T-P	**: 3-0-0,**
Credits	**: 3**
Category	**: PSE**
Teaching Department	**: Chemical Engineering**

Course outcomes

By the end of this course the student will be able to

- Apply the knowledge of chemical engineering principles to biological systems.
- Understand the role of microorganisms and their metabolism for bioprocess development.
- Analyze and interpret kinetic nature of a given biological system and learn principles of bioreactor design.
- Develop mathematical model of growth and production kinetics

Syllabus

Introduction - Principles of microbiology. The kinetics of enzyme catalysed reactions. Metabolic Pathways and Energetic of the cell. Kinetics of substrate Utilisation. Biological reactors-applications, and design Fermentation Technology

Course Coverage:

Content	Lecture hours
Introduction to biochemical engineering and its applications	1
Role of microbes and microbiology in development of biochemical engineering. Types of organisms, their nomenclature.	2-4
Chemicals of life, proteins, lipids, carbohydrates	5-6
Enzymes as biocatalysts and comparison with chemical catalysts, examples on enzyme catalyzed reactions	7-9
Enzyme catalysed reactions and kinetics associated with them. Examples on enzyme kinectics	10-18
Basics of cell death kinetics and its application to Sterilization process development, e.g., batch and continuous. Examples on cell death kinetics and sterilization process development	19-25

Introduction to medium formulation for microorganisms and types of media used. Examples on media development from using stoichiometry of biological reaction	26-33
Growth kinetics of microorganisms in various bioreactor configurations. Various yield coefficients and its importance in media development. Examples on growth kinetics.	34-44
Introduction to downstream processing and unit operations used in downstream processes. Examples on downstream processing	45-48

Reference Books:

- Biochemical Engineering Fundamentals, James Edwin Bailey, David F. Ollis, 2nd Edn, McGraw-Hill, USA
- Bioprocess Engineering Principles, Pauline M. Doran, Academic Press
- Bioprocess Engineering, Michael L. Shuler, Fikret Kargı, Prentice Hall PTR

Evaluation Plan:

End semester Exam----50%; Mid semester Exam- ---25%, Insemester Evaluation: Total : 25%

(Assignments: 0, Tests/Quizzes : 2, Seminars: 0)

Course Code : **CH351**
Course title : **Process Dynamics and Control**
Credit : **(3-1-0)**
Credits : **4**
Category : **PC**

Course Description: Design and analysis of feedback control systems in chemical and natural systems. Topics include formulation of dynamic models, time and Laplace domain analysis of open-loop and closed-loop systems, and design of single variable and multivari-able controllers.

Course Objective: The main objective of the course is to tech design methodology of control strategies of chemical process and analysis of closed loop system.

Course Outcome: Upon completion of this course, students should:

- Apply the physico-chemical principles to develop the mathematical model to represent the process dynamics
- apply the mathematical principles to predict and analyze the transient response of the systems
- understand the limitations and advantages of various control strategies in chemical process
- Acquire skills in the design and development of controllers for chemical engineering systems.

Syllabus

Introduction Dynamic Behaviour of Lumped Parameter Systems. Transient analysis of control systems. Frequency response analysis. Advanced control strategies - Feed forward control, cascade control, inferential control, ratio control, adaptive control, selective control, smith predictor dead time compensator, interaction and decoupling in multi input - multi output control system.

Topics to be covered:

1. Introduction, Control objectives and benefits
2. Process Dynamics
3. Modes of Controller and its response
4. Laplace Transform
5. Open loop first order system and its transfer function
6. Transient response of first order system
7. First order system in series and parallel
8. Open loop second order system and its transfer function
9. Transient response of 2^{nd} order system

References

Process Systems Analysis and Control - D.R.Coughanowr, McGraw Hill, Second Edition, 1991.
Process Dynamics and Control, D.W.Seborg, T.F. Edger, D.A.Millichamp, John Wiley & Sons, 1988

Course Code : **CH352**
Course title : **Simultaneous Heat and Mass Transfer**
L-T-P : **2-1-0**
Credits : **3**
Category : **PC**
Teaching Department : **Chemical Engineering**

Course outcomes

By the end of this course the student will be able to gain

- Gain knowledge on the scientific and engineering principles of unit operations in chemical engineering processes involving both heat and mass transfer (Evaporation, Crystallization, Humidification and drying)
- Gain the skills in the use of charts monograms and other resources for extracting required data.
- Familiariaze with the mathematical analysis of engineering principles involved in the unit operations
- Understand the selection criteria for choosing particular equipment for specific application in chemical process industries.
- Develop skills in the processes design of equipments used for Evaporation, Crystallization, Humidification and drying

