

Department of Petrochemical Engineering
Courses under Minor Degree list

S. N.	Sem	Name of the course	Teaching Scheme	Name of equivalent NPTEL course	NPTEL Sem (Even/Odd)	Instructor's Name	Duration (weeks)	Credits
1	V	Introduction to Petroleum and Petroleum Geology	4Hrs/ week				12	4
2	V	Introduction to Petroleum Refinery and Refining	4Hrs/ week				12	4
3	VI	Petroleum Products	4Hrs/ week				12	4
4	VII	Basics of Petrochemicals	4Hrs/ week				12	4
5	VII	Energy Management in Petrochemical Engineering	4Hrs/ week				12	4

All The courses are of specialized type hence Mapping and level of content match is difficult. Hence for these courses study material and digital content will have to be developed separately .

Detailed Syllabus

Introduction to Petroleum and Petroleum Geology

Unit I

Petroleum Geology and its scope, origin of Petroleum, brief review of petroleum, its formation and composition of crude oil. Oil and gas traps.

Unit II

Geophysical and Geochemical Methods in oil exploration, the role of stable isotones, biomarkers and geomicrobiology in petroleum exploration.

Unit III

Drilling methods (vertical, deviated and horizontal), drilling fluids, platform.

Unit IV

Geochemical prospecting methods, Field reservoir studies (static and flowing bottom pressures, build up curves, draw down tests), methods of recovery (Activation and stimulation tests).

Unit V

Case histories of geophysical exploration in India for Petroleum resource development.

Text/ References

1. B. G. Deshpande, World of Petroleum
2. P. K. Mukharjee, Text Book of Geology

Introduction to Petroleum Refinery and Refining

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.

.Unit III

Types of refineries such as simple, intermediate and complex

Unit IV

General refinery set – up and function of various units, refinery flow diagram

Unit V

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

Texts / References

1. Hobson G.D., 'Modern Petroleum Technology, Volume – II' John Wiley & Sons 1986
2. Speight J.H., 'The Chemistry and Technology of Petroleum Hydrocarbons' Marcel Dekker, Inc, 1982
3. Bhaskar Rao, 'Modern Petroleum Refining'

Petroleum Products

(Major petroleum products, specifications and test)

Unit I

LPG, Gasoline

Unit II

Industrial solvents, naphtha, Kerosene, aviation turbine fuel (ATF)

Unit III

High speed diesel (HSD), LDO, furnace fuel,

Unit IV

Lubricants, Wax, tar and bitumen.

Unit V

Blending of various petroleum fractions to meet require specification

Text Books / Reference Books:

1. Hobson G.D., 'Modern Petroleum Technology, Volume – II' John Wiley & Sons 1986
2. Speight J.H., 'The Chemistry and Technology of Petroleum Hydrocarbons' Mercel Dekker, Inc,1982

Basics of Petrochemicals

Unit I

Scenario of Petrochemical Industries and its feed stock. Product pattern of paraffin's, olefins, diene and acetylene.

Unit II

Manufacture of important paraffin's, olefins, acetylene, butadiene, isoprene and oligomers and aromatics: Techniques, Equipment, Reactions, Catalyst, Solvents, Operating conditions, Separation and purification and developments in these areas.

Unit III

Production of synthesis gas: Various routes, reactions, mechanism, condition, thermodynamics, kinetics, coal gasification and hydrogenation.

Unit IV

Conversion of -

Ethylene to ethylene oxide, ethylene glycol, ethanol amine

Propylene to acrylic acid, methyl ethyl ketone, acrylonitrile

Unit V

Conversion of -

Butenes to iso and n butanols, MIBK, MTBE

Aromatics to maleic and phthalic anhydride, DMT, phenols and acetones

Texts /References

1. Dryden, Charles E., Outlines of Chemical Technology, affiliated East-West Press Pvt. Ltd. New Delhi
2. B.K. Bhaskarrao, "A text on Petrochemicals" 2nd Ed, Khanna publishers, New Delhi.

