

Name of Course: B. Tech. (Chemical Engineering)

Dr. APJ AKTU

Study and Evaluation Scheme

[Effective from the Session 2016 - 17]

B. Tech. (Chemical Engineering)

Year 4th, Semester - VII

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
THEORY SUBJECTS											
1	NOE-071- NOE-074	Open Elective from other Department	2	0	0	15	10	25	50	75	2
2	NCH-016- NCH-018	Open Elective from Home Department	3	1	0	30	20	50	100	150	4
3	NCH-701	Process Equipment Design	3	1	0	30	20	50	100	150	4
4	NCH-702	Energy Technology	3	1	0	30	20	50	100	150	4
5	NCH-021 - NCH-023	Departmental Elective -II	3	1	0	30	20	50	100	150	4
PRACTICAL/DESIGN/DRAWING											
6	NCH-751	Energy Lab	0	0	2	10	10	20	30	50	1
7	NCH-752	INDUSTRIAL TRAINING	0	0	3		75	75		75	2
8	**NCH-753	PROJECT**	0	0	8		50	50	100	150	4
	NGP-701	GP						50		50	
		TOTAL	14	4	13					1000	25

B. Tech. (Chemical Engg.)

Year 4th, Semester - VIII

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
THEORY SUBJECTS											
1	NOE-081- NOE-084	Open Elective from other Department	3	1	0	30	20	50	100	150	4
2	NCH-801	Process Utility & Safety in Chemical Plants	3	1	0	30	20	50	100	150	4
3	NCH-802	Plant Design & Project Engineering	3	1	0	30	20	50	100	150	4
4	NCH-031/ NCH-033	Departmental Elective - III	3	1	0	30	20	50	100	150	4
PRACTICAL/DESIGN/DRAWING											
5	NCH-851	SEMINAR	0	0	3		100	100		100	2
6	NCH-852	PROJECT	0	0	12		100	100	150	250	7
7	NGP-801	GP						50		50	
		TOTAL	12	4	15					1000	25

** ESE for VIIth Semester project (NCH-753) will be conducted by Inter departmental Faculty of the same institute.

Open Elective [at Sl. No. 2] in the 7th semester from Home Department:-

1. **NCH-016** Petrochemical Technology
2. **NCH-017** Bioprocess Engineering Principles
3. **NCH-018** Industrial Safety & Hazard Management

Departmental Elective-II [at Sl. No. 5] in the 7th semester:-

1. **NCH-021** Fertilizer Technology
2. **NCH-022** Material Technology
3. **NCH-023** Industrial Pollution Abatement & Waste Management

Departmental Elective-III [at Sl. No. 4] in the 8th semester:-

1. **NCH-031** Petroleum Engineering
2. **NCH-032** Optimization Techniques in Chemical Engineering
3. **NCH-033** Advance Separation Technology

NCH-016 PETROCHEMICAL TECHNOLOGY (3:1:0)

Unit 1

Production and consumption pattern of petrochemicals in India, Feedstocks for petrochemicals-Natural gas, LPG, Refinery off-gases, Hydroforming of petroleum stocks, Naphtha and fuel oils, Petroleum coke

Unit 2

Steam reforming and partial oxidation processes for syngas, Manufacture of Methanol, Formaldehyde, Chloromethanes, Trichloroethylene, Perchloroethylene, Acetic acid, adipic acid

Unit 3

Ethylene and acetylene via steam cracking of hydrocarbons, Manufacture of Ethylene dichloride, Vinyl chloride, Ethylene oxide, Ethanolamines, Acetaldehyde, Vinyl acetate, Ethyl acetate, Ethylene glycol

Unit 4

Manufacture of Isopropanol, Acetone, Methyl ethyl ketone, Methyl isobutyl ketone, Cumene, Acrylonitrile, Propylene oxide, Butadiene, Oxo process

Unit 5

Manufacture of Benzene, Toluene, Xylenes, Phenol, Styrene, Phthalic anhydride, Maleic anhydride, Nitrobenzene, Aniline, Bisphenol-A, Caprolactum

Books Recommended:

1. Mall, I D, Petrochemical Process Technology, McMillan India
2. Rao Bhaskar, Modern Petroleum Refining Processes, Oxford & IBH Publishing
3. Speight J., Chemistry & Technology
4. Robert Mayer, Handbook of Petroleum Refining Processing, McGraw Hill

NCH-017: BIOPROCESS ENGINEERING PRINCIPLES (3:1:0)

Unit 1

Introduction, engineering calculations, presentation and analysis of data, material balance, energy balance.

