

Dr. Babasaheb Ambedkar Technological University, Lonere



Course Structure and Syllabus
for
B.Tech. Petrochemical Engineering
Programme

(With effect from the Academic Year 2011-2012)



Dr. Babasaheb Ambedkar Technological University, Lonere

Semester I				
Code	Course of Study	L	P	C
BH101	Basic Course in Communicative English	3	0	6
BH102	Engineering Mathematics-I	4	0	8
BH103	Engineering Physics-I	3	2	8
BH104	Engineering Chemistry-I	3	2	8
CL105/CL205	Basic Civil Engineering	2	0	4
ID106	Energy and Environmental Engineering	2	0	4
ME107/ME207	Engineering Graphics***	1	4	6
XB108	Branch Specific Course*	3	0	6
XC109	NCC/NSS/Sports	0	0	0
Total		21	8	50
Semester II				
Code	Course of Study	L	P	C
BH201	Basic Course in Human Rights	2	0	4
BH202	Engineering Mathematics-II	4	0	8
BH203	Engineering Physics-II	3	2	8
BH204	Engineering Chemistry-II	3	2	8
EM205/EM105	Engineering Mechanics	3	0	6
ID206	Basic Electrical and Electronics Engineering	2	0	4
WS207/WS107	Workshop Practice	0	4	4
XA208	Branch Specific Programming and Softwares**	3	0	6
XC209	NCC/NSS/Sports	0	0	0
Total		20	8	48

*PC108 Introduction to Petrochemical Engineering, for Petrochemical Engineering Department

**PE208 Petrochemical Engineering: Programming and Softwares, for Petrochemical Engineering Department

***Four Hours End Semester Examination

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Semester III				
Code	Course of Study	L	P	C
BH 301	Engineering Mathematics-III	4	0	8
CHPC 302	Numerical Methods	4	0	8
PC 303	Petroleum Geology	4	0	8
CHPC 304	Fluid & Solid-fluid Operations	4	0	8
CHPC 305	Fluid Flow Operations	4	0	8
CHPC 306	Process Calculations	4	0	8
PC 307	Seminar Report and Presentation [#]	0	4	4
Total		24		52
Semester IV				
Code	Course of Study	L	P	C
CHPC 401	Chemical Engineering Thermodynamics - I	4	0	8
CHPC 402	Heat Transfer Operations	4	0	8
PC 403	Petrochemical Engineering – I	3	0	6
CHPC 404	Process Plant Utilities & Safety	4	0	8
PC 405	Elective – I*	3	0	6
PC 406	Chemical Engineering Laboratory - I	0	4	4
	Industrial Exposure (2 weeks after 4 th semester) ^{***}	0	0	0
Total		18	4	40

[#]Seminar Report and Presentation: Self Study Report on any topic of choice based on the subjects studied so far

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

b) Fuel Cell Technology

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

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Semester V				
Code	Course of Study	L	P	C
CHPC 501	Chemical Engineering Thermodynamics - II	4	0	8
CHPC 502	Inorganic Chemical Technology	3	0	6
CHPC 503	Mass Transfer Operations - I	4	0	8
CHPC 504	Optimization Techniques	3	0	6
PC 505	*Elective -II	3	0	6
PC 506	Petrochemical Engineering - II	3	0	6
PC 507	**Chemical Engineering Laboratory - II	0	4	4
PC 508	Petrochemical Engineering Laboratory - I	0	2	2
PC 509	Industrial Exposure (Assessment PP or NP grades)	0	0	0
Total		20	4	46
Semester VI				
Code	Course of Study	L	P	C
CHPC 601	Mass Transfer Operations - II	4	-	8
CHPC 602	Chemical Reaction Engineering - I	4	-	8
CHPC 603	Process Instrumentation	3	-	6
PC 604	Chemistry of Petroleum Hydrocarbons	3	-	6
PC 605	*Elective - III	3	-	6
PC 606	Chemical Engineering Laboratory - III	-	4	4
PC 607	Petrochemical Engineering Laboratory - II	-	2	2
PC 608	Seminar	-	1	4
	Industrial Training (4 weeks at the end of VIth semester.)	-	-	-
Total		17	9	44

*Elective – II (courses):a) Process Plant Safety b) Introduction to Sociology

*Elective – III (courses) : a)Energy Management in Petrochemical Industriesb) Process Design of Heat Exchangers

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Semester VII				
Code	Course of Study	L	P	C
CHPC 701	Chemical Reaction Engineering - II	4	-	8
CHPC 702	Process Dynamics and Control	4	-	8
CHPC 703	Process Economics and Project Management	3	-	6
PC 704	*Elective – IV	3	-	6
CHPC 705	Process Equipment Design & Drawing	4		8
PC 706	Petrochemical Processes -I	3		6
PC 707	**Chemical Engineering Laboratory – IV	-	4	4
PC 708	**Petrochemical Synthesis Laboratory	-	4	4
PC 709	Project Work – Stage I	-	-	4
PC 710	Industrial Training (Assessment)	--	-	-
PC 711	Process Equipment Design & Drawing Laboratory		2	2
Total		21	1	56
Semester VIII				
Code	Course of Study	L	P	C
CHPC 801	Transport Phenomena	4	-	8
CHPC 802	Pollution Control in Process Industries	4	-	8
PC 803	Process Design, Flow Sheetting & Simulation	-	3	3
PC 804	*Elective – V	3	-	6
PC 805	Petrochemical Processes – II	3		6
PC 806	Chemical Engineering Laboratory – V	-	4	4
PC 807	Project Work – Stage II	-	-	08
Total		14	8	43

*Elective – IV (courses): a) Advanced Petroleum Refining; b) Newer Methods of Separation;

c) Introduction to Colloid and Interface Science and Engineering; d) M.Tech Courses

**Assessment includes term work, lab report and viva.

*Elective – V (courses): a) Entrepreneurship Development; b) Catalyst Science and Technology; c) Lubricants, Waxes and Petroleum Specialty Chemicals; d) M. Tech. courses

** Assessment includes power point presentation in front of a panel of internal and external examiners.

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BH101	Basic Course in communicative English	6 Credits
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UNIT - 1

Communication:

An introduction-Its role and importance in the corporate world-Tools of communication-Barriers-Level of communication.

UNIT - 2

Listening:

Importance of listening in the corporate world-Listening process and practice-Exposure to recorded and structured talks, class room lectures – Problems in comprehension and retention – Note-taking practice –Listening tests.

UNIT - 3

Reading-1:

Introduction of different kinds of materials: technical and non-technical – Different reading strategies: skimming, scanning, inferring, predicting and responding to content.

UNIT - 4

Reading-2:

Guessing from context –Note making –Vocabulary extension.

UNIT - 5

Speaking:

Barriers to speaking –Building confidence and fluency–dialogue practice-Extempore speech practice–Speech assessment.

UNIT - 6

Writing:

Effective writing practice–Effective sentences : role of acceptability, appropriateness,

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brevityandclarityinwriting–Cohesivewritingpractice–Paragraphwriting–Discoursewriting.

Text/Reference Books

1. Meenakshi Raman and Sangeetha Sharma, *Technical Communication*, Oxford University Press, New Delhi, 2008.
2. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw-Hill, New Delhi, 2005.
Golding S.R, *Common Errors in English Language*, Macmillan, 1978.
3. Christopher Turk, *Effective Speaking*, Eand FNSpon, London, 1985.

BH102	Engineering Mathematics - I	8 Credits
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UNIT - 1

Linear Algebra – Matrices:

Matrix operations, cofactors, normal form of a matrix, rank, consistency, Eigen and eigen values, Cayley–Hamilton theorem

UNIT - 2

Differential Calculus:

Successive differentiation, Leibnitz's theorem, Taylor's theorem, Maclaurin's Theorem

UNIT - 3

Vector Calculus :

Differentiation of vectors, Curves in space, Velocity and acceleration, Tangential and normal acceleration

UNIT - 4

Applications of Vector and Scalar Point Functions :

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Vector operator ∇ , ∇ applied to the scalar point function –
Gradient, ∇ applied to the vector point functions,
Divergence and Curl, ∇ applied to the vector point function, Line Integral, Surface integral, Volume integral, Divergence theorem, Green's theorem, Stoke's theorem.

UNIT - 5

Integral Calculus :

Double integral, Triple integral, Application to the area, volume, surface area, Moment of inertia, Center of gravity

UNIT - 6

Infinite Series :

Positive term series –
Integral test, Comparison test, D'Alembert's ratio test, Cauchy's root test, Raabe's test, Log Test, Alternating Series – Leibnitz rule, absolute and conditional convergence, power series

Text/Reference Books

1. Grewal B.S., *Higher Engineering Mathematics*, Khanna Publication, New Delhi.
2. Kreyszig E., *Advanced Engineering Mathematics*, Wiley Eastern Publication.

BH103

Engineering Physics - I

8 Credits

UNIT - 1

Wave and Oscillations :

Free oscillation, damped oscillation and forced oscillation and resonance. Examples, Longitudinal and transverse wave, wave equation.

UNIT - 2

Acoustics:

Ultrasonic waves Piezoelectric effect, Magnetostriction effect and production of ultrasonic waves,

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Applications of Ultrasonic waves.

UNIT - 3

Optics:

Interference in thin films, wedge shaped film and Newton's ring application of interference of light, Polarization of light, Methods for production of polarized light, Hygen's theory of double refraction, Laurent's half shade Polarimeter, faraday effect, Kerr effect.

UNIT - 4

Laser and Fiber Optics:

Principle of Laser, Spontaneous and stimulated emission – Einstein's co-efficient, Types of Laser and its applications, Total internal reflection, materials and types of optical fibers, numerical aperture, fiber optics communication principle and application.

UNIT - 5

Electron Optics:

Motion of charged particles in electric field and magnetic field, Measurement of e/m by Thomson's Method, Millikan's Oil Drop method. Positive Rays, Bainbridge mass spectrograph.

UNIT - 6

Nuclear Physics and Quantum Mechanics:

Nuclear reaction, Q -value of Nuclear reaction, G.M. Counter. Duality of Matter, de-Broglie's wave, Electron Diffraction, Davisson and Germer's diffraction experiment, Heisenberg's Uncertainty Principle, Schrodinger's time dependent and time independent wave equation, Physical Significance of wave function.

Text/Reference Books

1. M. N. Avadhanulu and P. G. Kshrisagar, *A Text of Engineering Physics*
2. R. K. Gaur and S. L. Gupta, *Engineering Physics*
3. D. Halliday, R. Resnick and J. Walker, *Fundamental of Physics*, Sixth Edition
4. F. S. Crawford Jr., *Waves – Berkeley Physics Courses*, Volume 3
5. A. Ghatak, *Optics*, Third Edition.