Syllabus

Evaporation -Concept and applications. Humidification and Dehumidification. Crystallisation. Drying Operations

Course Coverage

Contents	Approximate No. of Lecture Hours
Principles of boiling of liquids, different modes and type of evaporators. Concepts of evaporation capacity, heat transfer coefficients, temperature difference summary, boiling point raise, circulation of liquor, hydrostatic head etc. in industrial evaporators. Evaporator accessories. Working principles of single and multiple effect evaporators. Evaporation by thermocompression.	15
Concepts of supersaturation, Meir’s Theory, types of crystals and crystallizers. Types, nucleation, crystal habit, crystal growth, size distribution of crystals, Delta L law of crystal growth and its significance. MSMPR crystallizer.	10

Principles of drying, drying conditions, drying rates, drying material. Types of moisture content, types of drying and design of some industrial dryers. Special trying techniques.	10
Concepts of humidification and dehumidification processes. Wet bulb theory, Psychometric Chart, Adiabatic cooling lines and Lewis Relationship. Design aspects of air conditioners and cooling towers.	10
Total	45

Reference Books:

1. Chemical Engineering Vol. I by J M Coulson and J F Richardson 3rd ed. Pergamon and ELBS, 1977
2. Unit Operations of Chemical Engineering by W L McCabe, Peter Harriot and J C Smith McGraw Hill (1976)
3. Introduction to Chemical Engineering by Walter L. Badger and Julius T. Banchero, Tata McGraw – Hill, 4th ed., New Delhi 1997

Evaluation Plan:

End semester Exam 50%
Mid semester Exam 30%

Insemester Evaluation: Total : 20 %
Assignments: 10 %
Tests/Quizzes : 10 %
Seminars --

Course Code	**: CH354**
Course title	**: Mass Transfer Operations Lab**
L-T-P	**: 0-0-3**
Credits	**: 2**
Category	**: PC**
Teaching Department	**: Chemical Engineering**

Course outcomes:

By the end of this course, the student will be able to

- Apply the mass transfer fundamentals to plan and conduct the experiments
- Gain hands-on experience and visualization of the working principles of mass transfer equipment, auxiliary units, and utilities.
- Plan and conduct experiments on laboratory scale systems; generate, analyze, and interpret the experimental data
- Acquire skills for technical report preparation with relevant conclusions
- Demonstrate skills to work in a team

Syllabus:

Experiments based on Mass Transfer I & II.

List of Experiments:

S. No.	Experiment
1.	Atmospheric Tray Drier
2.	Batch Adsorption
3.	Counter Current Leaching
4.	Cross Current Leaching
5.	Diffusivity
6.	Packed Bed Distillation
7.	Simple Distillation
8.	Steam Distillation
9.	Surface Evaporation
10.	Vapour Liquid Equilibrium

Evaluation Plan:

End semester Exam:40%
In-semester Evaluation: 60% (Conducting Experiments: 20%; Calculation and interpretation of data: 20%; Record preparations: 20%)

Course Code : **CH355**
Course title : **Chemical Process industries**
L-T-P : **3-0-0**
Credits : **3**
Category : **PC**
Teaching Department : **Chemical Engineering**

Course outcomes

By the end of this course the student will be able to

- Apply the knowledge acquired in unit operations and unit processes in the development of industrial scale processes
- Apply the knowledge of process design in the context of industrial process to meet desired specifications
- Identify individual unit operations for a given chemical process and connect them to demonstrate entire process flow.
- Assess the role of safety and pollution control in chemical industries.
- Understand contemporary issues related to energy and environment in chemical process industries.

Syllabus

Chlor-alkali industries. Sulphur industries. Nitrogen industries. Phosphate industries. Potash industries. Manufacture of soaps, detergents and glycerine. Manufacture of paper pulp, paper and paperboard. Manufacture of industrial alcohol, acetone and butanol. Petroleum Refining. Petrochemicals. Synthetic fibres.

