

**AFFILIATED INSTITUTIONS
ANNA UNIVERSITY, CHENNAI
R - 2008**

**B.TECH. PETROCHEMICAL TECHNOLOGY
II TO VIII SEMESTERS CURRICULUM AND SYLLABI**

SEMESTER II

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	HS2161	<u>Technical English – II*</u>	3	1	0	4
2.	MA2161	<u>Mathematics – II*</u>	3	1	0	4
3.	PH2161	<u>Engineering Physics – II*</u>	3	0	0	3
4.	CY2161	<u>Engineering Chemistry – II*</u>	3	0	0	3
5. a	ME2151	<u>Engineering Mechanics</u> (For non-circuit branches)	3	1	0	4
5. b	EE2151	<u>Circuit Theory</u> (For branches under Electrical Faculty)	3	1	0	4
5. c	EC2151	<u>Electric Circuits and Electron Devices</u> (For branches under I & C Faculty)	3	1	0	4
6. a	GE2151	<u>Basic Electrical & Electronics Engineering</u> (For non-circuit branches)	4	0	0	4
6. b	GE2152	<u>Basic Civil & Mechanical Engineering</u> (For circuit branches)	4	0	0	4
PRACTICAL						
7.	GE2155	<u>Computer Practice Laboratory-II*</u>	0	1	2	2
8.	GS2165	<u>Physics & Chemistry Laboratory - II*</u>	0	0	3	2
9. a	ME2155	<u>Computer Aided Drafting and Modeling Laboratory</u> (For non-circuits branches)	0	1	2	2

9. b	EE2155	<u>Electrical Circuits Laboratory</u> (For branches under Electrical Faculty)	0	0	3	2
9. c	EC2155	<u>Circuits and Devices Laboratory</u> (For branches under I & C Faculty)	0	0	3	2
TOTAL : 28 CREDITS						
10.	-	<u>English Language Laboratory</u> ⁺	0	0	2	-

* Common to all B.E. / B.Tech. Programmes

+ Offering English Language Laboratory as an additional subject (with no marks) during 2nd semester may be decided by the respective Colleges affiliated to Anna University Chennai.

A. CIRCUIT BRANCHES

I Faculty of Electrical Engineering

1. B.E. Electrical and Electronics Engineering
2. B.E. Electronics and Instrumentation Engineering
3. B.E. Instrumentation and Control Engineering

II Faculty of Information and Communication Engineering

1. B.E. Computer Science and Engineering
2. B.E. Electronics and Communication Engineering
3. B.E. Bio Medical Engineering
4. B.Tech. Information Technology

B. NON – CIRCUIT BRANCHES

I Faculty of Civil Engineering

1. B.E. Civil Engineering

II Faculty of Mechanical Engineering

1. B.E. Aeronautical Engineering
2. B.E. Automobile Engineering
3. B.E. Marine Engineering
4. B.E. Mechanical Engineering
5. B.E. Production Engineering

III Faculty of Technology

1. B.Tech. Chemical Engineering
2. B.Tech. Biotechnology

3. B.Tech. Polymer Technology
4. B.Tech. Textile Technology
5. B.Tech. Textile Technology (Fashion Technology)
6. B.Tech. Petroleum Engineering

SEMESTER III

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	MA3202	<u>Transforms and Partial Differential Equations</u>	3	1	0	4
2	CH3202	<u>Organic Chemistry</u>	3	0	0	3
3	GE3213	<u>Environmental Science and Engineering</u>	3	0	0	3
4	PC3204	<u>Industrial Chemical Technology</u>	3	0	0	3
5	EE3205	<u>Electrical Drives and Control</u>	3	0	0	3
6	CS3206	<u>Data Structures</u>	3	0	0	3
PRACTICAL						
7	CH3207	<u>Organic Chemistry Laboratory</u>	0	0	3	2
8	PC3208	<u>Electrical Machines Laboratory</u>	0	0	3	2
9	CS3209	<u>Data Structures Laboratory</u>	0	0	3	2
		TOTAL	18	1	9	25

SEMESTER IV

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	MA3021	<u>Numerical Methods</u>	3	1	0	4
2	CH3211	<u>Physical Chemistry</u>	3	0	0	3
3	CH3212	<u>Material Technology</u>	3	0	0	3
4	PC3213	<u>Process Calculations</u>	4	0	0	4
5	CE3214	<u>Fluid Flow Operations</u>	3	0	0	3
6	CH3215	<u>Mechanical Operations</u>	3	0	0	3
PRACTICAL						
7	CH3216	<u>Physical Chemistry Laboratory</u>	0	0	3	2
8	CE3217	<u>Fluid Flow Operations Laboratory</u>	0	0	3	2
9	CH3218	<u>Mechanical Operations Laboratory</u>	0	0	3	2
		TOTAL	19	1	9	26

SEMESTER V

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	PC3301	<u>Special Functions</u>	3	1	0	4
2	CH3302	<u>Heat Transfer</u>	4	0	0	4
3	PC3303	<u>Mass Transfer Fundamentals</u>	4	0	0	4
4	PC3304	<u>Engineering Thermodynamics</u>	4	0	0	4
5	PE3305	<u>Natural Gas Engineering</u>	4	0	0	4
6	PC3306	<u>Petroleum Exploration and Exploitation Techniques</u>	3	1	0	4
PRACTICAL						
7	CH3307	<u>Heat Transfer Laboratory</u>	0	0	3	2
8	CH3308	<u>Technical Analysis Laboratory</u>	0	0	3	2
9	GE3318	<u>Communication Skills and Soft Skills Laboratory</u>	0	0	2	1
		TOTAL	22	2	8	29