Unit 2

Fluids in motion, viscosity, rheological properties of fermentation broth, mixing equipment, scale-up for mixing systems, heat transfer equipments in bioprocess, heat transfer coefficients for stirred vessel, cooling-coil length in fermenter design, molecular diffusion, O₂ uptake in cell cultures, oxygen transfer in fermenters, measurement of dissolved oxygen concentrations.

Unit 3

Filtration, Centrifugation, Cell disruption, Adsorption, Application of Chromatography in bioprocess.

Unit 4

Basic reaction theory, reaction kinetics for biological systems, zero-order, first order and M-M kinetics, cell growth kinetics, kinetics of cell death, concentration gradients and reaction rates in solid catalysts, reaction rates for free and immobilized enzyme, internal O₂ transfer to immobilized cells.

Unit 5

Bioreactor configurations, practical considerations for bioreactor construction, monitoring and control of bioreactors, operations in bioreactor (Enzyme reaction and cell culture).

Text Books

1. Doran P. M., "Bioprocess Engineering Principles" 2nd Ed., Elsevier (2013)

NCH-018: INDUSTRIAL SAFETY & HAZARD MANAGEMENT**(3:1:0)****Unit 1**

Industrial safety, Industrial hygiene and safety aspects related to toxicity, noise, pressure, temperature, vibrations, radiation etc. Explosions including dust, vapor, cloud and mist explosion.

Unit 2

Elements of safety, safety aspects related to site, plant layout, process development and design stages, identification of hazards and its estimation, risk, risk analysis and assessment methods; fault free method, event free method, scope of risk assessment, controlling toxic chemicals and flammable materials.

Unit 3

Toxic substances and degree of toxicity, its estimation, their entry routes into human system, their doses and responses, control techniques for toxic substances exposure, use of respirators, ventilation systems.

Unit 4

Prevention of losses, pressure relief, provision for firefighting, release of hazardous materials from tanks, pipes through holes and cracks, relief systems: types and location of reliefs.

Unit 5

Handling, transportation and storage of flammable liquids, gases, and toxic materials and wastes, regulation and legislation, government role, risk management routines, emergency preparedness, disaster planning and management.

Books

1. Sanders R.E. "Chemical Process Safety" 3rd Ed., Elsevier, 2007.
2. D. A. Crowl and J.F. Louvar-Chemical Process Safety (Fundamentals with Applications), Prentice Hall (1990)
3. H.H. Fawcett and W.S. Wood – Safety and Accident prevention in Chemical Operations, 2nd Edition, John Wiley & Sons, New York, 1982.
4. Coulson & Richardson's Chemical Engineering-Vol.6, R.K. Sinnott, Butterworth-Heinmann Ltd., 1996.
5. Sanjoy Banerjee, Industrial Hazards & Plant Safety, Taylor & Francis Group

NCH-701: PROCESS EQUIPMENT DESIGN**(3:1:0)****Unit 1**

Mechanical properties of materials used in material of construction, different metallic and non-metallic materials used as material of construction in chemical process industries, corrosion and its control, Application and use of various codes and standards in design like IS, ASME, BIS and TEMA.

Unit 2

Thin and thick walled pressure vessels, design of thin walled pressure vessels under internal pressure, design of flanged and dished heads like torispherical, ellipsoidal, hemispherical and conical for vessels under internal pressure, design of different class of storage vessels.