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BH104	Engineering Chemistry - I	8 Credits
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UNIT - 1

Fuels and Lubricants:

Fuels: Introduction, classification of fuel, essential properties of fuel, characteristics of good fuel, solid fuels- wood and coal, various types of coal, analysis of coal- Proximate and Ultimate analysis, liquid fuel- refining of petroleum.

Lubricants: Introduction, types of lubrication, classification of lubricants, properties of lubricants.

UNIT - 2

Physical Properties in Liquid State:

Additive and Constitutive properties, Surface tension and its determination, Viscosity and its determination, Refractive index and its determination, Optical activity, Specific rotation, Polarimeter.

UNIT - 3

Chemical Bonding:

Types of chemical bonds, Ionic bonding and its characteristics, factors affecting the formation of ionic bond, Born-Haber cycle for determination of lattice energy, the concept of Molecular Orbital theory, characteristics of bonding and anti-bonding molecular orbitals, formation of MO, bond order and stability of molecule, energy level sequence, MO diagram of H_2 , O_2 , etc. Hydrogen bonding.

UNIT - 4

Corrosion:

Introduction, fundamental reason, electrochemical corrosion, direct chemical corrosion, factors affecting the rate of corrosion, types of corrosion- pitting corrosion, microbiological corrosion, stress corrosion, methods to minimize the corrosion- proper design, cathodic and anodic protection, metallic coating, organic coating.

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UNIT - 5

Fundamentals of Organic Chemistry-1:

Introduction, E1 and E2 reactions, Birch reduction, Oppenauer oxidation, Study of Aromatic compounds: Naphthalene, Anthracene.

UNIT - 6

Fundamentals of Organic Chemistry-2:

Study of Heterocyclic compound: Pyridine and Quinoline. Manufacture of alcohol by fermentation process.

Text/Reference Books

1. Bhal and Bhal, *Advanced Organic Chemistry*, S. Chand and Company, New Delhi, 1995.
2. Jain P.C. and Jain Monica, *Engineering Chemistry*, Dhanpat Rai and Sons, Delhi, 1992.
3. Finar I.L., *Organic Chemistry* (Vol. I and II), Longman Gr. Ltd. and English Language Book Society, London.
4. Barrow G.M., *Physical Chemistry*, McGraw-Hill Publication, New Delhi.

CL105/CL205

Basic Civil Engineering

4 Credits

UNIT - 1

Properties and uses of Construction Materials:

Stones, bricks, cement, concrete and steel. Site selection for buildings.

UNIT - 2

Component of Building:

Foundation-Shallow and deep foundations

UNIT - 3

Brick and Stone Masonry:

Plastering-Lintels, beams and columns-Roofs.

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UNIT - 4

Roads:

Classification of Rural and urban Roads - Pavement Materials - Traffic signs and road marking - Traffic Signals

UNIT - 5

Surveying:

Classification - Chain Survey - Ranging - Compass Survey - exhibition of different survey equipment.

UNIT - 6

Water Supply:

Quality of Water - Wastewater Treatment units - Their functional utility - Need for conservation of water.

Text/Reference Books

1. Sushil Kumar (2001), *Building Construction*, Standard Publishers Distributors.
2. S. C. Rangwala (1996), *Building Materials*, Charotar Publishing House.
3. Lecture notes prepared by Department of Civil Engineering.

ID106	Energy and Environmental Engineering	4 Credits
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UNIT - 1

Power Generation-1:

Conventional Vs Non conventional power generation, Renewable and alternative energy trends in power generation in future.

UNIT - 2

Power Generation-2:

Solar, Wind, Bioenergy, Ocean Thermal energy conversion (OTEC), Tidal, Fuel cell, Magnetof

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HydroDynamics(MHD).

UNIT - 3

PowerGeneration-3:

Thermoelectricandthermionicgenerators–PrincipleandApplication-
Energyconservationandmanagement-Industry, domestic,casestudies.

UNIT - 4

Pollution-Air:

Airpollution-sources-effects-control-airqualitystandards,airpollutionact-measurement,

UNIT - 5

Pollution-Water:

Waterpollution-effects-selectionofprocess-Disposalofsolidwastes.

UNIT - 6

Pollution-General:

Greenhouseeffect-Acidrain-Noisepollution–Thermalpollution-Pollutionaspectsofvariouspowerplants.

Text/Reference Books

1. Rai.G.D.,Non-ConventionalEnergySources,KhannaPublishers,Delhi,2006.
2. GilbertM.Masters,*IntroductiontoEnvironmentalEngineeringandScience*,2ndEdition,PrenticeHall,2003.
3. RaoS.,ParulekarB.B.,*EnergyTechnology-Non conventional, RenewableandConventional*, KhannaPublishers,Delhi,2005.
4. GlynnHenryJ.,GaryW.Heinke,*EnvironmentalScienceandEngineering*,PearsonEducation,Inc,2004.

ME107/ME207

Engineering Graphics

6 Credits

UNIT - 1

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Drawing standard:

Drawing standard SP46: Dimensioning, Lettering, type of lines, scaling conventions.

UNIT - 2

Geometrical Constructions:

Dividing a given straight line into any number of equal parts, bisecting a given angle, drawing a regular polygon given one side, special methods of constructing a pentagon and a hexagon

UNIT - 3

Orthographic/Isometric Projection:

Introduction to orthographic projection, drawing orthographic views of objects from their isometric views –

Orthographic projections of points lying in four quadrants, Orthographic projection of lines parallel and inclined to one or both planes. Orthographic projection of planes inclined to one or both planes. Isometric Projection and views of planes and simple solids.

UNIT - 4

Solids and Sectioning:

Types of solids, Projection of solids with axis perpendicular to HP, solids with axis perpendicular to VP, solids with axis inclined to one plane. Projection of spheres touching each other. Sectioning of solids: section planes perpendicular to one plane and parallel or inclined to other plane.

UNIT - 5

Studies of Surfaces:

Intersection of surfaces: intersection of cylinder and cylinder, intersection of cylinder and cone, intersection of prisms.

Development of surfaces: Development of cylindrical and conical surfaces. Development of prisms.

UNIT - 6

Computer Aids:

Introduction to computer aided drafting: introduction to computer aided drafting package to make drawings.

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Text/Reference Books

1. N.D.Bhatt,*Engineering Drawing*, Charotar publishing House, 46th Edition, 2003.
2. K.V.Natarajan, *A text book of Engineering Graphic*, Dhanalakshmi Publishers, Chennai, 2006.
3. K.Venugopal and V.Prabhu Raja, *Engineering Graphics*, New Age International (P) Ltd, 2008.

XB108/PC108 Introduction to Petrochemical Engineering 6 Credits

UNIT - 1

Origin, Formation and Composition of Petroleum

Origin and formation of Petroleum, Reserves and deposits of world, Indian Petroleum Industry, Composition of Petroleum

UNIT - 2

Overview of Petroleum Refinery

Petroleum Refinery Processes and operations, Petroleum Refinery flow schemes, Definitions of Refining terms.

UNIT - 3

Introduction to Unit operations and Unit processes

Development of flow diagrams, Basic tools of Chemical Engineering Physico-Chemical Calculations

UNIT - 4

Chemical Process Calculations

Material and Energy Balances

UNIT - 5

Fluid flow and Heat Transfer

Principle and applications of flow of fluids and solids, Fundamental Laws for modes of Heat Transfer

UNIT - 6

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Chemical Kinetics and Mass Transfer

Concept of Diffusion and Mass Transfer, Reaction rates and Chemical Kinetics

Text/Reference Books

- 1 S. K. Ghosal, S. K. Sanyal and S. Datta, *Introduction to Chemical Engineering*, TMH Book Company, 1998.
- 2 B. K. Bhaskara Rao, *Modern Petroleum Refining Processes*, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2005, Fourth Edition.
- 3 G.N. Sarkar, *Advanced Petroleum Refining*, Khanna Publishers, Delhi, First Edition, 1998.

BH201 Basic Course in Human Rights

6 Credits

UNIT - 1

The Basic Concepts:

Individual, group, civil society, state, equality, justice. Human values: - Humanity, virtues, compassion.

UNIT - 2

Human rights and Human Duties:

Origin, civil and political rights, Contribution of American bill of rights, French revolution. Declaration of independence, Rights of citizen, Rights of working and exploited people, Fundamental rights and economic programme, India's charter of freedom.

UNIT - 3

Society, religion, culture, and their inter-relationship:

Impact of social structure on human behavior, Role of socialization in human values, Science and Technology, modernization, globalization, and dehumanization.

UNIT - 4

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Social Structure and Social Problems:

Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labour.

Migrant workers and human rights violations, human rights of mentally and physically challenged.

UNIT - 5

State, Individual liberty, Freedom and Democracy:

The changing of state with special reference to developing countries. Concept of development under development and social action, need for collective action in developing societies and methods of social action. NGOs and human rights in India: - Land, Water, Forest issues.

UNIT - 6

Human Rights in Indian Constitution and Law:

The constitution of India:

- (i) Preamble
- (ii) Fundamental rights.
- (iii) Directive principles of state policy.
- (iv) Fundamental duties.
- (v) Some other provisions.

Universal declaration of human rights and provisions of India. Constitution and law. National human rights commission and state human rights commission.

Text/Reference Books

1. Shastry, T.S.N., *India and Human Rights: Reflections*, Concept Publishing Company India (P Ltd.), 2005.
2. Nirmal, C.J., *Human Rights in India: Historical, Social and Political Perspectives (Law in India)*, Oxford India.