SEMESTER VI

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	PC3310	<u>Process Dynamics and Control</u>	4	0	0	4
2	PC3311	<u>Mass Transfer Operations</u>	3	1	0	4
3	PC3312	<u>Principles of Chemical Kinetics</u>	4	0	0	4
4	PC3313	<u>Equipment Design and Drawing I</u>	2	0	2	4
5	PC3314	<u>Petrochemical Unit Processes</u>	4	0	0	4
6	PC3315	<u>Petroleum Crude Processing Technology</u>	4	0	0	4
PRACTICAL						
7	PC3316	<u>Process Dynamics and Control Laboratory</u>	0	0	3	2
8	PC3317	<u>Petroleum Physical Properties Testing Laboratory</u>	0	0	3	2
9	CH3318	<u>Mass Transfer Laboratory</u>	0	0	3	2
		TOTAL	21	1	11	30

SEMESTER VII

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	PC3401	<u>Equipment Design and Drawing II</u>	2	0	2	4
2	PC3402	<u>Chemical Reaction Engineering</u>	3	1	0	4
3	PC3403	<u>Petrochemical Derivatives</u>	4	0	0	4
4	PC3404	<u>Petroleum Secondary Processing Technology</u>	4	0	0	4
5	PC3405	<u>Water Treatment and Management</u>	4	0	0	4
6		Elective I	3	0	0	3
Practical						
7	PC3406	<u>Petrochemical Analysis Laboratory</u>	0	0	3	2
8	PC3407	<u>Petroleum Product Testing Laboratory</u>	0	0	3	2
9	PC3408	<u>Chemical Reaction Engineering Laboratory</u>	0	0	3	2
		TOTAL	20	1	11	29

SEMESTER VIII

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	GE3403	<u>Total Quality Management</u>	4	0	0	4
2	PC3410	<u>Safety and Risk Management</u>	4	0	0	4
3		Elective II	3	0	0	3
PRACTICAL						
4	PC3411	<u>Project Work</u>	0	0	12	12
		TOTAL	11	0	12	23

LIST OF ELECTIVES
ELECTIVE FOR SEMESTER III

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	CH3002	<u>Process Modelling and Simulation</u>	3	0	0	3
2	CH3003	<u>Transport Phenomena</u>	3	0	0	3
3	PC3003	<u>Process Instrumentation</u>	3	0	0	3
4	CH3004	<u>Fluidization Engineering</u>	3	0	0	3
5	PC3005	<u>Petroleum Process Equipment Auxiliaries</u>	3	0	0	3
6	PC3006	<u>Industrial Management</u>	3	0	0	3

ELECTIVES FOR SEMESTER IV

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	PC3007	<u>Energy Management in Chemical Industries</u>	3	0	0	3
2	PC3008	<u>Novel Separation Process</u>	3	0	0	3
3	CH3009	<u>Fertilizer Technology</u>	3	0	0	3
4	PC3010	<u>Multicomponent Distillation</u>	3	0	0	3
5	PC3011	<u>Combustion and Furnace Design</u>	3	0	0	3
6	PC3012	<u>Polymer Technology</u>	3	0	0	3

AIM:

To encourage students to actively involve in participative learning of English and to help them acquire Communication Skills.

OBJECTIVES:

- To help students develop listening skills for academic and professional purposes.
- To help students acquire the ability to speak effectively in English in real-life situations.
- To inculcate reading habit and to develop effective reading skills.
- To help students improve their active and passive vocabulary.
- To familiarize students with different rhetorical functions of scientific English.
- To enable students write letters and reports effectively in formal and business situations.

UNIT I**12**

Technical Vocabulary - meanings in context, sequencing words, Articles- Prepositions, intensive reading& predicting content, Reading and interpretation, extended definitions, Process description

Suggested activities:

1. Exercises on word formation using the prefix 'self' - Gap filling with preposition.
2. Exercises - Using sequence words.
3. Reading comprehension exercise with questions based on inference – Reading headings
4. and predicting the content – Reading advertisements and interpretation.
5. Writing extended definitions – Writing descriptions of processes – Writing paragraphs based on discussions – Writing paragraphs describing the future.

UNIT II**12**

Phrases / Structures indicating use / purpose – Adverbs-Skimming – Non-verbal communication - Listening – correlating verbal and non-verbal communication -Speaking in group discussions – Formal Letter writing – Writing analytical paragraphs.

Suggested activities:

1. Reading comprehension exercises with questions on overall content – Discussions analyzing stylistic features (creative and factual description) - Reading comprehension exercises with texts including graphic communication - Exercises in interpreting non-verbal communication.
2. Listening comprehension exercises to categorise data in tables.
3. Writing formal letters, quotations, clarification, complaint – Letter seeking permission for Industrial visits– Writing analytical paragraphs on different debatable issues.

UNIT III**12**

Cause and effect expressions – Different grammatical forms of the same word - Speaking – stress and intonation, Group Discussions - Reading – Critical reading - Listening, - Writing – using connectives, report writing – types, structure, data collection, content, form, recommendations .

Suggested activities:

1. Exercises combining sentences using cause and effect expressions – Gap filling exercises using the appropriate tense forms – Making sentences using different

- grammatical forms of the same word. (Eg: object –verb / object – noun)
2. Speaking exercises involving the use of stress and intonation – Group discussions– analysis of problems and offering solutions.
 3. Reading comprehension exercises with critical questions, Multiple choice question.
 4. Sequencing of jumbled sentences using connectives – Writing different types of reports like industrial accident report and survey report – Writing recommendations.

UNIT IV

12

Numerical adjectives – Oral instructions – Descriptive writing – Argumentative paragraphs – Letter of application - content, format (CV / Bio-data) - Instructions, imperative forms - Checklists, Yes/No question form – E-mail communication.

Suggested Activities:

1. Rewriting exercises using numerical adjectives.
2. Reading comprehension exercises with analytical questions on content – Evaluation of content.
3. Listening comprehension – entering information in tabular form, intensive listening exercise and completing the steps of a process.
4. Speaking - Role play – group discussions – Activities giving oral instructions.
5. Writing descriptions, expanding hints – Writing argumentative paragraphs – Writing formal letters – Writing letter of application with CV/Bio-data – Writing general and safety instructions – Preparing checklists – Writing e-mail messages.