Unit 3

Design of pressure vessels operating under external pressure, design of stiffening rings for vessels under external pressure, stresses acting on tall vertical vessels, design of different sections of shell for tall vertical vessel, design of supports for tall vertical vessels.

Unit 4

Pipe stress analysis, process design of few equipments like Shell and Tube Heat Exchanger, Plate Heat Exchanger, single and multi-effect Evaporator, Distillation column, Absorber, Reactor and Dryer.

Unit 5

Design of nozzles, openings and reinforcements, design of bolted flanges and gaskets, design of heat exchanger tube sheet and expansion joint, design of steam trap, design of expansion loop in piping system, design of bubble cap tray.

Text Books:

1. Peters, M. S. and Timmerhaus K. D., "Plant Design & Economics for Chemical Engineers", McGraw Hill.
2. Coulson, J. M. and Richardson J. F. "Chemical Engineering", Volume VI Pergamon Press.
3. Brownell and Young, "Process Equipment Design", Wiley India.
4. Kern, D. Q., "Process Heat Transfer", McGraw Hill.
5. Perry, J. H., Chemical Engineers Handbook, McGraw Hill.
6. Evans, F. L., "Equipment Design Handbook", Gulf Publishing Company.
7. Joshi, M. V., "Process Equipment Design", Macmillan India Ltd.
8. Bhattacharya, B. C., "Introduction to Chemical Equipment Design", CBS Publishers.

Reference:

9. IS 2825 (for pressure vessel design).

NCH-702: ENERGY TECHNOLOGY (3:1:0)**Unit 1 :Solid fuels**

Coal origin, Chemical composition, Calorific value, Classifications, Characteristics and Distribution of Indian coals, Storage and spontaneous combustion of coal, Coal washing and blending, Petrographic constituents of coal, Carbonization of coal, Manufacture and properties of metallurgical coke, Recovery of byproducts.

Unit 2 :Liquid fuels

Origin and composition of crude oil, Crude oil distillation and its products with special reference to gasoline, kerosene and diesel oil, Cracking and reforming, Coal tar distillation products, Shale oil; Testing of oils, viscosity, flash point, pour point, aniline point, carbon residue, Diesel index, octane and cetane number, moisture content.

Unit 3 : Gaseous fuels

Natural gas, Coal gas, Coke oven and blast furnace gas, Manufacture of water gas and producer gas, Carbureted water gas; Synthetic fuels: Hydrogenation of coal, Fischer – Tropsch synthesis; Introduction to nuclear fuels and nuclear reactors, fuels, Moderators and structural materials, Combustion: Combustion of solid fuels, Pulverized coal, Calculation of volumes and weights of air necessary for combustion of fuels, Gas analysis.

Unit 4 : Overview of Renewable Energy

Prospects of Renewable energy sources; Solar energy fundamentals and application; Introduction and Utilization of Geothermal energy, Fundamentals and application of Wind energy : Biomass Energy Resources and its Conversion Process. Introduction of Ocean Energy conversion Technologies, tidal power plant and Hydro Energy.

Unit 5: Energy Conservation

Total energy concept, waste heat recovery & utilization, hybrid and integrated energy systems, carbon credits, energy policy related acts & regulations, clean development mechanism.

Books:

1. S. Rao and Dr. B.B. Parulekar, Energy Technology, Non conventional, Renewable and Conventional, Khanna Publishers.
2. G. D. Rai, Non-conventional Energy Sources, Khanna Publishers.
3. S. Sarkar, Fuels and Combustion. Sangam books Ltd (Imported)
4. Himus, Elements of Fuel technology.
5. J. Brame and King, Fuels: Solid, liquid and gaseous fuels, Kessinger Publishing, LLC, 2007.
6. O. P. Gupta, Elements of Fuels, Furnaces and Refractories.

NCH-021: FERTILIZER TECHNOLOGY (3:1:0)**Unit 1**

Introduction of Indian fertilizer industries, types of fertilizers process details.

Unit 2

Manufacture of Nitrogeous, Phosphatic, potassic, complex, NPK, mixed, Dio and other fertilizers.