BH202

Engineering Mathematics - II

8 Credits

UNIT - 1

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Linear Algebra–Matrices:

Matrix operations, cofactors, normal form of a matrix, rank, Consistency, Eigen and eigenvalues, Cayley–Hamilton theorem

UNIT - 2

Differential Calculus:

Successive differentiation, Leibnitz's theorem, Taylor's theorem, Maclaurin's Theorem

UNIT - 3

Vector Calculus:

Differentiation of vectors, Curves in space, Velocity and acceleration, Tangential and normal acceleration

UNIT - 4

Applications of Vector and Scalar Point Functions:

Vector operator del, Del applied to the Scalar point function – Gradient, Del applied to the Vector point functions – Divergence and Curl, Del applied twice to point function, Line Integral, Surface integral, Volume integral, Divergence theorem, Green's theorem, Stoke's theorem

UNIT - 5

Integral Calculus:

Double integral, Triple integral, Application to the area, volume, surface area, Moment of Inertia, Center of gravity

UNIT - 6

Infinite Series:

Positive term series – Integral test, Comparison test, D'Alembert's ratio test, Cauchy's root test, Raabe's test, Log Test, Alternating Series – Leibnitz rule, absolute and conditional convergence, power series

Text Books

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publication, New Delhi
2. Kreyszig E., Advanced Engineering Mathematics, Wiley Eastern Publication

BH203

Engineering Physics - II

8 Credits

UNIT - 1

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Crystallography and X-rays:

Crystalline and amorphous solids, crystal structure, Lattice point, space lattice, unit cells, lattice parameter and crystal systems, cubic system, number of atoms per unit cell, coordination number, atomic radius, packing density, Lattice constant. Lattice plane and Miller Indices, Interplanar spacing for cubic system, Production and types of x-ray spectrum, x-ray diffraction, Bragg's law, Moseley's law

UNIT - 2

Conducting Materials:

Electrical conduction, free electron theory, Fermi Dirac statistics, band theory of solids, Resistivity of metals, Superconductivity and types - Meissner effect, High temperature superconductor, applications

UNIT - 3

Semiconductor:

Intrinsic and extrinsic semiconductor, conductivity of semiconductor and its temperature dependence, Fermi level, Hall Effect, semiconductor devices (P-N junction diode, Transistor)

UNIT - 4

Dielectric Materials:

Dielectric constant, polarization, types of polarization, Internal field and Clausius-Mossotti equation, types of dielectric materials, temperature and frequency effect, application.

UNIT - 5

Magnetic Materials and Advanced Materials:

Magnetic dipole moment, magnetic flux density, magnetic field strength, magnetization, magnetic permeability, types of magnetic materials, domain theory, hysteresis loop, hard and soft materials, Nanomaterials, physical properties, ferrites and garnets and application

UNIT - 6

Electrodynamics:

Coulomb's law for distribution of charges, polarization and Gauss's law, Maxwell's equation, electromagnetic wave equation, propagation of electromagnetic waves in free-space

Text/Reference Books

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1. A text of Engineering Physics – M. N. Avadhanulu and P. G. Kshirsagar
2. Materials Science and Engineering – V. Raghavan

Text/Reference Books

1. E. M. Purcell, Electricity and Magnetism – Berkeley Physics Course Volume 2
2. J. R. Reitz, F. J. Milford and R. W. Christy, Foundation of electromagnetic theory, third edition

BH204

Engineering Chemistry - II

8 Credits

UNIT - 1

Water:

Introduction, Hard and soft water, softening of water – zeolite process, ion-exchange process, hot lime-soda process, purification of water – method to remove suspended impurities, method to remove germs and bacteria.

UNIT - 2

Metallurgy:

Introduction, occurrence of metals, Types of ores, conc. of ores – crushing and sizing, froth flotation, magnetic separation, tabling process etc. calcination, roasting, reduction by pyrolysis. Chemical reductions, Refining of metals

UNIT - 3

Phase Rule:

Phase Rule, statement & derivation, explanation of the terms – Phase, components, degrees of freedom, one component system – water & sulphur, two component alloy system.

UNIT - 4

High Polymers:

Introductions, Types of polymerization – addition, condensation & co-polymerization, molecular weight determination by viscosity method & osmotic pressure method, plastic and its classification

UNIT - 5

Electrochemistry - I:

Introduction, conductivity –

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specific conductance, equivalent conductance, measurement of conductance, cell constant, factors affecting the conductance of electrolytic solution, conductometric titrations, Debye-Huckel theory of strong electrolyte, Transport number & determination of transport number by moving boundary method

UNIT - 6

Electrochemistry - II:

Introduction, Theory of acid-base indicator, glass electrode, Quinhydrone electrode, measurement of pH, potentiometric titration

Text Books

1. Bhal and Bhal, *Advanced Organic Chemistry*, S. Chand and Company, New Delhi, 1995
2. Jain P. C. and Jain Monica, *Engineering Chemistry*, Dhanpat Rai and Sons, Delhi, 1992

Reference Books

1. I. L., *Organic Chemistry* (Vol. I and II), Longman Gr. Ltd. and English Language Book Society, London
2. Barrow G. M., *Physical Chemistry*, McGraw-Hill Publication, New Delhi
3. S. S. Dara, *Engineering chemistry*, S. Chand & company, New Delhi

ID206 Basics of Electrical and Electronics Engineering 8 Credits

For Chemical, Petrochemical, Civil, Mechanical Engineering

UNIT - 1

DCCircuits:

Direct currents and voltages, power, Kirchhoff's Laws, batteries, DC machines- Construction, principle of operation and applications.

UNIT - 2

AC Circuits and transformers:

Alternating current and voltage, circuit elements R, L & C, Phase impedance, real and reactive power in single phase circuits, Single phase transformer - construction, principle of operation, Introduction to three phase systems.

Diagram,

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UNIT - 3

AC machines:

Synchronous and Induction machines -
Construction, Principle of operation, and applications, introduction to brushless DC motor.

UNIT - 4

Basic Electronics:

Semiconductor devices – p-n junction diode, BJT, operational amplifiers - Principle of operation and applications, introduction to number systems and logic gates.

UNIT - 5

Signal measurement and processing:

Peak, RMS and average values.

UNIT - 6

Data acquisition system:

ADC, DAC – Principles of operation.

Text/Reference Books

1. Hughes revised by McKenziesmith with John Hilcy and Keith Brown, *Electrical and Electronics Technology*, 8th Edition, Pearson, 2006.
2. R.J. Smith, R.C. Dorf, *Circuits devices and systems*, 5th edition, John Wiley and sons, 2001.
3. Malvino, A.P., Leach D. P. and Gowtham Sha, *Digital Principles and Applications*, 6th Edition, Tata McGrawhill, 2007.
4. Vincent Del Toro, *Electrical Engineering Fundamental*, Prentice Hall India, 2002

CH208 Petrochemical Engineering: Programming & Software 8 Credits

Commented [PD1]: Not given first yr syllabus

UNIT - 1

Introduction to MATLAB:

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MATLAB and its family, Menus and toolbars, Types of windows and types of files, MATLAB Help system, Basic calculations in MATLAB, Vectors and arrays, Multi-dimensional arrays, Element by element operations, Polynomial operations using arrays

UNIT - 2

Functions and Files and Programming Techniques:

Elementary mathematical functions, User defined functions, Working with input and output files, Program design and development, Relation and Logical Operators, Conditional statements, Loops and switch structure

UNIT - 3

Plotting:

X-Y Plotting functions, Subplots, 3-D Plots and Contour plots

UNIT - 4

Introduction to Polymath:

Equation solvers available with polymath, plotting with polymath

UNIT - 5

Introduction to ASPEN:

Menus and toolbars, Creating flowsheet, Specifying components, Specifying property method, Stream information, Running simulation and viewing results, Creating report file

UNIT - 6

Introduction to Office Automation:

Word processor (Ms Office) and LaTeX, Spreadsheet (Ms Excel)

Handson Experience:

- a) Five programs using MATLAB (Program will be on Basic Calculation, Calling Data file and sending results to Data file, Control structure, Plots and Subplots, creating and using built-in functions) (5 Program Submissions)
- b) Solving differential equation using polymath (One)

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- c) Simple calculation using ASPEN (One)
- d) Journal Paper will be created using Ms Word and using LaTeX each. (Two)
- e) One exercise using Ms Excel (One)

Text/Reference Books

1. *Getting started with MATLAB: A quick introduction for scientists and engineers* by Rudra Pratap, Oxford University press, 2003.
2. *Introduction to MATLAB 7 for Engineers*, W.L. Palm III, McGraw Hill, 2005
3. Aspen user manual (Freely downloadable from Aspen official website)
4. Polymath user manual (Freely downloadable from Polymath official website)

Engineering Mathematics-III

8 Credits

UNIT - 1

Power series methods for solution of ordinary differential equation legendre equations and legendre polynomials, Bessel equations Bessel functions of first and second kind; orthogonality, Sturm Liouville problems.

UNIT - 2

Laplace transforms, Inverse transforms shifting on the S axis, Convolutions, Partial fractions.

UNIT - 3

Fourier series, half – range expansions, approximation by trigonometric polynomials fourier integrals.

UNIT - 4

Partial differential equations

First and second order linear partial differential equations with variable coefficients, wave equation and heat equation in one and two dimensions, Laplace equation in two and three dimensions (cartesian coordinates only) Transforms, techniques in O.D.E and P.D.E

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UNIT - 5

Infinite sequences and series of numbers, improper integrals

UNIT - 6

Cauchy criterion, test of convergence, absolute and conditional convergence series of function, uniform convergence, power series, Radius of convergence.

Text/Reference Books

1. E. Kreyszig, *Advanced Engineering Mathematics*, Wiley eastern, 5thed, 1985.
2. P. E. Danko, A. G. Popov, T. Yakovlevich, *Higher Mathematics in problems and exercises part II*. Mir publishers, Moscow, 1983.

Numerical Methods

8 Credits

UNIT - 1

Solutions of Linear Algebraic Equations :

Gauss elimination and LU decomposition, Gauss-Jordan Elimination, Gauss-Seidel and relaxation methods.

UNIT - 2

Eigen values and Eigen Vectors of Matrices:

Faddeev-Leverrier method, Power method, Householder's and Given's methods.

UNIT - 3

Nonlinear Algebraic Equations :

Fixed point method, Multivariable successive substitutions, Single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.

UNIT - 4

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Function Evaluation:

Least-squares curve fit, Newton's Interpolation formulae, Newton's divided difference interpolation polynomial, Lagrangian interpolation, Pade approximations, Cubic spline approximations.

UNIT - 5

Ordinary Differential Equations (Initial value problems):

RungeKutta Methods, Semi-implicit RungeKutta Techniques, Step size control and estimates of error

UNIT - 6

Ordinary Differential Equations (Boundary value problems):

Finite difference technique, Orthogonal collocation technique, Orthogonal collocation on finite elements

Partial Differential Equations:

Introduction to finite difference technique

Text/Reference Books

1. S.K. Gupta, *Numerical Methods for Engineers*, Wiley Eastern, 1995.
2. M.E. Davis, *Numerical Methods & Modeling for Chemical Engineers*, Wiley, 1984.

Petroleum Geology

8 Credits

UNIT - 1

Petroleum Geology and its scope, Origin of Petroleum (emphasis on both techniques and geochemistry), Composition of petroleum, Hetroatoms and metallic trace impurities, Oil and gas traps.