UNIT V

9

Speaking - Discussion of Problems and solutions - Creative and critical thinking – Writing an essay, Writing a proposal.

Suggested Activities:

1. Case Studies on problems and solutions
2. Brain storming and discussion
3. Writing Critical essays
4. Writing short proposals of 2 pages for starting a project, solving problems, etc.
5. Writing advertisements.

TOTAL: 60 PERIODS

TEXT BOOK:

1. Chapters 5 – 8. Department of Humanities & Social Sciences, Anna University, 'English for Engineers and Technologists' Combined Edition (Volumes 1 & 2), Chennai: Orient Longman Pvt. Ltd., 2006. Themes 5 – 8 (Technology, Communication, Environment, Industry)

REFERENCES:

1. P. K. Dutt, G. Rajeevan and C.L.N Prakash, 'A Course in Communication Skills', Cambridge University Press, India 2007.
2. Krishna Mohan and Meera Banerjee, 'Developing Communication Skills', Macmillan India Ltd., (Reprinted 1994 – 2007).
3. Edgar Thorpe, Showick Thorpe, 'Objective English', Second Edition, Pearson Education, 2007.

EXTENSIVE READING:

1. Robin Sharma, 'The Monk Who Sold His Ferrari', Jaico Publishing House, 2007

NOTE:

The book listed under Extensive Reading is meant for inculcating the reading habit of the students. They need not be used for testing purposes.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS**12**

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

UNIT II VECTOR CALCULUS**12**

Gradient Divergence and Curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

UNIT III ANALYTIC FUNCTIONS**12**

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy – Riemann equation and Sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping : $w = z+c$, cz , $1/z$, and bilinear transformation.

UNIT IV COMPLEX INTEGRATION**12**

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor and Laurent expansions – Singular points – Residues – Residue theorem – Application of residue theorem to evaluate real integrals – Unit circle and semi-circular contour(excluding poles on boundaries).

UNIT V LAPLACE TRANSFORM**12**

Laplace transform – Conditions for existence – Transform of elementary functions – Basic properties – Transform of derivatives and integrals – Transform of unit step function and impulse functions – Transform of periodic functions.

Definition of Inverse Laplace transform as contour integral – Convolution theorem (excluding proof) – Initial and Final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

TOTAL: 60 PERIODS**TEXT BOOKS:**

1. Bali N. P and Manish Goyal, "Text book of Engineering Mathematics", 3rd Edition, Laxmi Publications (p) Ltd., (2008).
2. Grewal. B.S, "Higher Engineering Mathematics", 40th Edition, Khanna Publications, Delhi, (2007).

REFERENCES:

1. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, (2007).
2. Glyn James, "Advanced Engineering Mathematics", 3rd Edition, Pearson Education, (2007).
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 7th Edition, Wiley India, (2007).
4. Jain R.K and Iyengar S.R.K, "Advanced Engineering Mathematics", 3rd Edition, Narosa Publishing House Pvt. Ltd., (2007).

UNIT I CONDUCTING MATERIALS 9

Conductors – classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – Draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals.

UNIT II SEMICONDUCTING MATERIALS 9

Intrinsic semiconductor – carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination – extrinsic semiconductors – carrier concentration derivation in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration – compound semiconductors – Hall effect – Determination of Hall coefficient – Applications.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetic moment – Bohr magneton – Dia and para magnetism – Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – anti – ferromagnetic materials – Ferrites – applications – magnetic recording and readout – storage of magnetic data – tapes, floppy and magnetic disc drives.

Superconductivity : properties - Types of super conductors – BCS theory of superconductivity(Qualitative) - High T_c superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.

UNIT IV DIELECTRIC MATERIALS 9

Electrical susceptibility – dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation – internal field – Clausius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer) – ferroelectricity and applications.

UNIT V MODERN ENGINEERING MATERIALS 9

Metallic glasses: preparation, properties and applications.

Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, advantages and disadvantages of SMA

Nanomaterials: synthesis –plasma arcing – chemical vapour deposition – sol-gels – electrodeposition – ball milling - properties of nanoparticles and applications.

Carbon nanotubes: fabrication – arc method – pulsed laser deposition – chemical vapour deposition - structure – properties and applications.

TOTAL: 45 PERIODS**TEXT BOOKS:**

1. Charles Kittel ‘ Introduction to Solid State Physics’, John Wiley & sons, 7th edition, Singapore (2007)
2. Charles P. Poole and Frank J.Ownen, ‘Introduction to Nanotechnology’, Wiley India(2007) (for Unit V)

REFERENCES:

1. Rajendran, V, and Marikani A, ‘Materials science’Tata McGraw Hill publications, (2004) New delhi.
2. Jayakumar, S. ‘Materials science’, R.K. Publishers, Coimbatore, (2008).
3. Palanisamy P.K, ‘Materials science’, Scitech publications(India) Pvt. LTd., Chennai, second Edition(2007)
4. M. Arumugam, ‘Materials Science’ Anuradha publications, Kumbakonam, (2006).

AIM

To impart a sound knowledge on the principles of chemistry involving the different application oriented topics required for all engineering branches.

OBJECTIVES

- The student should be conversant with the principles electrochemistry, electrochemical cells, emf and applications of emf measurements.
- Principles of corrosion control
- Chemistry of Fuels and combustion
- Industrial importance of Phase rule and alloys
- Analytical techniques and their importance.

UNIT I ELECTROCHEMISTRY 9

Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf – Single electrode potential – Nernst equation (problem) – reference electrodes – Standard Hydrogen electrode – Calomel electrode – Ion selective electrode – glass electrode and measurement of pH – electrochemical series – significance – potentiometer titrations (redox - Fe^{2+} vs dichromate and precipitation – Ag^+ vs Cl^- titrations) and conduct metric titrations (acid-base – HCl vs, NaOH) titrations,

UNIT II CORROSION AND CORROSION CONTROL 9

Chemical corrosion – Pilling – Bedworth rule – electrochemical corrosion – different types – galvanic corrosion – differential aeration corrosion – factors influencing corrosion – corrosion control – sacrificial anode and impressed cathodic current methods – corrosion inhibitors – protective coatings – paints – constituents and functions – metallic coatings – electroplating (Au) and electroless (Ni) plating.