Course Coverage:

Content	Approximate Lecture hours
Introduction to Chemical Process Industries, various unit processes and unit operations	1
Sulfur and sulphuric acid: sulphur manufacturing of sulfur, sulfuric acid from sulfur, sulfur pollution	2-4
Nitrogen industries: Manufacturing of synthetic ammonia, inorganic ammonium compounds, urea	5-7
Potassium industries: manufacturing of various inorganic potaasium containing chemicals	8-10
Phosphorus industries: Manufacturing of various phosphorus compounds	11-13
Chlor-alkali industries: Manufacturing of soda ash, chlorine, caustic soda	14-16

Pulp and paper industries	17-18
Manufacturing of soap, detergents and glycerine	19
Industrial gases	20
Food industries: food processing, food by-products	21-23
Water production	24
Cement and lime industries	25-27
Manufacturing of dyes, polymerization technology	28-29
Coal and coal chemicals	30-32
Synthetic organic chemical industries	33-36

Reference Books:

- *C.E.Dryden - Edited and Revised by M.Gopala Rao - Outlines of Chemical Technology, Edition 2,Affiliated East West Press Pvt. Ltd., New Delhi, 1973,*
- *Austin G. T. - Shreves Chemical Process Industries, McGraw Hill Book Co., 5th Edition, 1986.*

Evaluation Plan:

End semester Exam----50%
Mid semester Exam- ---25%
Insemester Evaluation: Total : 25%
Assignments: 0
Tests/Quzzies : 4
Seminars: 0

Course Code : **CH361**
Course title : **Process Modelling and Simulation**
L-T-P : **(3-1-0)**
Credits : **4**
Category : **PSE**
Teaching Department : **Chemical Engineering**

Course outcome:

By the end of this course the student will be able to

- Formulate mathematical models for different Chemical Engineering systems involving steady and unsteady state, lumped and distributed parameter systems from the basics of balance laws, transport equations, thermodynamics, chemical kinetics using suitable assumptions
- Identify and choose appropriate numerical methods for solving different types of model equations.
- Write algorithms for solving the models
- Simulate different steady state and unsteady state systems by solving the model equations using appropriate software tools.

Syllabus

Introduction. Numerical solutions of Mathematical equations. Lumped Parameter models: steady state and unsteady state. Distributed Parameter models: Steady state and unsteady state. Unsteady state distributed parameter models (one-dimension).

Course Coverage:

Contents	Approx. No. of Lecture hours Required
Introduction to the course	1
Benefits and Limitations of /Precautions in Modeling	1
Strategy of model building	2
Classification of models,General classification,Classification of Transport phenomena models- Deterministic vs stochastic models Linear vs nonlinear,Steady state vs unsteady state,Lumped parameter vs distributed parameter. Basis for mathematical model equations	

Classification based on stratum of detail of physicochemical priniciples	5
Numerical solutions of mathematical equations	6
Lumped parameter systems (steady state and unsteady state) Vapor-liquid equilibrium models-multipoint dew point and flash calculations,Boiling operations Batch and continuous distillation Tank models-Basic tank model,tank with flow rate as a function of level,mixing tank,stirred tank with heating jacket,CSTR with multiple series parallel reactions,chlorination of Benzene,autocatalytic reactions,order of magnitude analysis,Nonisothermal CSTR-multiplicity and stability-Van heedren stability criteria-proportional control of CSTR at the unstable steady state. Non ideal CSTR models-Models with dead space and bypassing, estimation of model parameters	16
Distributed parameter models (steady state) Solution of split boundary value problems –shooting techniques, quasilinearisation solution;countercurrent heat exchanger,tubul;ar reactor with axial dispersion,countercurrent gas absorber,pipe line gas flow,tubular permeation process, pipe line flasher ,packed bed catalytic reactor	8
Unsteady state Distributed parameter models(one dimension) Solution of partial differential equations using finite difference method-convection problems,explicit and implicit centered difference methods;diffusive problems,Crank-Nicolson finite difference scheme;combined convective and diffusive problems.Examples- Unsteady state conduction and diffusion,unsteady state heat exchangers, Unsteady state gas absorbers,dynamics of a tubular reactor with dispersion	6
Stochastic models	4
Total	49

Reference Books:

1. Computational Methods in Process Simulations- W.F.Ramirez, Butterworth publishers,1989
2. Modeling and Simulation in Chemical Engineering ,Roger.E.Franks, John Wiley and Sons,1972
3. Mathematical Methods in Chemical Engineering ,Seinfield and Lapidus,Prentice Hall,1974.