Unit 3

Discussion of existing Indian plants pollution and its control, abatement and disposal of waste of fertilizer units.

Unit 4

Retrofits and modernization, computer control and Instrumentation, Energy conservation and diversification.

Unit 5

Design of Ammonia converters and other reactors, cooling water, expansion, capacity utilization and other problem of fertilizers industry.

Books:

1. Mortvedt J. J., Murphy L. S. & Follett R. H., Fertilizer Technology & Application, Meister Publishing Company
2. Shreves Chemical Process Industries, McGraw Hill
3. Drydens Outlines of Chemical Technology, East West Press

NCH-022: MATERIAL TECHNOLOGY

(3:1:0)

Unit 1

Introduction: Introduction to material science, Classification of engineering materials, Levels of Structure, Structure-Property relationship in materials.

Crystal Geometry and Structure Determination: Geometry of crystals- the Bravais lattices, Crystal directions and Planes- Miller indices, Structure determination by X-ray diffraction - Braggs Law and the powder method, by Electron microscopy (TEM & SEM).

Unit 2

Atomic Structure, Chemical Bonding and Structure of Solids: Structure of atom, Periodic table,

Crystal Imperfections: Point Imperfections, Line imperfections- edge and screw dislocations, Surface imperfections.

Unit 3

Phase Diagram And Phase Transformations: Phase rule, Single component systems, Binary Phase Diagrams, Lever rule, Typical Phase diagrams for Magnesia-Alumina, Copper-Zinc, Iron-carbon system, Nucleation and growth, Solidification, Allotropic transformation, Cooling curves for pure iron, Iron-carbon equilibrium diagram, Isothermal transformations (TTT curves).

Deformation Of Materials- Fracture: Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture.

Unit 4

Heat Treatment: Annealing, Normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening.

Corrosion and Prevention: Direct Corrosion, electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, factor influencing corrosion rate, Control and of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, protective coatings. Corrosion charts.

Unit 5

Typical Engineering Materials: Ferrous metals, Nonferrous metals and alloys- Aluminum and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high temperature service, Ceramic materials- Structure of ceramic, Polymorphism, mechanical, electrical and thermal properties of ceramic phase. Smart materials, biomaterials, nanomaterials.

Books:

1. "Material Science and Processes" Hajra Choudhary S. K., Indian Book Distributing Co., 1982.
2. "Material Science and Engineering- A First Course", Raghavan V., 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 1996.
3. William D Callister, Material Science
4. "Elements of Materials Science", Van Vlack, H.L., 2nd Edition, Addison-Wesley Publishing Company, NY, 1964.

NCH-023: INDUSTRIAL POLLUTION ABATEMENT & WASTE MANAGEMENT

(3:1:0)

Unit 1

Introduction: Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental Laws and rules, standards for ambient air, noise emission and effluents.

Unit 2

Pollution Prevention: Process modification, alternative raw material, recovery of by co-product from industrial emission effluents, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization. Water use minimization, Fugitive emission/effluents and leakages and their control-housekeeping and maintenance.

Unit 3

Air Pollution Control: Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by adsorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers.

Water Pollution Control: Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation.

Unit 4

Chemical Treatment: Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying.

Unit 5

Waste management: Characterization of wastes-hazardous and non-hazardous wastes. Waste disposal and management laws and guidelines. Non-hazardous industrial wastes-treatment, disposal, utilization and management. Value-extraction from the wastes. Handling, storage and disposal of hazardous wastes. Case studies of a few real scenarios of waste management – sugar, pulp and paper, and fertilizer units

Books:

1. Pollution Control Acts, Rules and Notifications, CPCB, Delhi. 1995
2. Vallero D., "Fundamentals of Air Pollution", 4th Ed., Academic Press, 2007
3. Eckenfelder W. W., "Industrial Water Pollution Control", 2nd Ed., Mc Graw Hill, 1999
4. Kreith F. and Tchobanoglous G., "Handbook of Solid Waste Management", 2nd Ed., Mc Graw Hill, 2002
5. Pichtel J., "Waste Management Practices: Municipal, Hazardous and Industrial", CRC, 2005
6. Conway R.A. & Ross R.D., "Handbook of Industrial Waste Disposal", Van-Nostrand Reinhold, 1980
7. Tchobanoglous G., Theisen H. & Vigil S.A., "Integrated Solid Waste Management : Engineering Principles and Management Issues", McGraw Hill, 1993