UNIT III FUELS AND COMBUSTION 9

Calorific value – classification – Coal – proximate and ultimate analysis metallurgical coke – manufacture by Otto-Hoffmann method – Petroleum processing and fractions – cracking – catalytic cracking and methods-knocking – octane number and cetane number – synthetic petrol – Fischer Tropsch and Bergius processes – Gaseous fuels-water gas, producer gas, CNG and LPG, Flue gas analysis – Orsat apparatus – theoretical air for combustion.

UNIT IV PHASE RULE AND ALLOYS 9

Statement and explanation of terms involved – one component system – water system – condensed phase rule – construction of phase diagram by thermal analysis – simple eutectic systems (lead-silver system only) – alloys – importance, ferrous alloys – nichrome and stainless steel – heat treatment of steel, non-ferrous alloys – brass and bronze.

UNIT V ANALYTICAL TECHNIQUES 9

Beer-Lambert's law (problem) – UV-visible spectroscopy and IR spectroscopy – principles – instrumentation (problem) (block diagram only) – estimation of iron by colorimetry – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry – atomic absorption spectroscopy – principles – instrumentation (block diagram only) – estimation of nickel by atomic absorption spectroscopy.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. P.C.Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi (2002).
2. S.S.Dara "A text book of Engineering Chemistry" S.Chand & Co.Ltd., New Delhi (2006).

REFERENCES:

1. B.Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2008).
2. B.K.Sharma "Engineering Chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2001).

ME2151**ENGINEERING MECHANICS****L T P C**
3 1 0 4**OBJECTIVE**

At the end of this course the student should be able to understand the vectorial and scalar representation of forces and moments, static equilibrium of particles and rigid bodies both in two dimensions and also in three dimensions. Further, he should understand the principle of work and energy. He should be able to comprehend the effect of friction on equilibrium. He should be able to understand the laws of motion, the kinematics of motion and the interrelationship. He should also be able to write the dynamic equilibrium equation. All these should be achieved both conceptually and through solved examples.

UNIT I BASICS & STATICS OF PARTICLES**12**

Introduction – Units and Dimensions – Laws of Mechanics – Lamé's theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT II EQUILIBRIUM OF RIGID BODIES**12**

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT III PROPERTIES OF SURFACES AND SOLIDS**12**

Determination of Areas and Volumes – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, - Angle section, Hollow section by using standard formula – second and product moments of plane area – Rectangle, triangle, circle from integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia – Derivation of mass moment of inertia for rectangular section, prism, sphere from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 12

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton’s law – Work Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 12

Frictional force – Laws of Coloumb friction – simple contact friction – Rolling resistance – Belt friction.

Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion.

TOTAL: 60 PERIODS

TEXT BOOK:

1. Beer, F.P and Johnson Jr. E.R. “Vector Mechanics for Engineers”, Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, (1997).

REFERENCES:

1. Rajasekaran, S, Sankarasubramanian, G., “Fundamentals of Engineering Mechanics”, Vikas Publishing House Pvt. Ltd., (2000).
2. Hibbeller, R.C., “Engineering Mechanics”, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., (2000).
3. Palanichamy, M.S., Nagam, S., “Engineering Mechanics – Statics & Dynamics”, Tata McGraw-Hill, (2001).
4. Irving H. Shames, “Engineering Mechanics – Statics and Dynamics”, IV Edition – Pearson Education Asia Pvt. Ltd., (2003).
5. Ashok Gupta, “Interactive Engineering Mechanics – Statics – A Virtual Tutor (CDROM)”, Pearson Education Asia Pvt., Ltd., (2002).

EE2151

CIRCUIT THEORY

(Common to EEE, EIE and ICE Branches)

L T P C

3 1 0 4

UNIT I BASIC CIRCUITS ANALYSIS 12

Ohm’s Law – Kirchoffs laws – DC and AC Circuits – Resistors in series and parallel circuits – Mesh current and node voltage method of analysis for D.C and A.C. circuits.

UNIT II NETWORK REDUCTION AND NETWORK THEOREMS FOR DC AND AC CIRCUITS: 12

Network reduction: voltage and current division, source transformation – star delta conversion.

Thevenins and Novton & Theorem – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem.

UNIT III RESONANCE AND COUPLED CIRCUITS 12

Series and paralled resonance – their frequency response – Quality factor and Bandwidth - Self and mutual inductance – Coefficient of coupling – Tuned circuits – Single tuned circuits.

UNIT V SPECIAL SEMICONDUCTOR DEVICES (Qualitative Treatment only) 12

Tunnel diodes – PIN diode, varactor diode – SCR characteristics and two transistor equivalent model – UJT – Diac and Triac – Laser, CCD, Photodiode, Phototransistor, Photoconductive and Photovoltaic cells – LED, LCD.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Joseph A. Edminister, Mahmood, Nahri, "Electric Circuits" – Shaum series, Tata McGraw Hill, (2001)
2. S. Salivahanan, N. Suresh kumar and A. Vallavanraj, "Electronic Devices and Circuits", Tata McGraw Hill, 2nd Edition, (2008).
3. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, (2008).

REFERENCES:

1. Robert T. Paynter, "Introducing Electronics Devices and Circuits", Pearson Education, 7th Edition, (2006).
2. William H. Hayt, J.V. Jack, E. Kemmebly and Steven M. Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 6th Edition, 2002.
3. J. Millman & Halkins, Satyabranta Jit, "Electronic Devices & Circuits", Tata McGraw Hill, 2nd Edition, 2008.

