

Second Year B. Tech. Petrochemical Engineering (New Structure)

Semester - III

Sr. No.	Course Title	Contact Hours		Credits
		L	P	C
1	Engineering Mathematics-III	4		8
2	Numerical Methods	4		8
3	Petroleum Geology	4		8
4	Fluid & Solid-fluid Operations	4		8
5	Fluid Flow Operations	4		8
6	Process Calculations	4		8
7	Seminar Report and Presentation [Self study report on any topic of choice based on subject studied]			4
	Total	24		52

Semester - IV

Sr. No.	Course Title	Contact Hours		Credits
		L	P	C
1	Chemical Engineering Thermodynamics - I	4	-	8
2	Heat Transfer Operations	4	-	8
3	Petrochemical Engineering – I	4	-	8
4	Process Plant Utilities & Safety	4	-	8
5	*Elective – I	3	-	6
6	History of Science & Technology [Self Study course (objective : University level common examination)]	-	-	4
7	Chemical Engineering Laboratory - I [Includes experiments in Fluid Flow Operations and Fluid & Solid-Fluid Operations]	-	4	4
8	Industrial Exposure (2 weeks after 4 th semester. This course will be assessed in 5 th semester)	-	-	-
	Total	19	4	46

*Elective I (courses): a) Introduction to Non- renewable Fuel Energy Resources
b) Fuel Cell Technology

** Assessment includes term work, Laboratory report and Viva.

FOURTH SEMESTER

PCHE 401 <u>Chemical Engineering Thermodynamics - I</u>

UNIT I

INTRODUCTION : The Scope of thermodynamics; Dimensions and units; Measures of Amount or size; Force; Temperature; Pressure; Work; Energy; Heat.

THE FIRST LAW OF THERMODYNAMICS: Joule's Experiments; Internal Energy; The First Law of Thermodynamics; Energy balance for closed systems; Thermodynamic state and state functions; Equilibrium; The phase rule; The reversible process; Constant V and constant P processes; Enthalpy; Heat capacity; Mass and energy balances for open systems.

UNIT II

VOLUMETRIC PROPERTIES OF PURE FLUIDS : PVT Behaviour of pure substances; the Virial Equation; The Ideal Gas; Application of the Virial Equation; Cubic Equations of State; Generalised Correlation's for gases; Generalised correlation's for Liquids

Unit III

HEAT EFFECTS: Sensible Heat Effects, Heat Effects Accompanying Phase Changes of Pure Substances, The Standard Heat of Reaction, The Standard Heat of Formation, The Standard Heat of Combustion, Effect of Temperature on the standard Heat of Reaction.

UNIT IV

THE SECOND LAW OF THERMODYNAMICS : Statement of the Second law : The Heat Engine; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the Second Law; Entropy balance for open systems; Calculation of ideal work; Lost work; The Third Law of Thermodynamics; Entropy from the Microscopic view point.

UNIT V

THERMODYNAMIC PROPERTIES OF FLUIDS: Property Relations for Homogeneous phase; Residual Properties; Residual properties by equations of state; Two phase systems, Thermodynamic diagrams; Tables of Thermodynamic properties; Generalised property correlations for gases.

APPLICATIONS OF THERMODYNAMICS TO FLOW PROCESSES: Duct flow of compressible fluids; Turbines (expanders); Compression processes.

UNIT VI

REFRIGERATION AND LIQUEFACTION : The Carnot Refrigerator; the vapour-compression cycle; The Choice of refrigerant; Absorption Refrigeration; The heat pump; Liquefaction Processes.

TEXT BOOK :

1. Smith J.M, Van Ness H.C and Abbott M.M. - Introduction to Chemical Engineering Thermodynamics - 6th Edition, Mc Graw Hill International (2001).

REFERENCE BOOK :

1. Rao, Y.V.C. - Chemical Engineering Thermodynamics - Universities Press (India) Ltd., 1997.
2. Narayanan, K.V. - Chemical Engineering Thermodynamics - Prentice Hall of India Pvt. Ltd. - 2001
3. Hougen O.A, Watson. K.M and Ragatz R.A - Chemical Process Principles (Part - II) - 2nd edn., Asia Publishing House.