4. Process Modeling, Simulation and Control of Chemical Engineers,W.L.Luben,McGraw Hill,1990
5. Numerical Methods for Engineers, Santosh Kumar Gupta, Tata Mc Graw Hill,1995
6. Ramkrishna D., Population Balances, Prentice Hall

Evaluation Plan:

Assignments/quizzes/Tests	25
Mid semester examination	25
End semester examination	50

Course code **: CH362**
Course Title **: Separation Processes**
L-T-P **: 3-1-0**
Credits **: 4**
Pre-requisite **: Nil**
Course Instructor **: Dr. Vidya Shetty K**
Teaching Department **: Chemical Engineering**

Course Outcomes:

By the end of this course the student will able to

By the end of this course the student will be able

- To understand the importance, working principles and limitations of various advanced separation processes for various Chemical Engineering applications.
- To develop and analyse the mathematical equations governing the performance of equipment used for the selected advanced separation processes
- To understand and apply basic design criteria for equipment used for the selected advanced separation processes

Course Coverage:

Contents	Approx. No. of Lecture and tutorial hours Required
Introduction to Separation Processes	2
Membrane separation processes Different membrane separation processes and their applications, Types of membrane, Membrane modules, Membrane Gas separation, Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis, Pervaporation, Membrane fouling	23
Adsorption and Ion Exchange based separations	6
Surfactant based separations.	6
External field induced separations.	6
Supercritical fluid extraction	6
Total	49

Reference Books:

- D. Seader, Ernest J. Henley, D. Keith Roper, Separation Process Principles, Chemical and Biochemical Operations . 3rd Edition John Wiley & Sons, 2010

- R.W. Rousseau, Hand Book of Separation Process Technology, John Wiley and Sons.1987
- M.C.Porter, Hand Book of Industrial Membrane Technology, , Noyes Publication, Park Ridge, New Jersey. 1990
- Dutta B.K- Principles of Mass Transfer and Separation Processes, Prentice-Hall of India Private Ltd. (2007).

Evaluation Plan:

Assignments/quizzes/Tests	25
Mid Semester examination	25
End semester examination	50

Course Code : **CH364**
Course title : **Risk and Safety Management in Process Industries**
L-T-P : **3-0-0**
Credits : **3**
Category : **PSE**
Teaching Department : **Chemical Engineering**

Course outcomes:

By the end of this course the student will be able to

- Understand general concepts on Hazard and Risk in chemical process industries.
- Evaluate Hazard and Risk both quantitatively and qualitatively (what if, HAZOP analysis, FTA, ETA)
- Understand the hazards arising from Fire, Explosion and toxic gas dispersion
- Acquire skills for preparation of onsite and offsite emergency plans, safety audit and use of personal protective equipments
- Learn various legislations and Acts on Risk and Safety management

Syllabus

The concept of risk and safety management. Major disasters in chemical process industries. Hazard identification methods and risk quantification techniques. Fire and explosions. Hazards peculiar to various industries Safety education and training, safety management, legal aspects of industrial safety, safety audit. Concept of preparation of on-site and off-site emergency plan.

Evaluation Plan:

- End semester Exam: 50%
- Mid semester Exam: 30%
- Insemester Evaluation: 20%

Course Coverage:

Contents	Approximate No.of Lecture Hours
Introduction to Risk and Safety Differentiation between HAZARD and Risk Lessons from past disasters	05
HAZARD identification methodologies- Checklist, what if, HAZOP	08
Risk quantification methods - ETA, FTA	08
Fire, Fire chemistry, classification, Extinguishers	05
Explosion, VCE, Dust, BLEVE	05

Toxic gas dispersion models	05
Safety Audit, use of PPE, onsite/offsite emergency plan, Reliability, Transportation of hazardous materials, ware house safety	10
Total	46

Reference Books:

- Loss Prevention in Process Industries- F.P. Lees, 2nd ed. 1996, Butterworth- Heinemann
- Industrial Safety Handbook- W. Handley, 2nd ed. 1977, McGraw Hill

Course Code	**:**	**CH 365**
Course title	**:**	**Introduction to Molecular Simulations**
(L-T-P)	**:**	**(2-0-2)**
Credits	**:**	**3**
Category	**:**	**Elective**
Course Instructor	**:**	**Jagannathan T. K.**
Offering Department:	**:**	**Chemical Engineering**
Course Outcomes	:	By the end of the course the students will be able to:

CO 1: Understand the theory and methodology behind the molecular simulation tools along with elementary basics on statistical mechanics

CO 2: Appreciate the relevant applications of molecular simulations in chemical engineering

CO 3: Develop computational modelling skills to begin writing efficient molecular simulation code/scripts for higher studies, research, and other purposes.