GE2151 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C
(Common to branches under Civil, Mechanical and Technology faculty) **4 0 0 4**

UNIT I ELECTRICAL CIRCUITS & MEASUREMENTS 12

Ohm's Law – Kirchoff's Laws – Steady State Solution of DC Circuits – Introduction to AC Circuits – Waveforms and RMS Value – Power and Power factor – Single Phase and Three Phase Balanced Circuits.

Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

UNIT II ELECTRICAL MECHANICS 12

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, single phase induction Motor.

UNIT III SEMICONDUCTOR DEVICES AND APPLICATIONS 12

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation.

Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Elementary Treatment of Small Signal Amplifier.

UNIT IV DIGITAL ELECTRONICS 12

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops – Registers and Counters – A/D and D/A Conversion (single concepts)

UNIT V FUNDAMENTALS OF COMMUNICATION ENGINEERING 12
Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations.

Communication Systems: Radio, TV, Fax, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

TOTAL: 60 PERIODS

TEXT BOOKS:

1. V.N. Mittle “Basic Electrical Engineering”, Tata McGraw Hill Edition, New Delhi, 1990.
2. R.S. Sedha, “Applied Electronics” S. Chand & Co., 2006.

REFERENCES:

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, “Basic Electrical, Electronics and Computer Engineering”, Tata McGraw Hill, Second Edition, (2006).
2. Nagsarkar T K and Sukhija M S, “Basics of Electrical Engineering”, Oxford press (2005).
3. Mehta V K, “Principles of Electronics”, S.Chand & Company Ltd, (1994).
4. Mahmood Nahvi and Joseph A. Edminister, “Electric Circuits”, Schaum’ Outline Series, McGraw Hill, (2002).
5. Premkumar N, “Basic Electrical Engineering”, Anuradha Publishers, (2003).

GE2152 BASIC CIVIL & MECHANICAL ENGINEERING L T P C
(Common to branches under Electrical and I & C Faculty) **4 0 0 4**

A – CIVIL ENGINEERING

UNIT I SURVEYING AND CIVIL ENGINEERING MATERIALS 15

Surveying: Objects – types – classification – principles – measurements of distances – angles – leveling – determination of areas – illustrative examples.

Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel sections.

UNIT II BUILDING COMPONENTS AND STRUCTURES 15

[

Foundations: Types, Bearing capacity – Requirement of good foundations.

Superstructure: Brick masonry – stone masonry – beams – columns – lintels – roofing – flooring – plastering – Mechanics – Internal and external forces – stress – strain – elasticity – Types of Bridges and Dams – Basics of Interior Design and Landscaping.

TOTAL: 30 PERIODS

HARDWARE / SOFTWARE REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Hardware

- . 1 UNIX Clone Server
- . 33 Nodes (thin client or PCs)
- . Printer – 3 Nos.

Software

- . OS – UNIX Clone (33 user license or License free Linux)
- Compiler - C

GS2165

PHYSICS LABORATORY – II

L T P C
0 0 3 2

LIST OF EXPERIMENTS

1. Determination of Young's modulus of the material – non uniform bending.
2. Determination of Band Gap of a semiconductor material.
3. Determination of specific resistance of a given coil of wire – Carey Foster Bridge.
4. Determination of viscosity of liquid – Poiseuille's method.
5. Spectrometer dispersive power of a prism.
6. Determination of Young's modulus of the material – uniform bending.
7. Torsional pendulum – Determination of rigidity modulus.

- A minimum of FIVE experiments shall be offered.
- Laboratory classes on alternate weeks for Physics and Chemistry.
- The lab examinations will be held only in the second semester.

GS2165

CHEMISTRY LABORATORY – II

L T P C
0 0 3 2

LIST OF EXPERIMENTS

1. Conduct metric titration (Simple acid base)
2. Conduct metric titration (Mixture of weak and strong acids)
3. Conduct metric titration using BaCl_2 vs Na_2SO_4

4. Potentiometric Titration (Fe^{2+} / KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$)
 5. PH titration (acid & base)
 6. Determination of water of crystallization of a crystalline salt (Copper sulphate)
 7. Estimation of Ferric iron by spectrophotometry.
- **A minimum of FIVE experiments shall be offered.**
 - **Laboratory classes on alternate weeks for Physics and Chemistry.**
 - **The lab examinations will be held only in the second semester.**

ME2155 COMPUTER AIDED DRAFTING AND MODELING LABORATORY L T P C
0 1 2 2

List of Exercises using software capable of Drafting and Modeling

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg. V-block, Base of a mixie, Simple stool, Objects with hole and curves).
6. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.)
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
9. Drawing isometric projection of simple objects.
10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

Note: Plotting of drawings must be made for each exercise and attached to the records written by students.

List of Equipments for a batch of 30 students:

1. Pentium IV computer or better hardware, with suitable graphics facility -30 No.
2. Licensed software for Drafting and Modeling. – 30 Licenses
3. Laser Printer or Plotter to print / plot drawings – 2 No.

TOTAL: 45 PERIODS

EE2155

ELECTRICAL CIRCUIT LABORATORY
(Common to EEE, EIE and ICE)

L T P C
0 0 3 2

LIST OF EXPERIMENTS

1. Verification of ohm's laws and kirchoff's laws.
2. Verification of Thevemin's and Norton's Theorem
3. Verification of superposition Theorem
4. Verification of maximum power transfer theorem.
5. Verification of reciprocity theorem
6. Measurement of self inductance of a coil
7. Verification of mesh and nodal analysis.
8. Transient response of RL and RC circuits for DC input.
9. Frequency response of series and parallel resonance circuits.
10. Frequency response of single tuned coupled circuits.

TOTAL: 45 PERIODS

EC2155

CIRCUITS AND DEVICES LABORATORY

L T P C
0 0 3 2

1. Verification of KVL and KCL
2. Verification of Thevenin and Norton Theorems.
3. Verification of superposition Theorem.
4. Verification of Maximum power transfer and reciprocity theorems.
5. Frequency response of series and parallel resonance circuits.
6. Characteristics of PN and Zener diode
7. Characteristics of CE configuration
8. Characteristics of CB configuration
9. Characteristics of UJT and SCR
10. Characteristics of JFET and MOSFET
11. Characteristics of Diac and Triac.
12. Characteristics of Photodiode and Phototransistor.