UNIT - 2

Application of remote sensing in petroleum resource development, Basin and exploration strategies, Instruments used – principles and working; magnetometers, seismogram, radiation counters and gravimeters

UNIT - 3

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

UNIT - 4

Casting and cementation, geological formation testing, functions of geologist on drilling well, assessment of potential.

UNIT - 5

Geochemical concepts in oil exploration, the role of stable isotopes, biomarkers and geomicrobiology in petroleum exploration.

UNIT - 6

Geochemical prospecting methods, Field reservoir studies (static and flowing bottom pressures, build up curves, draw down tests), methods of recovery (Activation and stimulation tests). Case histories of geophysical exploration in India for Petroleum resource development.

Text/Reference Books

1. G. D. Hobson, *Modern Petroleum Technology*, Volume I
2. Lovetrsen, *Geology of Petroleum*
3. B. G. Deshpande, *World of Petroleum*
4. P. K. Mukharjee, *Text Book of Geology*

Fluid and Solid-fluid Operations

8 Credits

UNIT - 1

Particulate Solids:

Particle Characterization, Particulate Solids in Bulk, Blending of Solid Particle, Classification of Solid Particles

Size Reduction of Solids:

Mechanism of Size Reduction. Energy for Size Reduction, Methods of Operating Crushers, Nature of Material to be Crushed, Types of Crushing Equipments

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UNIT - 2

Sedimentation:

Gravitational Sedimentation, Centrifugal Separation, Flocculation.

UNIT - 3

Flow through Packed Columns:

Flow of a Single Fluid through a Granular Bed, Dispersion, Packed Columns

Fluidization:

Characteristics of Fluidized Systems, Liquid-Solid and Gas-Solid Systems, Applications of the Fluidized Solids Technique.

Pneumatic and Hydraulic Conveying:

Theory and Industrial Applications.

UNIT - 4

Filtration:

The Theory of Filtration. Filtration Practices, Filtration Equipments, Filtration in a Centrifuge and Filtration Calculations.

UNIT - 5

Gas Cleaning:

Gas Cleaning Equipments such as Gravity Separators, Centrifugal Separators, Electrostatic Precipitators etc.

UNIT - 6

Flow of particulate matter:

Flow of solids through silos and hoppers. Storage and transport of powders.

Size Enlargement:

Principles of agglomeration palletizing (cone and disk), press and tabulating machines and extrusion and granulating machines.

Text/Reference Books

1. J. M. Coulson and J. F. Richardson, *Chemical Engineering*, Vol. 2, 4th ed. Pergamon Press

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2. W. L. McCabe, J. C. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, 4th ed. McGraw Hill, 1985
3. S. K. Gupta, *Momentum Transfer Operations*, Tata McGraw Hill, 1979.
4. A. S. Foust, L. A. Wenzel, C. W. Clump, L. B. Andersen, *Principles of Unit Operations*, 2nd ed. Wiley, New York, 1980.

Fluid Flow Operations

8 Credits

UNIT - 1

Continuity equation for compressible and incompressible fluids. Bernoulli equation, Euler equation. Equation of motion.

UNIT - 2

Types of flow, steady and unsteady, laminar and turbulent flows, relationship between shear stress and pressure gradient, Hagen Poiseuille equation. Prandtl mixing length theory and eddy diffusivity, losses in pipes and fittings.

UNIT - 3

Darcy-Weisbach equation for frictional head loss, friction factor, Moody diagram. Velocity profile and boundary layer calculations for turbulent flow. Flow through packed and fluidized beds.

UNIT - 4

Pumps and compressors for handling different fluids, valves, pipe fittings and their standards, power requirement for flow. Piping layout and economical pipe diameter.

UNIT - 5

Flow measuring devices:

Orificemeter, venturimeter, rotameter, pitot tube, anemometer etc. Flow through constrictions such as notches, weirs, nozzles.

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UNIT - 6

Mixing and agitation, calculation of power numbers and mixing indices. Liquid-liquid and liquid solid mixing.

Vacuum producing devices. Introduction to non Newtonian flow and two phase flow.

Text/Reference Books

1. W. L. McCabe and J. C. Smith, P. Harriot, *Unit Operations of Chemical Engineering* 4th ed. McGraw Hill 1985.
2. S. K. Gupta, *Moment Transfer Operations*, Tata McGraw Hill, 1979.
3. J. M. Coulson and J. F. Richardson, *Chemical Engineering Vol. I*, Pergamon Press, 1970.
4. A. S. Foust, L. A. Wenzel, C. W. Clump, L. B. Andersen. *Principles of Unit Operations*, 2nd ed. John Wiley, New York, 1980.

Process Calculations

8 Credits

UNIT - 1

Basic Concepts:

Units and Dimensions, Steady state and dynamic processes, Lumped and distributed processes, Single and multiphase systems.

Types of Variables:

Intensive and extensive variables, Specific properties, State variables.

UNIT - 2

Types of Equations:

Mass and energy conservation, equilibrium relations, Rate laws, Constitutive equations for material behaviour, Correlations for physical and transport properties.

UNIT - 3

Material Balances for Steady State Processes:

Properties of gases, liquids and solids equations of state, phase equilibria for ideal mixtures, Reactions and stoichiometry, Non-

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UNIT - 4

Reacting single phase systems: Single and multiple units without recycle, Systems with recycle, bypass and purge, Non-Reacting multi-phase systems - Processes involving vaporization and condensation, Reacting systems.

UNIT - 5

Energy Balances for Steady State Processes:

Specific heat capacity, Enthalpy, Heat of reaction, Thermo-chemistry, Isothermal systems, Adiabatic systems, Simultaneous material and energy balances.

UNIT - 6

Unsteady State Material and Energy Balances:

Reaction rate laws, Transport laws.

Introduction to Computer Aided Process Calculations:

Degrees of Freedom and Specifications, Use of Spreadsheets, Tearing and Iterative techniques in Flowsheeting.

Text/Reference Books

1. D.M. Himmelblau, *Basic Principles and Calculations in Chemical Engineering*, Edition Prentice Hall of India, 1997.
2. B. I. Bhat and S. M. Vora, *Stoichiometry*, Tata McGraw-Hill, New Delhi.

Commented [PD2]: Which edition

Chemical Engineering Thermodynamics-I

8 Credits

UNIT - 1

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;

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Equilibrium; The phase rule; The reversible process; Constant V and constant P processes; Enthalpy; Heat capacity; Mass and energy balances for open systems.

UNIT - 2

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 - 3

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 - 4

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 - 5

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 - 6

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

Dr. Babasaheb Ambedkar Technological University, Lonere

Text/Reference Books

Text Book :

1. Smith J.M, Van Ness H.C and Abbott M.M., *Introduction to Chemical Engineering Thermodynamics*, 6th Edition, McGraw 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.

Heat Transfer Operations

8 Credits

UNIT - 1

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 - 2

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 - 3

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 - 4

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 - 5

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 - 6

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.

Text/Reference Books

Texts / References:

1. J. M. Coulson and J. F. Richardson, *Chemical Engineering, Vol. 1*, ELBS, Pergamon press, 1970
2. J. M. Coulson and J. F. Richardson, *Chemical Engineering, Vol. 2*, ELBS, Pergamon press, 1970
3. W. L. McCabe J. C. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, 4th ed. McGraw Hill 1985.
4. D. Q. Kern, *Process Heat Transfer*, McGraw Hill, 1950.

Dr. Babasaheb Ambedkar Technological University, Lonere

UNIT - 1

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

UNIT - 2

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 - 3

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

UNIT - 4

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 - 5

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

UNIT - 6

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

Text/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*, Marcel Dekker, Inc, 1982.
3. Sarkar G.N., *Advanced Petroleum Refining*, Khanna Publishers, New Delhi, 2006.

Process Plant Utilities and Safety

8 Credits

Dr. Babasaheb Ambedkar Technological University, Lonere

UNIT - 1

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 - 2

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 - 3

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

UNIT - 4

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 - 5

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.

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UNIT - 6

Combating Chemical Fires: Classification of fires, control of high vapour 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 Books

Text / Reference:

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

Text / Reference:

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

A Elective-I: Introduction to Non-renewable Fuel Energy Resources 6 Credits

UNIT - 1

Petroleum :

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

Prospecting, Exploration and production of crude oil.

UNIT - 2

General refinery setup and functions of various units, refinery flow diagram, equipment and tank yard layout.

UNIT - 3

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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 - 4

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 - 5

Coal:

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

Past present and future role of coal

UNIT - 6

Technologies for coal utilization

Effect of coal usage on human health and environment

Text/Reference Books

1. Bhaskara Rao B.K., Modern Petroleum Refining Processes, Oxford & IBH Publications, 2003.
2. Miller B.G., Coal Energy Systems, Elsevier, Academic Press, 2005.

B Elective-I: Fuel Cell Technology 6 Credits

UNIT - 1

Introduction and overview of fuel cells technology:

low and high temperature fuel cells.

UNIT - 2

Dr. Babasaheb Ambedkar Technological University, Lonere

Fuel cell thermodynamics

Fuel cell reaction kinetics: Introduction to electrode kinetics.

UNIT - 3

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

Fuel cell charge and mass transport.

UNIT - 4

Fuel cell characterization

UNIT - 5

Fuel cell modeling and system integration: Balance of plant

UNIT - 6

Hydrogen production and storage.

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

Text/Reference Books

1. Apple B.Y., *Fuel Cell Handbook*, Van Nostrand, 1989.
2. Viswanathan B.A., *Fuel Cell: Principles and Practice*, University Press, 2006.

History of Science and Technology [Self- study course

(objective: University level common examination)]

4 Credits

UNIT - 1

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 - 2

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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 - 3

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 - 4

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 - 5

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 - 6

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.

Dr. Babasaheb Ambedkar Technological University, Lonere

Text Books

1. KalpanaRajaram ,*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 SeshagiriRao, K.,(Eds.) *Science, Technology and Education for Development*,K., Nayudamma Memorial Science Foundation, Channai-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.

Chemical Engineering Thermodynamics-II 8 Credits

UNIT - 1

Vapour/Liquid Equilibrium Introduction:

The nature of equilibrium, the Phase Rule, Duhem's Theorem, VLE: Qualitative behaviour, Simple models for vapour/liquid equilibrium, VLE by modified Raoult's Law, VLE from K- value correlations.