NCH-751: ENERGY LAB

(0:0:2)

1. Determination of composting of the supplied sample of Coal by Proximate Analysis.
2. To find the effect of temperature on viscosity of the supplied samples of *liquid fuel using Red wood Viscometer/ lubricating oil using Engler's viscometer.*
3. To find the Flash and Fire point of the supplied samples of liquid fuel using (i) Penslery Martein closed cup apparatus (ii) Abel open cup apparatus.
4. To find the Aniline point of the supplied samples of liquid fuels using Aniline point apparatus and hence find out the Diesel Index Number of the Diesel oil.
5. To find the moisture content of the supplied samples of liquid fuel / Crude oil using Dean and Stark apparatus.
6. To find the Pour point and Solidification point of the supplied samples of liquid fuels.
7. To determine the Gross calorific value of the supplied sample of coal using Bomb Calorimeter (on ash free basis).
8. To determine the Smoke Point of kerosene oil using Smoke Point Apparatus.

NCH-752: INDUSTRIAL TRAINING**(0:0:2)**

The students must submit the report to their institute complete 4 week Industrial Training after the completion of their 6th semester. Students may opt this course at any Industry/Research Lab for 4 weeks.

NCH-753: PROJECT (0:0:8)

The students would be allotted an Industrial Project or any Research Project in the beginning of the VII semester itself. He/She may continue this project in detail, later in the (8th) semester. The assessment of ESE will be done by the faculty member of the other department within the same institute.

NCH-801 PROCESS UTILITY & SAFETY IN CHEMICAL PLANTS (3:1:0)**Unit 1**

Various process utilities, their role and importance in chemical plants. Water Sources of water and their characteristics ;Treatment storage and distribution of water; water for use in boilers, cooling purposes, drinking and process; Reuse and conservation of water; Water resource management.

Unit 2***Steam Generation and Utilization***

Steam generation and its application in chemical process plants, distribution and utilization; Design of efficient steam heating systems; steam economy, Steam condensers and condensate utilization Expansion joints ,flash tank design, steam traps their characteristics, selection and application, waste heat utilisation.; Lagging, selection and thickness .Selection and sizing of boilers; waste heat boilers.

Unit 3***Compressors, blowers and Vacuum Pumps***

Compressors, blowers and vacuum pumps and their performance characteristics; Methods of developing vacuum and their limitations, material handling under vacuum, Piping systems; Lubrication and oil removal in compressors and pumps. Air filters, Air and gas leakage. Inert gas systems , compressed air for process, Instrument air.

Insulation

Importance of insulation for meeting the process requirement, insulation materials and their effect on various material of equipment piping, fitting and valves etc. insulation for high intermediate, low and sub zero temperatures, including cryogenic insulation.

Unit 4***Elements of Safety***

Elements of safety, safety and site selection; Plant layout and unit plot planning; Definition of risk and hazard, Identification and assessment of the hazards, distinction between hazards and risk, Industrial hygiene, toxicological studies, Hazard operability (HAZOP) hazard analysis (HAZAN); Assessment of the risk, fault tree, event tree, scope of risk assessment; Control of hazards, controlling toxic chemicals and controlling flammable materials. Prevention of losses Prevention of losses, Pressure relief, fire & explosions, Provision of fire fighting equipments, Technology selection and transfer, choosing the right process.

Unit 5***Control of Process***

Control of process, Prevention of hazardous deviation in process variables, e.g. pressure, temperature flow by provision of automatic control systems- interlocks, alarms, trips together with good operating practices and management. Accidental analysis, Regulations and legislation, Role of government role, risk management routines and tackling disaster, case studies.