PCHE 402 <u>Heat Transfer Operations</u>

UNIT I

Conduction through a single homogeneous solid, thermal conductivity of solids, liquids and gases. Conduction through several bodies in series. Contact resistances.

Unsteady state heat conduction, lumped heat capacity system, transient heat flow in a semi-infinite solid.

UNIT II

Heat transfer by Convection: Forced convection, Laminar heat transfer on a flat plate Laminar and turbulent flow heat transfer inside and outside tubes. Film and overall heat transfer coefficients. Resistance concept, Coefficients for scale deposits, L.M.T.D. in heat exchangers with co and counter current flow. Heat exchanger design, Effectiveness – N T U method in finned tube heat exchangers.

UNIT III

Natural convection: Heat transfer from plates and cylinders in verticals and horizontal configuration, natural convection to spheres.

Heat transfer with phase change, i. e. heat transfer in Boiling and condensation, Single and multiple effect evaporators.

UNIT IV

Heat Transfer by Radiation: Black and gray body radiations, view factor, luminous and non-luminous gases. Combined heat transfer, i.e. conduction, convection and radiation together.

Concept of critical insulation thickness.

UNIT V

Combined natural and forced convection: Fluid flow and heat transfer across cylinders and spheres. Combined natural and forced convection heat transfer in horizontal circular conduits. Heat transfer in extended surfaces such as fins, conduction convection heat transfer, forced convection heat transfer in circular conduits with longitudinal fins. Heat transfer in non Newtonian fluids.

UNIT VI

Heat exchanger design: Design of single and multi pass shell and tube type exchangers using LMTD and effectiveness – NTU methods. Spiral coil and plate type heat exchangers. Single and multi phase condenser. Design of Reboilers vapourisers. Kettle type and Thermosiphon reboilers, forced circulation vaporizers. Heat transfer in agitated vessels both, jacketed and with coil, Determination of overall heat transfer coefficient, transient heating or cooling, Heat transfer in packed and fluidized beds.

Texts / References:

J. M. Coulson and J. F. Richardson, “Chemical Engineering”, Vol. 1 ELBS, Pergamon press, 1970

J. M. Coulson and J. F. Richardson, “Chemical Engineering” Vol. 2 ELBS, Pergamon press, 1970

W. L. McCabe J. C. Smith and P. Harriot, “Unit Operations of Chemical Engineering”, 4th ed. McGraw Hill 1985.

D. Q. Kern, “Process Heat Transfer”, McGraw Hill, 1950.

PCHE 403 <u>Petrochemical Engineering - I</u>
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UNIT I

Brief review of Petroleum, its formation and composition of crude oil.

UNIT II

Characterization of crude oil, pretreatment of crude, removal of moisture, salts etc., General refinery set – up and function of various units, refinery flow diagram, equipment and tank yard layout.

UNIT III

Types of refineries such as simple intermediate and complex, preflashing distillation principles, atmospheric distillation, column types, vaccum distillation, pressure distillation.

UNIT IV

Major petroleum products and their specifications like LPG, Gasoline, Industrial solvents, naphtha, Kerosene, aviation turbine fuel (ATF), high speed diesel (HSD), LDO, furnace fuel, lubricants, base oil, tar and bitumen.

UNIT V

Blending of various petroleum fractions to meet require specification, molecular rebuilding processes, eg. Gas to liquid processes. Methane, natural gas, CNG, rebuilding of hydrocarbons.

UNIT VI

Statistical information on Indian petroleum and petrochemical industry, future trends and developments.

References :

Hobson G.D., 'Modern Petroleum Technology, Volume – II' John Wiley & Sons 1986

Speight J.H., 'The Chemistry and Technology of Petroleum Hydrocarbons' Mercel Dekker, Inc, 1982

Sarkar G.N., 'Advanced Petroleum Refining' Khanna Publishers, New Delhi,2006

<u>PCHE 404 Process Plant Utilities and Safety</u>
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Utilities

UNIT I

Identification of common plant utilities: water, compressed air, steam, vacuum, refrigeration, venting, flaring and pollution abating. Water and its quality, storage and distribution for cooling and fire fighting.