UNIT - 2

Solution Thermodynamics: Theory:

Fundamental property relation, The chemical potential and phase equilibria, Partial properties, Ideal gas mixtures, Fugacity and fugacity coefficient.

UNIT - 3

Solution Thermodynamics: Theory: (continued)

Fugacity and fugacity coefficient: Species in the solution, Generalized correlations for the fugacity coefficient, The ideal solution, Excess properties.

UNIT - 4

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Solution Thermodynamics: Applications:

Liquid-phase properties from VLE data, Models for the excess Gibbs energy, Property changes of mixing, Heat Effects of mixing processes.

UNIT - 5

Chemical Reaction Equilibria:

The reaction coordinate, Application of equilibrium criteria to chemical reactions, The standard Gibbs energy change and equilibrium constant, Effect of temperature on the equilibrium constants.

UNIT - 6

Chemical Reaction Equilibria: (continued)

Relation of equilibrium constants to composition, Equilibrium conversions for single reactions, Phase rule and Duhem's theorem for reacting systems, Multi reaction equilibria, Fuel cells.

Text/Reference Books

1. J. M. Smith, H.C. Van Ness, and M.M. Abbott, *Chemical Engineering Thermodynamics*, 6thed, Tata McGraw Hill edition, 2003.
2. Y. V. C. Rao, *Chemical Engineering Thermodynamics*, University Press 1997
3. S. I. Sandler. *Chemical Engineering Thermodynamics*, Wiley, New York, 1999.

Inorganic Chemical Technology

6 Credits

UNIT - 1

Water:

Source: Impurities, Polluted, contaminated palatable waters, water pollutants and their effects.

Treatment - Sedimentation, coagulation, filtration softening, aeration, ion exchange reverse osmosis.

Gaseous fuels:

Classification, manufacture and use of LPG, wood gas, coal gas, producer gas, water gas, synthesis gas, carburetor water gas. Industrial Gases: Manufacture and uses of hydrogen, carbon dioxide, acetylene, oxygen, nitrogen, inert gases.

UNIT - 2

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Phosphorous Industries: Phosphate rock; super phosphate; wet process phosphoric acid; electric furnace phosphorous and phosphoric acid; phosphates; baking powders; fire retardant chemicals.

Nitrogen Industries:

Synthetic ammonia; ammonium nitrate; ammonium sulphate; ammonium phosphates; urea; nitric acid; sodium nitrate; potassium nitrate; Cyanamid

UNIT - 3

Fertilizers:

Status of industry, grading and classification of fertilizers, raw materials, hydrogen production, fixation of nitrogen, synthesis, ammonia based fertilizers, manufacture of phosphatic fertilizers and phosphoric acid, potash fertilizers, N-P-K values. Corrosion problems and materials of construction.

UNIT - 4

Soda Ash:

Manufacturing special materials of construction, solvay and modified solvay process environmental considerations, corrosion problems and material of construction.

Regenerated Cellulose:

Growth of industry, raw materials, pre-treatment, pulping, manufacture of paper, recovery of chemicals, environmental considerations, viscose rayon.

Petroleum Refining:

General composition of crude oil, typical refinery operations for obtaining different useful products and their utilization for manufacture of other commercial products.

UNIT - 5

Chlor Alkali Industry: Electrochemistry of brine electrolysis, current efficiency, energy efficiency, diaphragm cells, mercury cells, mercury pollution and control, caustic soda, chlorine, hydrochloric acid; corrosion problems and materials of construction.

Potassium Industries:

Potassium; potassium chloride; potassium sulphate; potassium bisulphate; potassium hydroxide; potassium carbonate; potassium bromide; potassium iodide; potassium nitrate; potassium acid tartrate; potassium permanganate; potassium dichromate.

UNIT - 6

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Soap and Detergents:

Detergents; soap; glycerin.

Sulfur and Sulfuric Acid:

Mining and manufacture of sulfur; sulfuric acid; sulfur trioxide; recovery of used sulfuric acid; sulfur pollution; concentration

Cement and Glass.

Text/Reference Books

1. Shreve R.N. and Brink J.A., Chemical Process Industries, McGraw Hill
2. *Chemical Technology, I,II,III and IV* Indian Institute of Technology, Madras
3. Dryden, Charles E., *Outlines of Chemical Technology*, affiliated East-West Press Pvt. Ltd. New Delhi.

Mass Transfer Operations-I

8 Credits

UNIT - 1

Diffusion in fluids :

Fick's Law of diffusion equimolecular counter diffusion, diffusion in stationary gas. Maxwell's law of diffusion.

Inter phase mass transfer - Mass transfer equilibrium, diffusion between two phases. Local mass transfer coefficient, Local and average overall mass transfer coefficients. Simultaneous heat and mass transfer.

Diffusion in fluids :

Fick's Law of diffusion equimolecular counter diffusion, diffusion in stationary gas. Maxwell's law of diffusion.

Inter phase mass transfer - Mass transfer equilibrium, diffusion between two phases. Local mass transfer coefficient, Local and average overall mass transfer coefficients. Simultaneous heat and mass transfer.

UNIT - 2

Material balance:

Steady state co current and counter current processes stage wise and differential contacts. Number of theoretical stages. Stage efficiency Height of mass transfer units.

UNIT - 3

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Gas Absorption:

Equilibrium solubilities of gases. Material balance for transfer of one component. Counter current multistage operations for binary and multi component systems. Continuous contactors, absorption with chemical reaction.

UNIT - 4

Liquid-liquid extraction:

Calculations with and without reflux for immiscible and partially miscible system.

Leaching:

Leaching single and multistage operations based on solvent free coordinates.

UNIT - 5

Adsorption and Ion-exchange: Types of adsorption; Nature of adsorption; Freundlich equation; Types of adsorption; Nature of adsorption; Freundlich equation; Stage wise and continuous adsorption. Stage wise and continuous adsorption. Theory of ion – exchange and its application to removal of ionic impurity.

UNIT - 6

Gas-Liquid operations:

Sparged vessels (bubble columns), mechanically agitated vessels for a single phase and gas liquid contact. liquid dispersed scrubbers, venturi scrubbers, wetted towers packed towers. Mass transfer coefficients for packed towers co-current flow of gas and liquid end effect and axial mixing.

Text/Reference Books

1. R. E. Treybal, *Mass transfer operations*, 3ed ed. McGraw Hill, 1980.
2. A. S. Foust et al. *Principles of Unit Operations*
3. J. M. Coulson and J. F. Richardson, *Chemical Engineering, Vol. 1*, ELBS, Pergamon press, 1970.
4. J. M. Coulson and J. F. Richardson, *Chemical Engineering Vol. 2*, ELBS, Pergamon press, 1970.

Optimization Techniques 6 Credits

UNIT - 1

Dr. Babasaheb Ambedkar Technological University, Lonere

Single-variable optimization algorithms:

Optimal problem formulation, Optimization algorithms, Optimality criteria, Bracketing methods, Region-elimination methods, Point-estimation method, Gradient based methods, Root finding using optimization techniques.

UNIT - 2

Multi-variable optimization algorithms:

Unidirectional search, Direct search methods, Gradient based methods.

UNIT - 3

Constrained optimization algorithms:

Kuhn-Tucker conditions, Transformation methods,

UNIT - 4

Sensitivity analysis, Direct search for constrained minimization, Linearized search techniques, Feasible direction method, Generalized reduced gradient method, Gradient projection method

UNIT - 5

Specialized algorithms:

Integer programming, Geometric programming.

UNIT - 6

Non-traditional optimization algorithms:

Genetic algorithms, Simulated annealing, Global optimization.

Text/Reference Books

Deb K., *Optimization for Engineering Design, Algorithms and Examples*, Prentice Hall of India, New Delhi 1996.

A Elective -II: Process Plant Safety

6 Credits

Dr. Babasaheb Ambedkar Technological University, Lonere

UNIT - 1

Hazard Assessment and Statistics, Fire and explosion Hazards.

UNIT - 2

Prevention of Fire and Explosion.

UNIT - 3

Toxicological Studies, Industrial Hygiene

UNIT - 4

Radiation Hazards, Hazard Identification

UNIT - 5

Risk Assessment

UNIT - 6

Case studies

Text/Reference Books

1. F.P. Lees, *Loss Prevention in the Process Industries*, Vol. 1, 2, and 3, Second Edition, Butterworth (1996).
2. Danial A Crowl and Joseph F. Louvar, *Chemical Process Safety: Fundamentals with Applications*, Prentice Hall (1990).
3. Sanjay Banerjee, *Industrial Hazards and plant Safety*, Taylor & Francis (2003).

B Elective-II: Introduction to Sociology 6 Credits

UNIT - 1

What is Sociology, some sociological concepts: Social structure, status, role, norms, values, etc. Socialization, and culture and change.

Dr. Babasaheb Ambedkar Technological University, Lonere

UNIT - 2

Social stratification - various approaches and concept of social mobility. Population and society - Trends of demographic change in India and the world;

UNIT - 3

Human ecology; Trends of Urbanization in the developing countries and the world.

UNIT - 4

Major social institutions - Family and marriage, caste and tribe; Organizations : (i) formal organization (bureaucracy) (ii) informal organization.

UNIT - 5

Processes of social change - Modernization (including Sanskritization), industrialization, environmental / ecological changes and development.

UNIT - 6

Social movements - protest movements, reformist movement and radical movements in India.

Text/Reference Books

1. L. Broom, P. Selznick and D. Dorrock, *Sociology*, 11th ed., Harper International, 1990.
2. M. Haralambos, *Sociology : Themes and Perspectives*, OUP, 1980.
3. M. S. A. Rao (Ed), *Social movements in India, Vols 1-2*, Manohar, 1984.
4. David Mandelbaum, *Society in India*, Popular, 1990.
5. Guy Rocher, *A General Introduction to Sociology*, MacMillan, 1982.

Petrochemical Engineering-II

6 credits

UNIT - 1

Heating of crude oil through exchangers. Pipestill heaters, their types and constructional features, estimation of heat duty, combustion calculation and heat transfer area in different parts in pipe still heater. Calculation of pressure drop and stack height.

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UNIT - 2

Flash distillation , Dew point and Bubble point calculations, temperature and concentration profile in a distillation column.

UNIT - 3

Multicomponent distillation , Calculation of number of stages in distillation , Key component concept, Comparison between multicomponent distillation and petroleum distillation

UNIT - 4

Distillation curves and their interconversion at atmospheric ,subatmospheric and superatmospheric pressure, Collection and data for distillation column design and operation etc.