Course Syllabus:

Introduction and basics of molecular simulations – model systems, interaction potentials, periodic boundaries, minimum image convention, Equations of motion. Elementary statistical mechanics: ensembles, Boltzmann's distribution, and free energy. Measure and control of temperature and stress in molecular systems. Length and time scale limits of simulation methods. Molecular dynamics of simple model fluids such as hard spheres. Structure of a simulation program and introduction to programming methods. Applications in solids, liquids, and biomolecules. Demonstration using LAMMPS (Large-scale Atomic/Molecular Massively Parallel Simulator).

Allen, M.P., Tildesley, D.J. Computer Simulation of Liquids, Oxford University Press
Frenkel, D., Smit, B., Understanding Molecular Simulations: From algorithm to applications, Academic Press.
Rapport, D.C., The Art of Molecular Dynamics Simulation, Cambridge University Press.
Donald Allan McQuarrie, Statistical Mechanics, University Science Books.

Course Coverage:

Contents	**No. of contact hours (approx.)**
Introduction	2

Basics of Statistical Mechanics and thermodynamics	8
Molecular Simulation Basics	4
Molecular Dynamics Simulations	6
Monte Carlo Methods	5
MD/MC examples	5
Practical/ Hands-on	22
Total	52

References:

1. M. P. Allen and D. J. Tildesley, "Computer Simulation of Liquids", Oxford Science Publications, Oxford, 1987.
2. D. Frenkel and B. Smit, "Understanding Molecular Simulation: From Algorithms to Applications", Academic Press, San Diego, 1996.
3. Rapport, D.C., "The Art of Molecular Dynamics Simulation", Cambridge University Press
4. D. A. McQuarrie, "Statistical Mechanics." Harper Collins Publishers, New York, 1976.
5. S.I. Sandler, "An Introduction to Applied Statistical Thermodynamics", John Wiley &Sons, Inc.

Evaluation Plan:

Tool	***Weightage***
End semester Exam	40%
Mid semester Exam	20%
Quizzes/Tests (2*10)	20%
Tutorials/Assignments	20%

Course Code : **CH367**
Course title : **Energy Conservation and Management in Process Industries**
(L-T-P) : **(3-0-0)**
Credits : **3**
Category : **Elective**
Prerequisite : **Nil**
Teaching Department : **Chemical Engineering**

Course Outcomes:

By the end of this course, the student will be able to

CO1: Understand the Energy Outlook, conservation and its importance
CO2: Gain insight into engineering fundamentals related to energy efficiency, audit and principles of management
CO3: Gain knowledge on the software tools for industrial energy efficiency and savings and energy management information systems
CO4: explore the case studies on energy conservation and management in process industries

Syllabus:

Energy Outlook, Energy conservation and its importance, Energy intensive industries, Global industrial energy efficiency benchmarking, Engineering fundamentals related to energy efficiency, Principles on energy management, Energy Audit, Detailed thermodynamic analyses of common unit operations, Opportunities and techniques/methods for energy conservation in equipment and utility systems in process industries, Process synthesis, Thermo-economics, Energy Management Information Systems (EMIS). Software tools for industrial energy efficiency and savings, Case studies on energy conservation and management in process industries

References:

Kenney W F, Energy Conservation in the Process Industries. Academic Press Inc., 1984.
Stepanov V S Analysis of Energy Efficiency of Industrial Processes. 1st Edition, Springer-Verlag, 1993.
Jakob de SwaanArons, Hedzer van der Kooi, Krishnan Sankaranarayanan, Efficiency and Sustainability in the Energy and Chemical Industries, 1st Edition, Marcel Dekker, Inc., 2004

Course Code : **CH368**
Course title : **Fuel Cell Engineering**
(L-T-P) : **(3-0-0)**
Credits : **3**
Category : **Elective**
Prerequisite : **Nil**
Teaching Department : **Chemical Engineering**

Course Outcomes:

By the end of this course, the student will be able to understand

CO1: Basic understanding of fuel cell fundamentals and current scenario of this technology
CO2: Gain knowledge on the electrochemical reactions of fuel cells and have insights on the various voltage losses and its impact
CO3: Understand the various ways of production and storage of fuels for fuel cells and its processing
CO4: Gain knowledge of the fuel cell process and design concepts by understanding PEMFC

Syllabus:

Overview of Fuel Cells, Classification, Basic chemistry and thermodynamics. Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels. Fuel cell electrochemistry: electrode kinetics. Fuel cell process design: PEM fuel cell components. Fuel cell operating conditions: pressure, temperature, flow rates, humidity. Components of solid-oxide fuel cells. Fuel processing: Direct and indirect internal reforming, steam reformation, CO2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, Impurity removal, renewable fuels for SOFCs

Course Coverage:

Contents	Approximate No. of Lecture Hours
Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics	06
Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.	07
Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.	05
Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates	08

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modelling	07
Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal , Using renewable fuels for SOFCs	07
Total	**40**

References:

Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, 2003.
Karl Kordesch & Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.
Barbir F, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, 2013.
Subhash C. S and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications, 2003.