Energy Management in Petrochemical Industry

Unit I

General energy problems, energy use patterns and scope for conservation

Unit II

Energy management principles, needs of organization and goal setting, energy audit in plant metering, review of conservation technologies.

Unit III

Properties of Hydrogen with respect to its utilization as a renewable form of energy

Unit IV

Energy conservation economics, basic discounting life cycle, costing and other methods, factors affecting economics

Unit V

Energy pricing and incentives for conservation of energy, energy conservation of available work in the plants, identification of irreversible processes

Primary energy sources, optimum use of prime movers, energy efficient housekeeping, energy recovery in thermal systems, energy storage and thermal insulation

Texts/References

1. D.A.Reay, Industrial Energy Conservation, Pergamon press, 1980
2. T.L. Boyen, Thermal Energy Recovery, Wiley, 1980

Department of Petrochemical Engineering
List of Courses for Major Degree
Refinery Engineering

S. N.	Sem	Name of the course	Teaching Scheme	Name of equivalent NPTEL course	NPTEL Sem (Even/Odd)	Instructor's Name	Duration (weeks)	Credits
1	V	Chemical Technology	4Hrs/week	Chemical Technology	Video	Prof ID Mall IIT Roorkee	12	4
2	VI	Petroleum Refinery Engineering	4Hrs/week	--	--	--	12	4
3	VI	Heterogeneous Catalysis and Catalytic Processes	4Hrs/week	Heterogeneous Catalysis and Catalytic Processes	Video	Dr.K.K. Pant, Department of Chemical Engineering I.I.T Delhi	12	4
4	VII	Lubricant, Waxes and Specialty Chemicals	4Hrs/week	---	--	--	12	4
5	VII	Natural Gas Engineering	4Hrs/week	Natural Gas Engineering	Video	Prof. Pankaj Tiwari, Department of Chemical Engineering IIT Guwahati	08	4

1. Chemical Technology

- Introduction
- Coal Chemicals
- Paper and Pulp
- Soap and detergent
- Fermentation
- Petroleum Refinery
- Petrochemicals
- Polymers
- Dye and Pesticides

2. Petroleum Refinery Engineering

Multicomponent distillation, calculation of no of stages, in distillation key component concept
Flash distillation, dew point and bubble point calculation, concentration and temperature profile in distillation.

Comparison between multicomponent and refinery distillation.

Text/References:

1. B.D. Smith : Design of equilibrium stage processes
2. Vanwinkle ; Distillation

3. Heterogeneous Catalysis and Catalytic Processes

- Introduction to basic concept of green catalysis

- Solids and bases as catalyst, application of catalyst functionality concept or control
- Kinetics and reaction on surfaces application of functionality concept for control
- Steps in Catalytic reactions
- Selection design and preparation of catalyst
- Characterization of catalyst
- Zeolite Catalyst: Preparation ,characterization and applications
- Catalyst deactivation kinetics
- Environmental catalysis and its application
- Commercial Catalytic reactors
- Industrially important catalyst and processes

4. Lubricants, Waxes and Specialty Chemicals

Unit I

Lubricating oils, Specifications, characteristics, production, lube specialties, additives.

Unit II

Refining of lubricating oil - solvent, chemical and hydrogenation method, dewaxing DE asphaltting etc. Re-refining of lubricating oil, Asphalt and asphalt specialties, Air blowing and emulsification techniques.

Unit III

Waxes - Introduction, History of waxes and their applications, definitions, Classification- Natural, partially synthetic and fully synthetic wax.

Unit IV

Petroleum wax: Macro-crystalline wax (Paraffin wax), Microcrystalline wax (Micro waxes), Division into product classes of paraffin wax. Production of microwaxes, candles.

Unit V

Process for the manufacture of specialty chemicals such as synthetic lubricants, pore point depressant.

Process for manufacture of flow additive, oil field additives, Naphthaticacid , anti-oxidants and other performance chemicals.