TOTAL: 45 PERIODS

ENGLISH LANGUAGE LABORATORY (Optional)

L T P C
0 0 2 -
5

1. Listening:

Listening & answering questions – gap filling – Listening and Note taking- Listening to telephone conversations

2. Speaking:

Pronouncing words & sentences correctly – word stress – Conversation practice.

Classroom Session

20

1. Speaking: Introducing oneself, Introducing others, Role play, Debate- Presentations: Body language, gestures, postures. Group Discussions etc
2. Goal setting – interviews – stress time management – situational reasons

Evaluation

(1) Lab Session – 40 marks

- Listening – 10 marks
- Speaking – 10 marks
- Reading – 10 marks
- Writing – 10 marks

(2) Classroom Session – 60 marks

- Role play activities giving real life context – 30 marks
- Presentation – 30 marks

Note on Evaluation

1. Examples for role play situations:
 - a. Marketing engineer convincing a customer to buy his product.
 - b. Telephone conversation – Fixing an official appointment / Enquiry on availability of flight or train tickets / placing an order. etc.
2. Presentations could be just a Minute (JAM activity) or an Extempore on simple topics or visuals could be provided and students could be asked to talk about it.

REFERENCES:

1. Hartley, Peter, Group Communication, London: Routledge, (2004).
2. Doff, Adrian and Christopher Jones, Language in Use – (Intermediate level), Cambridge University Press, (1994).
3. Gammidge, Mick, Speaking Extra – A resource book of multi-level skills activities , Cambridge University Press, (2004).
4. Craven, Miles, Listening Extra - A resource book of multi-level skills activities, Cambridge, Cambridge University Press, (2004).
5. Naterop, Jean & Rod Revell, Telephoning in English, Cambridge University Press, (1987).

LAB REQUIREMENTS

1. Teacher – Console and systems for students
2. English Language Lab Software
3. Tape Recorders.

UNIT I ALIPHATIC HYDROCARBONS AND ALCOHOLS 9

Alkanes – General methods of preparation – Physical and chemical properties – Alkenes – General methods of preparation – Physical and chemical properties – Markovnikov's rule – Peroxide effect – Bayer's test – Alkynes – General methods of preparation and properties monohydric alcohols – Saytzeff rule – Methods of distinguishing the three classes of alcohols – Lucas test – Dichromate test.

UNIT II ALDEHYDES, KETONES AND ACIDS 9

General methods of preparation – Physical and chemical properties – Aldol condensation – Clemmensen reduction – Wolf-Kishner reduction – Haloform reaction – Cannizzaro reaction – Reformatsky reaction – Wittig reaction – Saturated monocarboxylic acids – Methods of preparation – Physical and chemical properties – Hell-Volhard-Zelinsky reaction – Amino acids – Methods of preparation – Physical and chemical properties.

UNIT III CARBOHYDRATES 9

Classification of carbohydrates – Monosaccharides – Reactions of glucose and fructose – Open chain and cyclic structures of glucose and fructose – Mutarotation – Epimerization – Killiani-Fisher synthesis – Ruff degradation – Conversion of aldoses to ketoses and ketoses to aldoses – Disaccharides – Properties and structure of sucrose – Polysaccharides – Properties and structure of starch and cellulose – Derivatives of cellulose – Carboxy methyl cellulose and gun cotton.

UNIT IV AROMATIC HYDROCARBON, AMINE AND DIAZONIUM SALT 9

Benzene – Aromaticity – Huckel rule – General methods of preparation of benzene – Electrophilic substitution reactions – Directive effects of substituents – Aromatic amino compounds – General methods of preparation – Physical and chemical properties – Carbylamines reaction – Aryldiazonium salts – Preparation and synthetic applications.

UNIT V DYES AND DYEING 9

Colour and constitution – Synthesis – Azodyes – Methyl orange – Methyl red and congo red – Triphenylmethane dyes – Malachite green – Para-rosaniline – Alizarin – Eosin – Introduction to natural and reactive dyes.

TOTAL: 45 PERIODS**TEXT BOOKS**

1. Morrison R.T. and Boyd R.N., "Organic chemistry", 6th Edition, Prentice Hall of India (P) Ltd., 2003.
2. Arun Bahl and Bahl B.S., "Advanced Organic Chemistry", 16th Edition, S.Chand and Company Ltd., 2002.

REFERENCES

1. March J., "March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure", 5th Edition, John Wiley, 2001.
2. Finar I.L., "Organic chemistry" Vol-I, 6th Edition, Pearson Education, 2002.
3. Sharma B.K., "Industrial Chemistry", 12th Edition, Goel Publishing house, 2001.

AIM

To create awareness in every engineering graduate about the importance of environment, the effect of technology on the environment and ecological balance and make them sensitive to the environment problems in every professional endeavour that they participate.

OBJECTIVE

- At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity. The role of government and non-government organization in environment managements.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Masters, G.M. "Introduction to Environmental Engineering and Science", 2nd Edition, Pearson Education, 1998.
2. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, 2006.

REFERENCES

1. Trivedi, R.K. "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2001.
3. Senger, Dharmendra S. "Environmental Law", Prentice Hall of India, 2007.
4. Rajagopalan, R, "Environmental Studies-From Crisis to Cure", Oxford University Press, 2005.

**PC3204 INDUSTRIAL CHEMICAL TECHNOLOGY L T P C
3 0 0 3**

UNIT I ALKALIES 9

Chloro-alkali industries – Manufacture of soda ash – Caustic soda – Chlorine.

UNIT II ACIDS 9

Manufacture of sulphuric acid – Hydrochloric acid – Phosphoric acid – Nitric acid.

UNIT III GLASSES 9

Manufacture of glasses – Special glasses – Ceramics and refractories – Paints and pigments.