Evaluation Plan:

Minor Test - 1	---	10 Marks
Mid-Semester Examination	---	30 Marks
Surprise tests	---	10 Marks
End Semester Examination	---	50 Marks
Total	---	100 Marks

Code: **: CH402**
Course: **: Process Design of Chemical Equipments**
L-T-P **: (2-0-3)4**
Credits **: 4**
Category **: PC**
Teaching department: Chemical Engineering

Course Description: Detailed Chemical Engineering Process Design of the following equipments is to be carried out. Mechanical aspects of the design are not included here. Heat Exchangers; Evaporators; Packed and Tray towers for Absorption and distillation.

Course Objective: The main objective of the course is to tech design methodology of heat and mass transfer equipments and to teach design tools like CHEMCAD.

Course Outcome: Upon completion of this course, students should:

- Understand the scientific and engineering principles in the working of heat and mass transfer equipments used in chemical process industries
- Acquire skills in the application of mathematical concepts and design methodology in designing important heat and mass transfer equipments
- Acquire skills in the application of standard simulation tools for design of heat and mass transfer equipments
- Acquire skills for interpretation and selection of appropriate design/ equipment for specific chemical engineering applications.

Syllabus

Detailed Chemical Engineering Process Design of the following equipments is to be carried out. Mechanical aspects of the design are not included here. Heat Exchangers; Packed and Tray towers for Absorption and distillation. Design of equipments mentioned above using simulation software.

Topics to be covered:

1. Design consideration for heat transfer equipment.
2. Design methodology of double pipe heat exchanger (Rating)
3. Design approach of double pipe heat exchanger in CHEMCAD
4. Design methodology of shell and tube heat exchange (Designing) (Kern’s and Bell’s Method)
5. Design approach of shell and tube heat exchanger in CHEMCAD
6. Introduction of evaporators and its type.
7. Design consideration of mass transfer equipment.
8. Properties estimation.

9. Design methodology of packed tower absorption.
10. Design approach of packed tower adsorption in CHEMCAD
11. Design methodology of tray tower adsorption.
12. Design approach of tray tower adsorption in CHEMCAD
13. Design methodology of packed distillation tower.
14. Design approach of packed tower distillation in CHEMCAD
15. Design methodology of tray distillation tower.
16. Design approach of tray tower distillation in CHEMCAD

Reference textbooks

Donald Q Kern - Process Heat Transfer, McGraw Hill Book CO, 1950.
J.M.Coulson and J.F.Richardson - Chemical Engineering, Vol.6, Design, Second Edition, Pergaman Press, 1993.
Robert H. Perry and Don Green - Chemical Engineers' Hand Book, 6th Edition, McGraw Hill Book Co.
Douglas J.M., Conceptual design of Chemical Processes McGraw Hill, New York, 1988.
W.D. Seider, J.D. Seader and R.L. Daniel, Product and Process Design Principles, Wiley, 2004

Course title	**: CRE AND PROCESS CONTROL LAB**
Course code	**: CH403**
L-T-P	**: (0-0-3)**
Credits	**: 2**
Category	**: PC**
Teaching department	**: Chemical Engineering**

Course Description: Experiments based on Reaction Engg. I & II and Process Control courses

Course Objective: The main objective of the course is to expose the student to different chemical reaction engineering experiment and process control experiment to understand the fundamentals learnt in the theory subject.

Course Outcome: Upon completion of this course, students will be able to :

- Apply the fundamental concepts of reaction engineering and process dynamics and control to conduct relevant experiments
- Gain hands on experience and visualization of the working principles of reactors measurement systems and controllers
- Plan and conduct experiments on laboratory scale systems generate, analyze and interpret the experimental data
- Acquire skills for technical report preparation with relevant conclusions
- Demonstrate skills to work in a team

Topics to be covered:

PROCESS CONTROL:

1. Time constant of a thermometer in a thermowell.
2. Time constant of a pressure vessel and mercury manometer.
3. Non-interacting tanks in series.
4. Interacting tanks in series.
5. Study of Level control System.
6. Study of Pressure control System
7. Study of Flow control System
8. Pneumatic Control Valve Characteristics.