UNIT - 5

Atmospheric distillation , principles and mode of excess heat removal , Flash zone calculation and estimation of side draw tray temperatures, Design aspects, Post treatment of straight run products.

UNIT - 6

Vacuum distillation column internals and operational aspects for lubes,asphalt, cracking feedstock, Pressure distillation and gas fractionation units, Difference between various types distillation regaining products of pressure distillation.

Text/Reference Books

1. B.K.BhaskarRao ,*Modern Petroleum Refining Processes* , Oxford & IBH (2006).
2. W.L. Nelson ,*Petroleum Refinery Engineering*, McGraw –Hill ,1964.
3. M. Vanwinkle, *Distillation*, McGraw –Hill ,1961.

Mass Transfer Operations-II 8 credits

UNIT - 1

Dr. Babasaheb Ambedkar Technological University, Lonere

Distillation:

Vapour liquid equilibria, flash vapourisation, batch distillation, differential distillation.

UNIT - 2

Continuous fractionation:

Binary systems, Mc-Cabe.Thiele and PonchonSavarit method calculations with multiple feeds and withdrawal

UNIT - 3

Humidification:

Vapour liquid equilibrium, enthalpy for pure substances, vapour gas contact operation.

Psychrometric charts and measurement of humidity

Dehumidification and Cooling Tower Design:

Adiabatic and non adiabatic operations evaporative cooling, cooling tower design and dehumidification methods.

UNIT - 4

Drying:

Drying equilibrium and rate of drying, drying operation batch and continuous number of transfer units.

UNIT - 5

Crystallisation:

Theories of crystallisation nucleation and crystal growth, principles of super saturation. different types of crystallisers.

UNIT - 6

Special topics in separation:

Types of membranes for osmosis and dialysis; Mechanism of solute/solvent rejection in the process; Design of R.O. and dialysis units; applications.

Text/Reference Books

Dr. Babasaheb Ambedkar Technological University, Lonere

R. E. Treybal, Mass transfer operations, 3ed ed. McGraw Hill, 1980.

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

Chemical Reaction Engineering-I

8 Credits

UNIT - 1

Mole Balances : Definition of the rate of reaction, General mole balance equation, Batch Reactors, Continuous-flow reactors, Industrial reactors

UNIT - 2

Conversion and Reactor Sizing: Definition of conversion, Design equations, Applications of the design equations for continuous-flow reactors, Reactors in series

UNIT - 3

Rate-Law and Stoichiometry: Basic definitions, Approach to reactor sizing and design, Stoichiometric table, Expressing concentrations in terms other than conversion, Reactions with phase change

UNIT - 4

Isothermal Reactor Design: Design structure for isothermal reactors, Scale up of liquid-phase batch reactor data to the design of a CSTR, Tubular reactors, Recycle reactors

UNIT - 5

Collection and Analysis of Rate Data:

Batch reactor data, Method of initial rates, Method of half-life, Differential reactors, Least square analysis

UNIT - 6

Catalysis and Catalytic Reactors:

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Catalysts, Steps in a catalytic reaction, Synthesizing a rate law, mechanism and rate-limiting step, Design of Reactors for gas-solid reactions, Heterogeneous data analysis for reactor design

Text/Reference Books

1. H. S. Fogler, *Elements of Chemical Reaction Engineering*, 3rd Ed, New Delhi-Prentice Hall, 2001
2. O. Levenspiel, *Chemical Reaction Engineering*, Wiley Eastern, 3rd Ed., 2000
3. J. M. Smith, *Chemical Engineering Kinetics*, 3rd Ed., McGraw- Hill, 1988

Process Instrumentation

6 Credits

UNIT - 1

Introduction to measurements:

Elements of measuring systems and their functions. Signal transmission. Transmitters electronic pneumatic etc.

UNIT - 2

Fundamentals of Measuring Devices:

Temperature Measurement : Temperature scales Mercury in glass thermometer, Bimetallic thermometer, pressure spring thermometer, Thermoelectric temperature measurements, thermocouples, thermal well and potentiometers, Resistance thermometer and pyrometers.

UNIT - 3

Level Measurement :

Level measurements of open and pressure vessels measurement of interface level.

UNIT - 4

Level Measurement :

Level measurements of open and pressure vessels measurement of interface level.

UNIT - 5

Commented [PD3]: Unit iii n iv are same

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Density Measurement: Density measurements by displacement meter, hydrometer and densitometer.

UNIT - 6

Flow Measurements :

Orifice, Venturi, Pitot, and Rota-meters flow measurement of open channels.
Instrumentation to flow plan symbols and chemical sensors.

Text/Reference Books

1. D. P. Eclaman, *Industrial Instrumentation*, Wiley Estern, 1989.
2. J. P. Bentley, *Principles of Measurement Systems*, 2nd ed. Longman London, 1988.
3. J. W. Dally, W. F. Riley and K. G. McConnell, *Instrumentation , Engineering Measurements*, John Wiley and Sons, Singapore, 1984.
4. C. S. Rangan, G. R. Sarma and V. S. V. Mani, *Instrumentation Devices and systems*, Tata McGraw Hill, New Delhi, 1983
5. B. C. Nakra and K. K. Chaudhary, *Instrumentation Measurement and Analysis*, Tat McGraw Hill, New Delhi, 1985.

Chemistry of Petroleum Hydrocarbons 6 Credits

UNIT - 1

Review of types of hydrocarbon groups present in petroleum and their structures, sulfur, nitrogen , oxygen and organo-metallic compounds in petroleum

UNIT - 2

Low and high molecular paraffins, olefins, aromatics naphthenes and Diens, their thermodynamic stability and reactivity and their relation ship with the performance characteristics

UNIT - 3

Dr. Babasaheb Ambedkar Technological University, Lonere

Chemistry of certain reactions such as cracking, cyclization, dehydrogenation, hydrogenation, oxidation, nitration

UNIT - 4

Chemistry of certain reactions such as chlorination, alkylation, disproportionation, transalkylation, esterification and etherification

UNIT - 5

Zeolite synthesis reactions, unit cell structure, classification, acidity, and basicity in Zeolites, cation exchange dealumination and isomorphous substitution principles

UNIT - 6

Applications of Zeolites in catalysis and in separation processes - a few case studies

Text/Reference Books

1. N.N. Lebedev, *Chemistry and technology of basic organic and petrochemical synthesis*, Vol. 1 & 2 Mir publications, Moscow
2. W.D. Breck, *Zeolite Molecular sieve structure, chemistry and use*, John Wiley & Sons, NY, 1974

* Elective-III: Energy Management in Petrochemical Industries 6 Credits

UNIT - 1

General energy problems, energy use patterns and scope for conservation

UNIT - 2

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

UNIT - 3

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

Dr. Babasaheb Ambedkar Technological University, Lonere

UNIT - 4

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

UNIT - 5

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

UNIT - 6

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

Text/Reference Books

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

B Elective-III: Process Design of Heat Exchangers 6 Credits

UNIT - 1

Introduction , various types of heat exchangers used in process industries, general design considerations of heat exchangers,

UNIT - 2

Double pipe heat exchanger

UNIT - 3

Shell and tube heat exchangers without phase change,

UNIT - 4

Dr. Babasaheb Ambedkar Technological University, Lonere

Shell and tube condenser – vertical condenser and horizontal condenser , Shell and tube condenser with sub-cooling

UNIT - 5

De-super-heater condenser , Shell and tube condensers in presence of non-condensable

UNIT - 6

Reboilers and Vaporizers - Kettle type reboiler, thermosyphon type reboiler etc

Text/Reference Books

1. Sinnott R. K., *Coulson and Richardson's Chemical Engineering Series, Vol. VI*, 4th Ed., Butterworth-Heinemann
2. D.Q. Kern, *Process Heat Transfer*, McGraw Hill, 1950.
3. Applied process *Design for Chemical and Petrochemical Plants*, Volume 3, 3rd Edition, Ernest E. Ludwig.
4. Bhattacharya B. C; *Introduction of Chemical Equipment Design*, CBS Publisher, 2003.

Chemical Reaction Engineering –II 8 credits

UNIT - 1

Multiple Reactions:

Maximizing desired product in parallel reactions, Maximizing desired product in series reactions, Stoichiometric table using fractional conversion

UNIT - 2

Multiple reactions in PFR and CSTR:

An alternative approach to using fractional conversion

UNIT - 3

Dr. Babasaheb Ambedkar Technological University, Lonere

Nonelementary Reaction Kinetics:

Fundamentals, Searching for a mechanism, polymerization, enzyme reaction fundamentals, Bioreactors

UNIT - 4

External Diffusion Effects on Heterogeneous Reactions:

Mass transfer fundamentals, Binary diffusion, External resistance to mass transfer, The shrinking core model

UNIT - 5

Distribution of Residence times for Chemical Reactors:

General characteristics, Measurement of RTD, Characteristics of RTD, RTD in ideal reactors, Reactor modeling with RTD, Zero-parameter models

UNIT - 6

Models for non-ideal reactors:

One-parameter models; tank-in-series model, dispersion model

Text/Reference Books

1. H. S. Fogler, Elements of Chemical Reaction Engineering, 3rd Ed, New Delhi-Prentice Hall, 2001
2. O. Levenspiel, Chemical Reaction Engineering, Wiley Eastern, 3rd Ed., 2000
3. J. M. Smith, Chemical Engineering Kinetics, 3rd Ed., McGraw- Hill, 1988

Process Dynamics and Control

8 Credits

UNIT - 1

Introduction:

Block diagrams, closed loop and open loop control systems, Basic control actions.

Open loop response of simple systems:

Dynamics of first order systems using transfer functions; Various first order response such as, a thermometer bulb. General response to step, ramp, impulse, and sinusoidal inputs; Concentration and temperature responses of a stirred tank;

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UNIT - 2

Linearization of liquid level systems: Response of a pressure system, second order systems, the manometer; Response of interacting and non interacting systems

UNIT - 3

Transient response of control systems:

Servo and regulated operation, General equations for the transient response, proportional control of a signal capacity process; Integral control, Proportional-integral control and derivative action.

UNIT - 4

Stability:

Concept of stability, Stability criterion, Routh test for stability.

Root locus analysis:

Concept of root locus, Locus diagram.

UNIT - 5

Frequency response analysis:

First order systems, Bode diagram, and Complex numbers to get frequency response.

UNIT - 6

Controller selection and tuning, Control valve characteristics and sizing, cascade control, Feed forward control. Introduction of digital control principles.