UNIT IV INDUSTRIAL GASES 9

Manufacture of carbon dioxide – Nitrogen – Hydrogen – Oxygen and acetylene.

UNIT V FERTILIZERS 9

Nitrogen fertilizers – Synthetic ammonia – Urea – Ammonium chloride – CAN – Ammonium sulphate – Phosphorous fertilizers – Phosphate rock – Super phosphate – Triple super phosphate – MAP and DAP – Potassium fertilizers – Potassium chloride – Potassium sulphate.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Austin G.T., "Shreve's Chemical Process Industries", Fifth Edition, McGraw Hill, 1998.
2. Gopala Rao M. and Sittig M., "Dryden's Outlines of Chemical Technology for the 21st Century", 3rd Edition, Affiliated East-West press, 2007.

REFERENCES

1. Shukla S.D. and Pandey G.N., "Text book of Chemical Technology" Vol-I, Vikas publishing house (P) Ltd., 1977.
2. Sharma B.K., "Industrial Chemistry", Twelfth Edition, Goel Publishing house, 2001.
3. Pandey G.N., "Text Book of Chemical Technology" Vikas publishing house (P) Ltd., 1992.

EE3205 ELECTRICAL DRIVES AND CONTROL L T P C
(Common to Mechanical, Production and Petrochemical technology) **3 0 0 3**

UNIT I INTRODUCTION 9

Basic elements – Types of electric drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and load variation factors

UNIT II MOTOR CHARACTERISTICS 9

Mechanical characteristics – Speed-torque characteristics of various types of load and drive motors – Braking of electrical motors – DC motors: Shunt, series and compound – Single phase and three phase induction motors.

UNIT III STARTING METHODS 9

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors.

UNIT IV	CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C. DRIVES	9
Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers –applications.		
UNIT V	CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES	9
Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.		
TOTAL: 45 PERIODS		

TEXT BOOKS

1. Vedam Subrahmaniam, “Electric Drives (concepts and applications)”, Tata McGraw-Hill, 2001.
2. Nagrath.I.J. & Kothari.D.P, “Electrical Machines”, Tata McGraw-Hill, 1998.

REFERENCES

1. Pillai.S.K “A first course on Electric drives”, Wiley Eastern Limited, 1998
2. M.D.Singh, K.B.Khanchandani, “Power Electronics”, Tata McGraw-Hill, 1998
3. H.Partab, “Art and Science and Utilisation of electrical energy”, Dhanpat Rai and Sons, 1994.

CS3206	DATA STRUCTURES	L T P C
		3 0 0 3
UNIT I	FUNDAMENTALS OF ALGORITHMS	8
Algorithm – Analysis of algorithm – Best case and worst case complexities – Analysis of algorithm using data structures – Performance analysis – Time complexity – Space complexity – Amortized time complexity – Asymptotic notation.		
UNIT II	FUNDAMENTALS OF DATA STRUCTURES	9
Arrays – Structures – Stacks – Definition and examples – Representing stacks – Queues and lists – Queue and its representation – Applications of stack – Queue and linked lists.		
UNIT III	TREES	10
Binary trees – Operations on binary tree representations – Node representation – Internal and external nodes – Implicit array representation – Binary tree traversal – Huffman algorithm – Representing lists as binary trees – Sorting and searching techniques – Tree searching – Hashing.		
UNIT IV	GRAPHS AND THEIR APPLICATIONS	9
Graphs – An application of graphs – Representation – Transitive closure – Warshall's algorithm – Shortest path algorithm – A flow problem – Dijkstra's algorithm – Minimum spanning trees – Kruskal and Prim's algorithm – An application of scheduling – Linked representation of graphs – Graph traversals.		

UNIT V STORAGE MANAGEMENT**9**

General lists – Operations – Linked list representation – Using lists – Freeing list nodes – Automatic list management : Reference count method – Garbage collection – Collection and compaction.

TOTAL: 45 PERIODS**TEXT BOOKS**

1. Cormen T. H., Leiserson C. E, and Rivest R.L., "Introduction to Algorithms", Prentice Hall of India, 2007.
2. M.A.Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 2005.

REFERENCES

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Computer Algorithms/C++", Universities Press (India) Private Limited, 2nd Edition, 2007.
2. Aho, A. V., Hopcroft, J. E. and Ullman, J. D., "Data Structures and Algorithms", 1st Edition, Pearson Education, 2003.
3. Gilberg, R. F. and Forouzan, B. A., "Data Structures", 2nd Edition, Thomson India Edition, 2005.
4. Kruse, R.L, Leung, B. P. and Tondo, C. L., "Data Structures and Program Design in C", Pearson Education, 2004.
5. Tanaenbaum A. S. Langram, Y. Augestein M.J, "Data Structures using C", Pearson Education, 2004.

CH3207**ORGANIC CHEMISTRY LABORATORY**

L	T	P	C
0	0	3	2

1. Estimation of Alcohol
2. Estimation of Aldehydes & Ketones
3. Estimation of Phenol
4. Pigment Analysis
5. Ore/Alloys analysis
6. Estimation of Amines
7. Estimation of Glucose
8. Preparation of Aspirin
9. Preparation of Methyl orange
10. Preparation of Schiff's base
11. Synthesis of Porphyrin
12. Qualitative analysis of simple Organic compounds.
13. Polymer Analysis
14. Hydrolysis of Sucrose.
15. Industrial Waste Water analysis

TOTAL: 45 PERIODS

PC3208	ELECTRICAL MACHINES LABORATORY	L	T	P	C
		0	0	3	2

1. Open circuit and load characteristics of separately excited and self excited D.C. generator
2. Load test on D.C. shunt motor
3. Load test on D.C. series motor
4. Speed control of D.C. shunt motor
5. Load test on single phase transformer and open circuit and short circuit test on single phase transformer
6. Regulation of three phase alternator by E.M.F. and M.M.F. methods
7. Load test on three phase induction motor
8. No load and blocked rotor tests on three phase induction motor (Determination of equivalent circuit parameters)
9. Load test on single- phase induction motor
10. Study of D.C. motor and induction motor starters

TOTAL: 45 PERIODS

CS3209	DATA STRUCTURES LABORATORY	L	T	P	C
		0	0	3	2

LIST OF EXPERIMENTS

1. Implement singly and doubly linked lists.
2. Represent a polynomial as a linked list and write functions for polynomial addition.
3. Implement stack and use it to convert infix to postfix expression
4. Implement a double-ended queue (dequeue) where insertion and deletion operations are possible at both the ends.
5. Implement an expression tree. Produce its pre-order, in-order, and post-order traversals.
6. Implement binary search tree.
7. Implement insertion in AVL trees.
8. Implement priority queue using binary heaps
9. Implement hashing with open addressing.
10. Implement Prim's algorithm using priority queues to find MST of an undirected graph.