UNIT II

Steam generation by boilers: Types of boilers and their operation, Steam generation by utilizing process waste heat using thermic fluids, Distribution of steam in a plant.

UNIT III

Principles of refrigeration: Creation of low temperature using various refrigerants.
Creation of low pressure/vacuum by pumps and ejectors.

Safety

UNIT IV

Safety in Chemical Processes: Introduction, Chemical Process classification, Process design and safety parameters. Safety parameters in the process design of phenol from cumene, safety in polyvinyl chloride plant.

Chemicals and their Hazards: Introduction, Acetonitrile, acetyl chloride, butyl amine, acrylamide, acrylonitrile, allyl alcohol, benzene, bromine, isopropyl alcohol, acetaldehyde, ethylene oxide, butane, n-hexane, anhydrous ammonia, acetone, toluene, p-xylene, acetic acid, monochloro benzene, oleum, carbon monoxide.

UNIT V

Hazards in Chemical Process plants: Introduction, Hazards, Hazard code and explosive limit, electrical safety in chemical process plants, static electricity hazards, pressure vessel hazards, LEL and UEL of various compounds, explosive hazard, flammable liquid hazards, protection to storage tanks, fire zone location, fireball, fireball hazard.

Safety in handling gases, liquids and solids: Introduction, safety in handling of gases, chlorine hazards, chlorine leakage management, safety in handling of fluorine, important safety considerations in ammonia storage, flammable solids storage, flammable liquid storage, handling of LNG, requirements to be fulfilled for storing hydrocarbons or chemicals, fail safe concept, transportation of hazardous chemicals, Hazardous in plastics processing.

UNIT VI

Combating Chemical Fires: Classification of fires, control of high vaour pressure fire, fire fighting foams, foam for fire protection, Foam characteristics, gaseous agent extinguishing system, automatic sprinkler system, chemical extinguishing powders, natural gas fire control.

Portable fire extinguishers: Soda-acid extinguishers, carbon dioxide extinguisher, dry chemical fire extinguisher, general safety precautions for maintenance of fire extinguishers.

Safety Checklist: safety studies for chemical plants, safety checklist during startup, safety checklist during shutdown mode, safety checklist for installation, safety needs during construction. Protective devices.

Text / Reference:

1. D. A. Wingham, Theory and practice of Heat engines, ELBS cambridge University press, 1970.
2. J. L. Threlkeld, Thermal Environmental Engineering, Prentic Hall 1970.
3. S.D.Dawande, Chemical Hazards and safety, Dennet & Co publishers, 2007

a) Introduction to Non-renewable Fuel Energy Resources

UNIT I

Petroleum : Brief review of Petroleum, its formation and composition of crude oil.
Prospecting ,Exploration and production of crude oil.

UNIT II

General refinery set – up and function of various units, refinery flow diagram, equipment and tank yard layout.

UNIT III

Major petroleum products and their specifications. Economic,health and environmental issues related to petroleum refining.

Indian petroleum and petrochemical industry , present status and future challenges

UNIT IV

Natural Gas: Definition, composition of natural gas, impurities present in natural gas

Natural gas treatment, Natural gas hydrates

Storage, handling and transportation of natural gas, Natural Gas liquids

UNIT V

Coal: Definition, origin, classification of coal ,coal distribution and resources, coal reserves in world, Indian scenario

Past present and future role of coal

UNIT VI

Technologies for coal utilization

Effect of coal usage on human health and environment

Text /Reference Books :

Bhaskara Rao B.K., ‘ Modern Petroleum Refining Processes’ Oxford & IBH Publications, 2003

Miller B.G., ‘Coal Energy Systems’ Elsevier, Academic Press, 2005

b) Fuel Cell Technology

UNIT I

Introduction and overview of fuel cells technology: low and high temperature fuel cells.

UNIT II

Fuel cell thermodynamics

Fuel cell reaction kinetics: Introduction to electrode kinetics.

UNIT III

Exchange current and electrocatalysis, Simplified activation kinetics, Catalyst-electrode design.

Fuel cell charge and mass transport.

UNIT IV

Fuel cell characterization

UNIT V

Fuel cell modeling and system integration: Balance of plant

UNIT VI

Hydrogen production and storage.