Text Books:

1. Nordell, Eskel, "Water Treatment for Industrial and Other Uses", Reinhold Publishing Corporation, New York.(1961).
2. Crowl, D.A. & Louvar, J.F.. "Chemical Process Safety: Fundamentals with Applications". New Jersey: Prentice-Hall. (1989).
3. Goodall, P. M., "The Efficient Use Of Steam" IPC Science and Technology (1980).

Reference Books:

1. Lees, F. P., "Loss Prevention in Process Industries 3 volume set" Butterworth-Heinemann, Oxford (1996).

NCH-802: PLANT DESIGN & PROJECT ENGINEERING**(3:1:0)****Unit 1**

Project identification, preliminary techno-economic feasibility, laboratory development and research, pilot plant level studies, scale-up methods. Process selection, alternative processes. Flow sheet preparation, different components of PFD, equipment numbering, stream designation, battery limit and off sites

Unit 2

Selection of process equipments, standard versus special equipments, selection Criteria, specification sheet of equipment, Process auxiliaries - piping design, layout, process control and instrumentation, Process utilities- process water, boiler-feed water, waste treatment & disposal, oil heating system, chilling plant., compressed air, instrumentation air.

Unit 3

Interest-types & calculations, Cost estimation-factors involved in project cost estimation, total capital investment, fixed capital and working capital, process equipment cost estimation. Cost index and scaling for equipment cost. Estimation of total product cost-factors involved

Unit 4

Depreciation-types & methods of determination, Profitability – criteria of profitability, payout period, return on investment, present value, cash flow analysis, alternative investment and replacement methods, factors in alternative & replacement investment, project profitability analysis

Unit 5

Project management, scheduling a project using CPM/PERT, Inventory control methods, Optimum conditions- production schedule, optimum production rates in plant operations, optimum conditions in batch and cyclic operations, Design reports, Plant location and layout principles- factors involved, case studies for specific plants

Text Books:

- (1) Peters, M. S. and Timmerhaus, K. D., "Plant Design & Economics for Chemical Engineers", McGraw Hill
- (2) Vilbrandt and Dryden, "Chemical Engineering Plant Design", McGraw Hill
- (3) Ulrich, G. D., "A Guide to Chemical Engineering Process Design & Economics", John Wiley and Sons

NCH-031: PETROLEUM ENGINEERING**(3:1:0)****Unit 1**

Petroleum Exploration Production and Refining of Crude oils Crude oils: Chemistry and composition (Characteristics and constituents of crude oils, Classification of crude oils).

Unit 2

Quality Control of Petroleum Products Classification of laboratory tests, distillation, vapour pressure, flash and fire points, octane number, performance number, cetane number, aniline point, viscosity index, calorific value, smoke point, char value, viscosity, viscosity index, penetration tests, cloud and pour points, drop point of grease, melting and settling points of wax, softening point of Bitumen, induction period of gasoline, thermal stability of jet fuels, gum content, Total Sulphur, Acidity and Alkalinity., Copper Strip Corrosion Test, Silver – Strip Corrosion Test for ATF, Ash, Carbon Residue (Conradson method, Ramsbottom method) Colour, Density and Specific gravity, Refractive index of hydrocarbon liquids, water separation index (modified) (WSIM), ductility.

Unit 3

Petroleum Products Composition, Properties & Specification of LPG, Naphthas, motor spirit, Kerosine, Aviation Turbine Fuels, Diesel Fuels, Fuel Oils, Petroleum Hydrocarbon Solvents, Lubricating oils (automotive engine oils, industrial lubricating oils electrical insulating oils, Jute Batching oils, white oils, steam turbine oils, metal working oils, etc.) Petroleum Waxes Bitumens, Petroleum coke. Crude Oil Distillation Desalting of crude oils, Atmospheric distillation of crude oil, Vacuum distillation of atmospheric residue. Thermal Conversion Process

Thermal Cracking Reactions, Thermal Cracking, Visbreaking, (Conventional Visbreaking and Soaker Visbreaking) Coking (Delayed Coking, Fluid Coking, Flexicoking), Calcination of Green Coke.