Reference Book:

- 1) Peter H.Spitz; Petrochemicals ‘The Rise of an Industry’
- 2) Wiley Critical Content Petroleum Technology- Vol-2, Wiley Interscience Publication.

5. Natural Gas Engineering

Week 1 : Introduction to Natural Gas

Week 2 : Properties of Natural Gas and Reservoir
Week 3 : Natural Gas Production –I
Week 4 : Natural Gas Production –II
Week 5 : Natural Gas Processing –I
Week 6 : Natural Gas Processing -II
Week 7: Natural Gas : Measurement and Transportation
Week 8 : Unconventional production of Natural Gas

Disaster Management in Chemical Industries

Unit I **[9 hrs]**

General aspects of industrial disaster: Due to fire, explosion, toxicity and radiation; Chemical hazards.

Unit II **[9 hrs]**

Classification of chemical hazards, Chemical as cause of occupational diseases – dust, fumes, gases and vapours.

Unit III **[9 hrs]**

Hazard analysis and health management; Engineering control of chemical plant hazards – Plant layout, ventilation and lighting.

Unit IV **[9 hrs]**

Pressure vessels, Storage, Handling, Transportation, Electrical systems, Instrumentation.

Unit V **[9 hrs]**

Emergency planning, Personal protective devices, Maintenance procedure; Emergency safety and laboratory safety; Legal aspects of safety. Management information system and its application in monitoring disaster, safety and health; Hazop Analysis.

Text Book:

1. H. H. Tawcatt & W S Wood, Safety and Accident Prevention in Chemical Operations.

Reference Books:

1. R. V. Betrabet and T. P. S. Rajan in CHEMTECH-I, Safety in Chemical Industry, Chemical Engineering Development Centre, Madras, 1975.
2. Wells, Safety in Process Plant Design.
3. Less, P. Frank, Loss Prevention in Process Industries.
4. J. Lolb & S. Roy Sterm, Product Safety and Liability.

Department of Petrochemical Engineering
List of Courses for Major Degree
Polymer Science and Technology

S. N.	Sem.	Name of the course	Teaching Scheme	Name of equivalent NPTEL course	NPTEL Sem. (Even/Odd)	Instructor's Name	Duration (weeks)	Credits
1	V	Polymer Science and Technology -I	4Hrs/week				12	4
2	VI	Polymer Science and Technology -I	4Hrs/week				12	4
3	VI	Polymer Science and Technology -I	4Hrs/week				12	4
4	VII	Thermoplastic and Thermoset Polymer Technology	4Hrs/week				12	4
5	VII	Compounding and Polymer Processing	4Hrs/week				08	4

All The courses are of specialized type hence Mapping and level of content match is difficult. Hence for these courses study material and digital content will have to be developed separately.

1. Polymer Science and Technology –I

2.

Historical developments in polymeric materials, Basic concepts & definitions : monomer & functionality, oligomer, polymer , repeating unites, degree of polymerization, molecular weight & molecular weight distribution.

Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins etc.

Raw material for synthetic polymers: Manufacturing of various fractions of crude petroleum important for polymer industry for

(a) Raw Materials such as ethylene, propylene, butadiene, vinyl chloride, vinylidene dichloride, styrene, acrylic monomers like acrylic acid, acrylonitrile, methacrylic acid, methacrylates, acrylamide etc,

(b) solvents such as alcohols, toluene, xylene, acetone, ketones, terpenes, chloromethanes etc. Evaluation of raw materials and reactants for synthesis & manufacturing of polymers.

(c) Polyacids such as phthalic acid, terephthalic acid, 7 isomers and anhydrides etc.

(d) phenols, polyols and their modifications,

(e) Isocyanates,

(f) Amino Compounds,

(g) Other petroleum based material

2. Polymer Science and Technology -II

Classification of polymers thermoplastic/ thermoset, addition/ condensation, natural /synthetic, crystalline/amorphous, step growth /chain growth, ,commodity...specialty, homochain/ heterochain, confirmation: homo & copolymers (detailed graft ,block alt, ladder etc. & nomenclature), configuration cis/trans; tacticity, branched/ crosslinked, Classification of polymers based on end use etc.