Safety issues and cost expectation and life cycle analysis of fuel cells.

Text/Referance

Apple B.Y., 'Fuel Cell Handbook' Van Nostrand,1989

Viswanathan B.A., ' Fuel Cell: Principles and Practice' University Press,2006

<u>PCHE 406 History of Science & Technology</u>
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[Self Study course (objective: University level common exam)]

UNIT I

Historical Perspective :

The Nature of Science and Technology , Roots of Science and Technology in India , Science and Society , Scientists and Society , Science and Faith and The Rise of Applied Sciences.

UNIT II

Polices and Plans After Independence :

Nehru's vision of Science for Independent India, Science and Technology Developments in the New Era Science and Technology Developments during the Five Year Plan Periods and Science and Technology Policy Resolutions.

UNIT III

Research and Development (R&D) in India :

Expenditure in R&D, Science and Technology Education, Research Activities and Promotion of Technology Development, Technology Mission, Programms Aimed at Technological self Reliance, Activities of Council of Scientific and Industrial Research (CSIR).

UNIT IV

Science and Technological Developments in Major Areas :

Space – Objectives of Space Programms, Geostationary Satellite Services – INSAT System and INSAT Services Remote Sensing Applications, Launch Vehicle Technology

Ocean Development – Objectives of Ocean Development, Biological and Mineral Resources, Marine Research and Capacity Building;

UNIT V

Defense Research --- Spin –off Technologies for Civilian Use;

Biotechnology--Applications of Biotechnology in – Medicine, Biocatalysts, Agriculture, Food, Fuel and Fodder, Development of Biosensors and Animal Husbandry;

Energy – Research and Development in Conservation of Energy, India's Nuclear Energy Programme –Technology Spin –offs.

UNIT VI

Nexus Between Technology Transfer and Development :

Transfer of Technology—Types, Methods, Mechanisms, Process, Channels and Techniques: Appropriate Technology, Technology Assessment, Technological Forecasting, Technological Innovations and Barriers of Technological Change.

Test Books :

1. Kalpana Rajaram , **Science and Technology in India**, Published and Distributed by Spectrum Books (P) Ltd., New Delhi-58.
2. Srinivasan, M., **Management of Science and Technology (Problems & Prospects)**, East – West Press (P) Ltd., New Delhi.

Reference Books :

1. Ramasamy , K. A. and Seshagiri Rao, K.,(Eds.) **Science, Technology and Education for Development**, K., Nayudamma Memorial Science Foundation, Chennai-8.
2. Kohili, G. R., **The Role and impact of Science and Technology in The development of India**, Surjeet Publications.
3. Government of India, **Five Year Plans**, Planning Commission, New Delhi. Sharma, K. D. and Quresh M. A., **Science, Technology and Development**, Sterling Publications (p) Ltd. New Delhi.

LIST OF PRACTICALS:

A. Fluid Flow Operations

1. Determination of flow regimes -Reynolds' apparatus
2. Verification of Bernoulli's equation
3. Determination of Fanning friction factor for smooth and rough pipes
4. Determination of equivalent length of pipe fittings
5. Determination of viscosity with capillary tube viscometer.
6. Determination of friction factor for flow through packed bed.
7. Study of venturi meter
8. Study of orifice meter
9. Study of characteristics of centrifugal pump
10. Study of Rota meter

B. Fluid & Solid-Fluid Operations

1. Determination of screen effectiveness
2. Dry screen analysis
3. Wet screen analysis
4. Study of sedimentation
5. Study of air elutriation
6. Study of cyclone separator
7. Study of froth flotation
8. To determine thermal conductivity of given metal rod

PCHE 408 Industrial Exposure

Industrial Exposure

This is an audit course. Students who would like to spend their part of the vacation in industry will have to request the Training Co-ordinator of the Department for providing request letters to the industries. With the request letters, the students will approach the industry of their interest for getting necessary permission to have Industrial Exposure for a period of four weeks. On completion of exposure the concerned student will prepare a report and submit the same to the Training Co-ordinator of the department. The student earns Audit for this Exposure course and the same will be indicated in his/her 5th semester grade report.