Text/Reference Books

1. D. R. Coughanowr, *Process system analysis and control*, 2nded, McGraw Hill, 1991.
2. P. Harriott, *Process Control, Reprint of text*, ed. Tata McGraw Hill, 1983.
3. G. Stephanopoulos, *Chemical Process Control: An introduction to theory and practice*, Prentice Hall, New Jersey, 1984.

Process Economics and Project Management

8 Credits

Dr. Babasaheb Ambedkar Technological University, Lonere

UNIT - 1

Capital cost estimation in chemical industries, different methods of calculation of fixed costs. Capital Investment and working Capital.

UNIT - 2

Time value of money, types of interest, investment costs, annuities, perpetuity and capitalized costs, discounted cash flow analysis

UNIT - 3

Taxes and insurance, depreciation, amortization and obsolescence in chemical industries, types of depreciation methods, breakeven point analysis

UNIT - 4

Discussion on projects , causes for time and cost overruns, project evaluation and assessment of project profitability, organization of project engineering.

UNIT - 5

Optimum process design with examples, project development and commercialization, plant location and layout, selection of plant capacity.

UNIT - 6

Project engineering management, project scheduling and its importance, use of CPM/PERT techniques.

Text/Reference Books

1. M. S. Peters and K. D. Timmerhaus, Plant Design Economics for Chemical Engineers, 5th Ed., McGraw-Hill, New York - 2003.
2. V. W. Uhl and A. W. Hawkins, Technical Economics for Chemical Engineers, AIChE - 1971.
3. J. Modes and Philips, Project Engineering with CPM and PERT, Rein Hold.
4. Choudhary, Project management
5. Jelen, Cost and optimization engineering

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A	Elective-IV: Advanced Petroleum Refining	6 Credits
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UNIT - 1

Coking and thermal processes: Types, properties and uses of petroleum coke, process description for delayed coking and fluid bed coking, case study problem.

UNIT - 2

Catalytic Cracking:

Fluidized bed catalytic cracking, New design of FCC units, cracking reactions, Coking of cracking catalyst, process variables, heat recovery, yield estimation, capital and operating cost, case study problem on catalytic cracker.

UNIT - 3

Catalytic Hydrocracker: Hydrocracking reactions, feed preparation, process description, hydrocracking catalyst, process variables, hydrocracking yield, investment and operating cost, case study problem on hydrocracker.

UNIT - 4

Hydroprocessing and resid processing:

Composition of vacuum tower bottoms, process options, hydroprocessing, expanded bed hydrocracking processes, moving bed hydroprocessors, solvent extraction, summary of resid processing operations. Hydrotreating- Hydrotreating catalyst, aromatic reduction, reactions, process variables, construction and operating cost, case study problem on hydrotreater.

UNIT - 5

Catalytic reforming and isomerization:

Feed preparation, catalytic reforming processes, reforming catalysts, reactor design, yields and costs.

Isomerization:

Capital and operating costs, isomerization yield, case study problem on Reformer and isomerization unit.

UNIT - 6

Dr. Babasaheb Ambedkar Technological University, Lonere

Alkylation and polymerization :

Alkylation reactions, process variables, alkylation feed stocks, alkylation products, HF and sulfuric acid alkylation process, comparison between the processes, alkylation yields and costs, polymerization , case study problem on alkylation and polymerization.

Text/Reference Books

1. J.H. Gary, *Petroleum Refining - Technology and Economics*, 3rd Ed., Marcel Dekkar Inc, 1994
2. G.D.Hobson, *Modern Petroleum Technology Vol.I& II*, 5th Ed., Applid science ,London

B Elective-IV: Newer Methods of Separation

6 Credits

UNIT - 1

Supercritical Fluid Extraction :

Physiochemical principles, thermodynamics modeling.

UNIT - 2

Supercritical Fluid Extraction: Process synthesis and energy analysis, case studies.

UNIT - 3

Membrane Processes:

Brief review, module design and module characteristics, plant design and operation.

UNIT - 4

Membrane Processes:

Reverse osmosis, ultrafiltration and microfiltration.

UNIT - 5

Surfactant based Separation:

Fundamentals of surfactants at surfaces and in solution, liquid membrane permeation

UNIT - 6

Dr. Babasaheb Ambedkar Technological University, Lonere

Surfactant based Separation:

Foam separations, micellar separations

Text/Reference Books

1. M. A. McHugh, and V. J. Krukonis, *Supercritical Extraction*, Butterworths, Boston, (1985).
2. R. G. Gutman, *Membrane Filtration*, Adam Hilger, Bristol, (1987).
3. R. Rautenbach, and R. Albercht, *Membrane Processes*, John Wiley & Sons, (1994).
4. J. F. Scamehorn, and J. H. Harwell, *Surfactant Based Separation Processes*, Surfactant Science Series, Vol. 33, Marcel – Dekkar Inc., New York, (1989).

C Elective-IV: Introduction to Colloid and Interface Science and Engineering 6 Credits

UNIT - 1

Introduction, aims, scope and applications.

Surface Tension, Adhesion and capillarity: molecular to meso-scopic concepts; theories and applications.

UNIT - 2

Intermolecular, nanoscale and interfacial forces in organic, polymeric, biological and aqueous systems.

UNIT - 3

van der Waals, electrostatic, acidbase, depletion interactions, entropic effects.

UNIT - 4

Nanoscale, Mesoscale and surface thermodynamics.

UNIT - 5

Stability and utilization of nanoparticle dispersions: DLVO and DLVO like theories and kinetics.
Nanomechanics and nano-fluidics.

UNIT - 6

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Mesoscale phenomena in soft matter and industrial applications.

D Elective-IV: M.Tech courses

6 Credits

Process Equipment Design and Drawing 10 Credits

UNIT - 1

Chemical Process Plant Materials: Stress characteristics, materials of construction for process equipment, stainless steel, non ferrous alloys, heat treatment of materials, Indian standard code for steels, polymeric materials, reinforced plastics, packing materials, materials of construction for handling specific chemicals, lining of chemical process equipments, non destructive methods for thickness measurements.

Corrosion Mechanism: theories of corrosion, forms of corrosion.

UNIT - 2

Pressure Vessels:

Vessels subjected to internal pressure and combined loading, cylindrical shell and spherical shell, stresses induced in vessel, vessels subjected to high pressure, high pressure vessel fabrication techniques, optimum proportion of a vessel, optimum vessel size, estimation of equipment weight, criteria for the purchase of new equipments, jacket for reaction vessel, comparison of jacket and coil, closures for vessels, flat plates, formed heads, standard shallow dished heads, torispherical head, elliptical head, hemispherical head, conical head, selecting the most economical head, scale up of process equipments, scale up of fluid flow systems, scale up technique for mixing system.

UNIT - 3

Vessel Supports:

Design of support for vessels, skirt support, stress due to dead weight, stress due to wind load, stress due to seismic load, skirt bearing plate, base plate radial stress, anchor bolts, base ring, design of bracket or long support, maximum total compressive load, stiffener and gusset plate, column supports for the brackets, design of saddle supports, stresses induced due to saddles, ring stiffeners, design of tall vessel columns, stresses in the shell of a tall vertical vessel.

UNIT - 4

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Flanges and Nozzles:

Classification of flanges, types of flanges, design of gaskets, gasket classification, selection of gasket, gasket seating stress and gasket factor, gasket factor, gasket width, bolt load, bolt selection, bolt circle diameter, flange thickness, rating of flange. Nozzles: nozzle reinforcement, design compensation, area for area method, controlled maximum shear stress method, experimental yield method.

UNIT - 5

Storage Tanks:

Liquefied gases, loss mechanism in storage tanks, optimum proportions of a storage tanks, estimation of volume of storage tanks, horizontal cylindrical tank with flat heads, volume of spherical tank filled upto certain height, partial volume of spherically dished vertical head, volume estimation in partially filled horizontal tank, mechanical design of storage tanks, wind girders, roof of the tank, types of floating roof, self supported conical roof, roof curb angles, mechanical design of horizontal storage tank with saddle supports, spherical storage tank, design consideration of ammonia storage tanks, estimation of nozzle diameter for drain in storage tanks, estimation of time required to drain a tank with piping, storage tank dike, solid materials, cryogenic liquid storage tanks.

UNIT - 6

Agitation:

Types of agitators, paddle agitator, anchor agitator, helical ribbon agitator, helical screw agitator, propeller, turbine agitator impeller, flat blade turbine agitator impeller.

Piping: pipe thickness, pipe diameter, condensate piping, pipe diameter for steam, pipe supports, cross country pipeline, design of pipe line for natural gas, pipe line design for transportation of crude oil, pipeline in sea water, pipeline design on fluid dynamics parameters, optimum size of delivery line in pump operation, pipeline for solid transportation.

Valves and relief devices: selection and classification of valves, types of valves, control valves, safety valves, rupture discs, pressure relief system, steam trap valve.

Text/Reference Books

1. J. M. Coulson, J. F. Richardson and R. K. Sinnott, *Chemical Engineering Vol. 6*, Pergamon press International Ed., 1989.
2. L. E. Brownell and E. H. Young, *Process equipment design*, John Wiley and Sons, New York, 1968.
3. M. V. Joshi, *Process Equipment Design*, McMillan, India, 1976.
4. S. D. Dawande, *Process Equipment Design, volume 1*, Dennett & Co publishers.

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Petrochemical Process -I

8 Credits

UNIT - 1

Scenerio of Petrochemical Industries and its feed stock. Product pattern of paraffins , olefins, diened and acetylene.

UNIT - 2

Manufacture of important paraffins ,olefins, acetylene,butadiene ,isoprene,oligomersand aromatics :
Techniques, Equipments,Reactions, Catalyst, Solvents, Operating conditions, Separation and purification
and developments in these areas.

UNIT - 3

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

UNIT - 4

Conversion of -
Ethylene to ethylene oxide, ethylene glycol, ethanol amine
Propylene to acrylic acid ,methyl ethyl ketone acrylonitrile

UNIT - 5

Conversions of -
Butenes to iso and n butanols, MIBK, MTBE
Aromatics to maleic and phthalicanhydride ,DMT , phenols and acetones
Cyclohexane to caprolactum ,adipic acid ,succenic acid

UNIT - 6

Hydration : Technologies for production of alcohols such as ethanol, isobutyl alcohol and higher
alcohols .
Esterification: Process for production of few esters such as acrylates, terephthalates ,ester for
flavoring industries etc

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Text/Reference Books

1. N.N. Lebdev, *Chemistry and technology of basic organic and petrochemical synthesis*, Vol. 1 & 2 Mir publications, Moscow
2. Dryden, Charles E., *Outlines of Chemical Technology*, affiliated East-West Press Pvt. Ltd. New Delhi
3. B.K. Bhaskarrao, *A text on Petrochemicals*, 2nd Ed, Khanna publishers, New Delhi.
4. G.N. Sarkar, *Advanced Petrochemicals*, 1st Ed, Khanna Publishers, New Delhi

Transport Phenomena 8 Credits

UNIT - 1

1. Viscosity and Mechanism of Momentum Transport :

Newton's Law of Viscosity; Non-Newtonian fluids ; The Bingham model; The power law model; The Elli's model and the Reiner Philippoff model; Temperature and pressure dependents of viscosity.