CHEMICAL REACTION ENGG:

9. Determination of rate constant using a Batch Reactor
10. Determination of rate constant using a Continuous Stirred Tank Reactor
11. Determination of rate constant using a Tubular Reactor
12. RTD Studies in a Continuous Stirred Tank Reactor
13. RTD Studies in a Plug Flow Reactor
14. RTD studies in a Packed Bed Column

References:

Levenspiel, O. - Chemical Reaction Engineering, 3rd edition, Wiley Eastern.
Scott Fogler, H. - Elements of Chemical Reaction Engineering, 3rd edition, Prentice Hall of India.
Process Systems Analysis and Control - D.R.Coughanowr, McGraw Hill, Second Edition, 1991.
Process Dynamics and Control, D.W.Seborg, T.F. Edger, D.A.Millichamp, John Wiley & Sons, 1989.

Course Code	**: CH411**
Course title	**: Fermentation Technology**
L-T-P	**: 3-0-0**
Credits	**: 3**
Category	**: PSE**
Teaching Department	**: Chemical Engineering**

Course outcomes:

By the end of this course the student will be able to

- Apply principles of chemical engineering science to develop fermentation processes for various products.
- Understand various downstream processing techniques and the engineering principles involved for the recovery of fermentation products.
- Develop mathematical models for fermentation processes.
- Acquire knowledge of contemporary issues related to energy, environment and society in context of products obtained through biological/fermentation route.

Evaluation Plan:

- End semester Exam : 50%
- Mid semester Exam : 25%
- Insemester Evaluation: Total : 25%
  Assignments: 10
  Tests/Quzzies : 15
  Seminars: None

Syllabus

Introduction, fermentors-principles and design, Manufacture of alcohol, pencillin, vitamins and other products.

Course Coverage:

Contents	Approximate No. of Lecture Hours
Introduction to Fermentation Technology • Introduction • Range of Fermentation processes • Chronological development of Fermentation Industry	05
Microbiology • Prokaryotic cells and Eukaryotic cells	06

• Bacteria, Fungi (Yeast, Molds), Algae and Protozoa, Plant Cells, Animal cells • Microbial Growth Kinetics • Biochemicals	
Component Parts of Fermentation Process • Isolation , Screening, Preservation and Improvement of Industrially important microorganisms • Media for Industrial Fermentation • Sterilization • Development of Inoculum for Industrial Fermentation • Recovery and Purification of Fermentation Products • Effluent Treatment	15
Fermenter • Components of Fermenter • Types of Fermenters • Instrumentation and Control	10
Case Studies: Production of Alcohol, Penicillin, Vitamins and other products	10
Fermentation Economics	02
Total	48

Reference Books:

- Principles of Fermentation Technology- P. F. Stanbury, A. Whitaker and S.J. Hall
- Biochemical Engineering Fundamentals- J.E. Bailey and D. F. Ollis
- Bioprocess Engineering Principles- Pauline M. Doran
- Comprehensive Biotechnology, Volume 3- Murray Moo-Young

Course Code	**: CH412**
Course title	**: Pollution Control and Safety in Process Industries**
L-T-P	**: 3-0-0**
Credits	**: 3**
Category	**: PSE**
Teaching Department	**: Chemical Engineering**

Course outcomes:

By the end of this course the student will be able to

- Understand the fundamentals of pollution origin and its effects on human and environment
- Understand methods to monitor and control pollution (Air, Water and Noise pollution)
- Be familiar with contemporary issues on environmental pollution problems and legislations
- Learn scientific and engineering aspects of safety in industry
- Know the fundamental aspects of design of major equipments to handle Air and water pollutants and solid wastes

Evaluation Plan:

End semester Exam: 50%, Mid semester Exam: 30%, Insemester Evaluation: 20%

Syllabus

Importance of environment for human kind, flora and fauna, Types of pollution damages due to environmental pollution (industrial gas, liquid and solid effluents). Legislations to environmental pollution problems. Indian standards waste recycling. Noise pollution and its control. Waste water treatment. Air Pollution. Pollution control of effluents from different industries. Scientific and Engineering aspects of safety in industry.