Molecular weight and its distribution determination (M_n to M_z & MWD), Carothers equation, states of polymers, transition temperatures such as T_g , T_c , T_m , solubility parameter, solution properties, temperature, good/ bad solvent,

Addition, condensation polymerization mechanism (7) Surface tension/ energy & contact angle measurements of different polymeric systems & their wettability with other substances.

3. Polymer Science and Technology -III

Techniques of polymerization: bulk, solution, suspension, emulsion, plasma etc. Different initiating systems such as free radical polymerization, redox, cationic & anionic polymerization (different terms such as living polymers, inifers, telechelics). Their kinetics & control over structure of polymer.

Condensation polymerization, different catalysts used case studies of condensation polymerization, Carothers equation, Comparison of these systems with advantages & disadvantages.

Copolymerization, reactivity ratios & kinetics of copolymerization (copolymer composition equation).

Rheological concepts of polymer solutions and melts, degradation plasticization Mixing operations: Typical agitation system, dissolution

Different advanced catalyst systems: Ziegler Natta catalyst & metallocene catalysts & their role in polyolefins, ATRP etc.

4. Thermoplastic and Thermoset Polymer Technology

Polyethylenes; modified polyethylenes, Polypropylene and copolymer of PP, modified Polyolefins like crosslinked & filled polyolefins, Polyisobutylene & polyolefin elastomers etc. Engineering Polymers Polyesters such as PET, PBT, PTT, Polycarbonates, Polyacetal etc.

Polyethylenes; modified polyethylenes, Polypropylene and copolymer of PP

Polyester Resins- unsaturated polyesters resins: Raw material: poly-basic acids, polyfunctional glycols. Curing of resins through unsaturation of the resin/polymer backbone. Curing systems, catalysts and accelerators. Polyester based composites & their recipes, Water reducible polyesters, high solid polyesters/ polyesters for powder coatings Moulding compositions, DMC, SMC, fibre and film forming compositions.

Phenolics: Basic components of the polymer. Different kinds of phenols and their derivatives, different kinds of aldehydes used. Novolacs and Resol: effect of the ratio of phenol to aldehyde

on the nature and the property of the polymer. Theory of resinification and effect of pH on the reaction mechanism and the reaction product. Curing of phenolics Modification of phenolics such as novolac-epoxy oil soluble and oil reactive. Phenolic moulding compounds, ingredients, compounding and applications. (9) Amino resins: Basic raw materials used like urea/melamine/aniline/ formaldehyde. Synthesis of UF and MF resins. Theory of resinification and effect of pH on the reaction mechanism and the reaction product. Properties and application of the UF, MF and AF resins Modification of resins with alcohols and phenols Moulding materials, compounding, processing and applications.

5. Compounding and Polymer Processing

Fillers and reinforcement: Varies materials such as Calcium carbonate, Dolomite, Silica Glass, Mica, Talc, Carbon, Clay etc. and reinforcement such as Inorganic and Organic fiber such as glass fiber, boron fiber, carbon fiber, aramide fibers, natural fibers etc. Functional fillers.

Polymer composites such as DMC, SMC, FRP etc. using fillers reinforcement and other polymeric fillers, Composites Mechanics

Reaction Injection Molding, Pultrusion, Pull winding, Handlay up technique etc

Post extrusion techniques such as - electroplating, Stamping, Welding and bonding Degradation and stabilization of plastics.

Texts/ Source Books

1. Text book of Polymer Science by Billmeyer, John Wiley and Sons 1984.
2. Encyclopedia of Polymer Science and Technology, John Wiley and Sons, Inc 1965.
3. Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, Inc 1988.
4. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
5. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
6. Handbook of Polyethylene, A. J. Peacock, Marcel Dekker Inc, 2000
7. PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co, 1994