Unit 4

Catalytic Conversion Process Fluid catalytic cracking; Catalytic reforming; Hydrocracking Catalytic Alkylation, Catalytic Isomerization; Catalytic Polymerization. Finishing Process Hydrogen sulphide removal processes; Sulphur conversion processes; Sweetening processes (Caustic treatment, Solutizer process; Doctor treating process; Copper chloride sweetening; Hypochlorite sweetening ;Air and inhibitor treating process; Merox processes; Sulphuric acid treatment; Clay treatment); Solvent extraction processes (Edeleanu process, Udex process, Sulfolane process), Hydrotreating processes.

Unit 5

Lube Oil Manufacturing Process Evaluation of crude oils for lube oil base stocks, Vacuum distillation, Solvent deasphalting Solvent extraction of lube oil fractions (Furfural, NMP and Phenol), Solvent dewaxing, Hydrofinishing, Manufacture of petroleum waxes (Wax sweating, Solvent deoiling) Manufacture of Bitumens Selection of crude oil, Methods of manufacture of bitumens, (Distillation, Solvent precipitation, Air blowing).

Books:

1. Nelson, W. L., Petroleum Refining Engineering, McGraw Hill
2. Mall, I. D., Petrochemical Process Technology, McMillan India
3. Sarkar, G. N., Advance Petroleum Refining, Oscar Publication

NCH-032: OPTIMIZATION TECHNIQUES IN CHEMICAL ENGINEERING

(3:1:0)

Unit 1

Analytical Method Necessary and sufficient conditions for optimum in single and multi-variable unconstrained and constrained problems.

Unit 2

Unconstrained One Dimensional Search Newton, Quasi-Newton and Secant method for unidimensional search, Region elimination methods (Golden Section, Fibonacci, Dichotomous. etc.)

Unit 3

Linear Programming, Graphical simplex method, revised simplex method, duality and transportation problems. Unconstrained Multi Variable Search, Direct methods, Indirect method.

Unit 4

Finite difference approximation, Dynamic Programming.

Unit 5

Principle of optimality, Discrete and continuous dynamic programming.

Books:

1. T. F. Edgar and D. M. Himmelblau Optimization of Chemical Processes – McGraw Hill (1989)
2. K. Urbanier and C. McDermott - Optimal Design of Process Equipment – John Wiley (1986)

NCH-033: ADVANCED SEPARATION TECHNOLOGY

(3:1:0)

Unit 1

Uses and characterization of separation processes, equilibrium and rate governed multistage processes.

Unit 2

Ideal cascades total interstage flows, squared off cascades, separative duty and potential, energy requirement for separation processes.

Unit 3

Membrane characterization, Gas permeation through polymeric membranes, Liquid membrane separation processes, reverse osmosis, Concentration polarization.

Unit 4

Dialysis, Ultra filtration, Electro-dialysis.

Unit 5

Chromatographic separation, molecular sieve separations.

Books:

1. Geankoplis, C.J.. "Transport Processes and Unit Operations", 3rd ed. Prentice Hall. (1993)
2. Sun-Tak-Hwang and Karl Kammermeyer – Membranes in Separations – John Wiley & Sons, New York (1975)
3. J.M. Coulson and J.F. Richardson – Chemical Engineering: Particle Technology and Separation Processes, Vol. 2, 4th Edition, Asian Books Pvt. Ltd. New Delhi (1998)
4. Christie J. Geankoplis – Transport Processes and Unit Operations – 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi
5. King C.J., Separation Processes, Tata McGraw Hill

NCH 851: SEMINAR**(0:0:3)**

This seminar course will enhance the personality of the students.

NCH 852: PROJECT**(0:0:12)**

This project course may be in continuation of project course (NCH 753) allotted in the beginning of the VII the semester. Here the students are supposed to do the detail work as scheduled in the last semester. Finally he/she will be required to submit a detailed project report on which viva-voce examination will be conducted by a committee having one External Examiner.