Course Coverage:

Contents	**Approximate No. of Lecture Hours**
Introduction to Environmental Pollution Energy policy Demographic pattern and impact International Regulations and Indian Standards	08
Water and waste water treatment- Origin, monitoring and characterization Design principles of physical operations viz Settling/ sedimentation, Screening, Filtration	15

Biological treatment- Activated sludge, trickling filters Tertiary/ Advanced treatment	
Air pollution- Characterization Design of settling chambers, cyclone filters, ESP, Scrubbers	10
Noise control criteria Solid waste management	05
Introduction to safety in process industries	05
ISO 14000 EMS, OSHAs Environment Audit	05
Total	48

Reference Books:

- Pollution Control in Process Industries- S. P. Mahajan, Tata McGraw Hill Book CO, 1950
- Environmental Pollution Control Engineering- C.S Rao, Wiley Eastern, 1992
- Waste Water Engineering- Metcalf and Eddy
- Air Pollution Control Theory- Martin Crawford

Course Code : **CH465**
Course title : **Air Pollution Control and Design of Equipments**
(L-T-P) : **(3-0-0)**
Credits : **3**
Category : **Open Elective for B.Tech**
Teaching Department : **Chemical Engineering**

Course Outcomes:

By the end of this course, the student will be able to understand

CO1: Gain knowledge on the sources of air pollutants and their adverse effects.
CO2: Know about atmospheric interactions of air pollutant.
CO3: Apply the dispersion models to predict the fate of air pollutants.
CO4: Estimate the strength of various air pollutants in the ambient air in the air and stacks and ways of sampling and treatment equipments.
CO5: Design various methods/devices for control of particulates and gas emissions.
CO6: Propose suitable corrective measures to minimize the emissions of air pollutants.

Syllabus:

Introduction. Air pollution laws and standards. Meteorological aspects of air pollutant dispersion, the Gaussian plume model, design of stacks and chimneys. Air pollution control methods and design of equipments- control of gaseous emissions, Air pollution control in specific industries.

Course Coverage:

Contents	**Approximate No. of Lecture Hours**
Introduction. Air pollution laws and standards.	10
Meteorological aspects of air pollutant dispersion, the Gaussian plume model, design of stacks and chimneys	12
Air pollution control methods-control of gaseous emissions	10
Air pollution control in specific industries	08
Total	**40**

References:

Martin Crawford -Pollution control theory, 1976, McGraw Hill,
NY. Joe Ledbetter - Air Pollution Part A&B, 1972,
Marcel Dekker, NY. N. Cheremissinoff - Air Pollution Control, Design Hand Book, Part I and II,1977,Marcel Dekker, NY.

Evaluation Plan:

Minor Test - 1	---	10 Marks
Mid-Semester Examination	---	30 Marks
Surprise tests	---	10 Marks
End Semester Examination	---	50 Marks
Total	---	100 Marks

Course Code **: CH 448**
Course title **: Seminar**
L-T-P **: 0-0-3**
Crédits **: 2**
Category **: Mandatory Learning Course (MLC)**
Teaching Department **: Chemical Engineering**

Course outcomes:

By the end of this course, student will be able to

- By the end of this course, student will be able to acquire skills to choose a topic by understanding the contemporary issues applying reasoning and relate to professional engineering practice.
- By the end of this course, student will be able to conduct literature survey, to read scientific articles, understand and analyse the information published
- By the end of this course, student will be able to write technical reports and prepare presentation material.
- By the end of this course, student will be able to communicate effectively in oral form with technical community.

Course Plan: Each student has to choose a topic, submit a seminar report and present a seminar. Student needs to give a power point presentation. Presentation is for 25 minutes followed by 5 minutes for question /answer and discussion.

Student will be awarded **S** or **N** grade based on whether the student performance is satisfactory or not. Student performance is evaluated based on the technical content of the seminar, his/her written report presentation, slide preparation, oral presentation and ability to answer the questions during the seminar.

Course code	**: CH 449**
Course title	**: Major Project I**
L-T-P	**: 0-0-3**
Credits	**: 2**
Category	**: MP**
Evaluating department	**: Chemical Engineering**

Course Outcomes

On successful completion of the course students will be able to:

CO-1: Formulate a problem and find solution.

CO-2: Work in a team.

CO-3: Use technical knowledge gained in theory and practice to solve problems.

CO-4: Make a technical report and present it to peers and superiors.

CO-5: Be self-sufficient, as a professional engineer.

Course code	**: CH 499**
Course title	**: Major Project II**
L-T-P	**: 0-0-9**
Credits	**: 6**
Category	**: MP**
Evaluating department	**: Chemical Engineering**

Course Outcomes

On successful completion of the course students will be able to:

CO-1: Formulate a problem and find solution.

CO-2: Work in a team.

CO-3: Use technical knowledge gained in theory and practice to solve problems.

CO-4: Make a technical report and present it to peers and superiors.

CO-5: Be self-sufficient, as a professional engineer.