2. Velocity Distributions in Laminar Flow :

Shell momentum balances; Boundary conditions ; Flow of a falling film; flow through a circular tube; flow through annulus.

UNIT - 2

3. Equation of change for Isothermal Systems :

Equations of continuity and motion in Cartesian and curvilinear co-ordinates; Use of the equations of change to set-up steady flow problems. Tangential annular flow of Newtonian fluid; Shape of surface of a rotating liquid.

4. Velocity Distributions with more than One independent variable :

Unsteady viscous flow ; Flow near a wall suddenly set in motion.

UNIT - 3

5. Interphase Transport in Isothermal Systems :

Definition of fraction factors; Friction factors for flow in tubes; for around spheres.

6. Thermal Conductivity and Mechanism of Energy Transport : Fourier's law of heat conduction; temperature and pressure dependence of thermal conductivity in gases and liquids.

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7. Temperature Distributions in solids and in Laminar Flow :

Shell energy balances; Boundary conditions; Heat conduction with an electrical heat source; with a viscous heat source.

UNIT - 4

8. Equations of change for Non-Isothermal Systems :

Use of equations of energy and equations of motion (for forced and free convection) in non-isothermal flow; Tangential flow in an annulus with viscous heat generation; steady flow of a non-isothermal film; Transpiration cooling.

9. Temperature Distributions with more than One Independent Variable :

Unsteady heat conduction in solids; Heating of a semi-infinite slab.

UNIT - 5

10. Interphase transport in Non-Isothermal Systems :

Definition of heat transfer coefficient; Heat transfer coefficients for forced convection in tubes; for forced convection around submerged objects.

11. Diffusivity and the mechanism of mass transport :

Definition of concentrations; Velocity and mass fluxes; Fick's law of diffusion; Temperature and pressure dependence of mass diffusivity.

UNIT - 6

12. Concentration Distribution in solids and in Laminar Flow:

Shell mass balances; Boundary conditions; Diffusion through a stagnant gas film; Diffusion with heterogeneous chemical reaction.

13. Equation of change for multicomponent systems :Equations of continuity for a binary mixture.

14. Interphase Transport in Multicomponent systems : Definition of binary mass transfer coefficients in one phase. Correlations of binary mass transfer coefficient in one phase at low mass transfer rates.

Text Book

Dr. Babasaheb Ambedkar Technological University, Lonere

Bird R.B., Stewart W.E. and Light Foot E.N. *Transport Phenomena*,
John Wiley International – 2nd Edition, New York, (2002).

Reference Book

Christie J. Geankoplis *Transport Processes and Unit Operations*, Pentice Hall of India Pvt. Ltd., New Delhi, 1997.

Pollution Control in Process Industries

8 Credits

UNIT - 1

1. Introduction :

The Biosphere, Energy Problem, Pollution of Air, Water and Soil.

2. Air Pollution :

Definition, Concentration, Classification, Emission Sources Behaviour and Effects of air pollution, Temperature lapse rates, Plume behaviour. Dispersion of air pollutants, the Gaussian plume model.

UNIT - 2

3. Air Pollution Sampling and measurement :

Types of sampling and measurement, Ambient air sampling, Gaseous air pollutants, Analysis of air pollutants, like Sulphur dioxide, Nitrogen Oxides, Carbon Monoxide, Oxidants and zones, Hydrocarbons, Particulate matter.

UNIT - 3

4. Air pollution control methods and equipment :

Control methods, Source correction methods, cleaning of gaseous effluents, particulate emission control, control of gaseous emissions.

5. Air pollution control methods and equipment :

Control methods, Source correction methods, cleaning of gaseous effluents, particulate emission control, control of gaseous emissions.

UNIT - 4

6. Control of Specific Gaseous pollutants:

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Control of Sulphur dioxide emission, Nitrogen oxides, Carbon monoxide and hydrocarbons.

7. Sources and Classification of water pollutants :

Water resources, origin of waste water, types of water pollutants and their effects, water pollution laws and standards.

UNIT - 5

8. **Waste Water sampling, Analysis and Treatment** : Sampling and methods of analysis, Organic and inorganic substance, physical character sticks, Bacteriological measurements, water quality standards, Primary, Secondary and advanced waste water treatment, recovery of materials from process effluents.

UNIT - 6

9. Solid waste management:

Sources & classifications of solid waste, Public health aspects, Methods of collection, Methods of disposal: Open dumping, Sanitary land fill, Incineration, Composting; Potential methods of disposal

Text Book

1. Rao C.S. *Environmental Pollution Control Engineering*, Wiley Eastern Limited, India, 1991

Reference Books

1. K. V. S. G. Murali Krishna *Air Pollution and Control*, Kaushal and Co., 1999.
2. W. Wesley Eckenfelder Jr. *Industrial Water Pollution Control*, McGraw Hill International, 1989;

A Elective-V Entrepreneurship Development 6 Credits

UNIT - 1

1. Introduction:

Objective of the course; What is entrepreneurship; Need and scope for entrepreneurship; Risks and rewards in entrepreneurship; Characteristics of an entrepreneur; Relevance and benefits of small scale industry.

UNIT - 2

2. Human Engineering (Theory and lab):

Entrepreneur and society; Attitude towards work; Self assessment and goal setting; Achievement motivation and behaviour (TAT, Who am I, Business exercise, Ring toss game etc.); Understanding human behaviour (Maslow's hierarchy of needs).

UNIT - 3

3. Setting-up an industry:

Forms of business organizations/ownership - their merits and demerits; Formation of a company; Procedures and formalities for setting up of a new industry; Sources of information (Whom to contact for what and where); Incentives; Subsidies and concessions for industry; Industrial development agencies and their functions; State and National level institutions for small scale industry (General set-up).

UNIT - 4

4. Project planning:

Identification of opportunities; Market survey; Techno-economic feasibility studies and economic analysis (Pay back period, Return on Investment, Cost-benefit analysis and Break-even analysis); Financial viability; Sources of finance for industry; Assessment of fixed and working capital requirements; Financial ratios, Project scheduling.

UNIT - 5

5. Marketing:

Components of marketing management; Market survey and analysis; Marketing arrangements; Strategies and assistance to small industry; Consumer behaviour; Market feed back; projections; Predictions and forecasts.

UNIT - 6

6. Project report:

Preparation of a detailed project report.

7. Industrial laws:

The factories act 1948; minimum wages act; payment of wages act 1936; Workmen compensation act 1923.

Dr. Babasaheb Ambedkar Technological University, Lonere

Text Books

1. *Handbook for New Entrepreneurs*, EDII, Ahmedabad
2. P Saravanel, *Entrepreneurial Development*
3. T. R. Banga, *Project planning and entrepreneurship development*

B Elective-V Catalyst Science and Technology

6 Credits

UNIT - 1

Heterogeneous catalytic processes, types of heterogeneous reactions. Absorption, absorption isotherms, rates of absorption, Physisorption and chemisorptions. Solid catalysis, types of catalysts, catalyst formulations and Preparation methods.

UNIT - 2

Catalysts Characterization methods : Surface area and pore volume determinations, XRD, various Spectroscopic techniques, Temperature programmed reduction & oxidation, Electron microscopy.

UNIT - 3

Testing of catalysts , various types of reactors, activity and selectivity studies. Effect of external transport processes on observed rate of reactions. Effect of internal transport processes: reactions and diffusion in porous catalysts.

UNIT - 4

Mechanism of catalytic reactions, Rates of adsorption, desorption, surface reactions, rate determining steps. Kinetic modelling and Parameter estimations, Model discriminations.

UNIT - 5

Catalysts promoters, Inhibitors, catalyst deactivations, kinetics of catalyst deactivations. Industrial processes involving heterogeneous solid catalysts.

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UNIT - 6

New development in solid catalysis, monolith catalysts ,nanocatalysts, Fuel cell catalysts, Environmental catalysts, In-situ characterization. Design of catalysts ; simulation techniques.

C Elective-V Lubricants, Waxes and Petroleum Specialty Chemicals 6 Credits

UNIT - 1

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

UNIT - 2

Refining of lubricating oil:

Solvent ,chemical and hydrogenation method, dewaxingdeasphalting etc. Re-refining of lubricating oil Asphalt and asphalt specialties , Air blowing and emulsification techniques

UNIT - 3

Waxes:

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

UNIT - 4

Petroleum wax :

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

UNIT - 5

Process for the manufacture of speciality chemicals such as synthetic lubricants, porepoint depressant.

UNIT - 6

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

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Reference Books

1. Peter H. Spitz, *Petrochemicals 'The Rise of an Industry'*
2. Wiley Critical Content, *Petroleum Technology- Vol-2*, Wiley Interscience Publication.

D Elective – V M. Tech Courses 6 Credits

Petrochemical Processes-II 6 Credits

UNIT - 1

Chlorination:

Chlorination of paraffins, olefins and aromatic hydrocarbons, technologies involved in production of chloromethane, chloroethane, ethylene chlorides, vinyl chloride, chlorobenzene. Precaution and safety while handling chlorine and fluorine compounds.

UNIT - 2

Nitration :

Nitrobenzene, aniline, nitrotoluene, nitrochlorobenzenes

UNIT - 3

Sulphonation:

Sulphonation of benzene and discussion in context of detergent industry

UNIT - 4

Polymerization:

Principle and types, control and monitoring of polymerization processes
Technology for production of :

Plastics:

Polyethylene, Polypropylene, PVC

Resins – Phenol formaldehyde, Melamine formaldehyde

UNIT - 5

Rubbers:

SBR, isoprene/neoprene

Fibres:

Nylons and polyesters , acrylic fibres.

UNIT - 6

Processing of polymers for making films, sheets, pipes, fibres etc by different techniques.

Compounding of polymers- additives and modifiers.

Text/Reference Books

1. P.H. Groggins, *Unit processes in Organic Synthesis*, 5thed, Eastwest press
2. Brydson, *Hand book of Plastics*,