TOTAL: 45 PERIODS

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS (10 + 3)

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton-Raphson method- Solution of linear system of equations - Gauss Elimination method – Pivoting - Gauss-Jordan methods – Iterative methods of Gauss-Jacobi and Gauss-Seidel - Matrix Inversion by Gauss-Jordan method - Eigenvalues of a matrix by Power method and by Jacobi's method.

UNIT II INTERPOLATION AND APPROXIMATION (8 + 3)

Interpolation with unequal intervals - Lagrange interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION (9 + 3)

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules – Romberg's method – Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS (9 + 3)

Single step-methods - Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first and second order equations – Multistep methods - Milne's and Adams-Bashforth predictor-corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS (9 + 3)

Finite difference methods for solving two-point linear boundary value problems. Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat-flow equation by explicit and implicit (Crank Nicholson) methods - One dimensional wave equation by explicit method.

L: 45 T: 15 TOTAL : 60 PERIODS

TEXT BOOKS

1. Grewal, B.S. and Grewal, J.S., "Numerical methods in Engineering and Science", 6th Edition, Khanna Publishers, New Delhi, 2004.
2. Sankara Rao, K. "Numerical methods for Scientists and Engineers", 3rd Edition Prentice Hall of India Private Ltd., New Delhi, 2007.

REFERENCES

1. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 5th Edition, Tata McGraw-Hill, New Delhi, 2007.
2. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 6th Edition, Pearson Education Asia, New Delhi, 2006.
3. Brian Bradie, "A friendly introduction to Numerical analysis", Pearson Education Asia, New Delhi, 2007.

UNIT I GASEOUS STATE 9

Van der Waals equation – Law of equipartition principle – Translational, rotational and vibrational energies of molecules – Joule-Thomson effect – Liquefaction of gases – Critical constants.

UNIT II CHEMICAL REACTION EQUILIBRIA 9

Law of mass action – Van't Hoff reaction isotherm – Standard free energy change – Le Chatelier's principle – Application to selected systems – Biological activity – The thermodynamics of ATP.

UNIT III CHEMICAL KINETICS 9

Rate of reaction – Order – Molecularity – Integrated rate law – Kinetics of parallel and opposing reactions – Concept of activation energy – Arrhenius equation – Theory of absolute reaction rates – Kinetics of enzyme catalyzed reactions.

UNIT IV SOLUTIONS 9

Ideal and non-ideal solutions – Solubility of gases in liquids – Henry's law – Completely miscible liquids – Raoult's law – Vapour pressure and boiling point diagrams – Partially miscible liquids – Critical solution temperature – Completely immiscible liquids – Nernst distribution law – Dilute solution and their colligative properties – Molecular weight determination using these properties.

UNIT V ELECTRICAL CONDUCTANCE 9

Electrolytes – Strong electrolytes and weak electrolytes – Arrhenius theory of electrolytic dissociation – Debye-Huckel Onsager theory – Ostwald's dilution law – Solubility of electrolytes and solubility product – Common ion effect – Acids – Bases – Definitions based on proton transference – Dissociation constant – Amphoteric electrolyte – pH – Buffer solutions.

TOTAL: 45 PERIODS**TEXT BOOKS**

1. Atkins, P.W. and Paula, J.D., "Physical Chemistry", 8th Edition, W.H Freeman and Company, 2006.
2. Puri, B.R. and Sharma, L.R., "Principles of Physical Chemistry", S.Chand and Company Ltd., 1998.

REFERENCES

1. Mortimer, R.G., "Physical Chemistry", 2nd Edition, Academic press, 2000.
2. Soni, P.L., "Text Book of Physical Chemistry", S.Chand and Company Ltd., 1970.
3. Bahl, B.S, Tuli, G.D. and Arun Bahl., "Essentials of Physical Chemistry", S.Chand and Company Ltd., 1998.

UNIT I NATURE OF MATERIALS 9

Micro and macro structures – Properties and definitions – Mechanical, thermal, chemical, electrical and magnetic properties – Processing of metals and alloys – Casting – Hot and cold rolling – Extrusion – Forging – Deep drawing – Plastic deformation of metal – Single crystals and poly crystalline metals – Recovery and recrystallization of plastically deformed metals.

UNIT II FERROUS AND NON-FERROUS METALS 9

Pure iron – Cast iron – Mild steel – Stainless steels – Special steels and alloys – High temperature steels – Iron carbide phase diagram – Heat treatment of plain steels – Carbon steels – Manufacture – Properties and application in chemical industries – Lead, tin and magnesium – Manufacturing methods – Properties and application in process industries.

UNIT III POLYMERIC AND CERAMIC MATERIALS 9

Polymeric Materials – Polymerization reactions – Industrial polymerization methods – Crystallinity and stereo-isomerism in some thermoplastics – Thermosetting elastomers – Creep and fracture of polymeric materials – Composite Materials – Fibre – Reinforced – Plastic composite materials – Manufacturing methods – Concrete – Asphalt and asphalt mixtures – Wood – Sandwich structures – Ceramic materials – Ceramic crystal and silicate structures – Processing of ceramics – Properties of glasses and enamels.

UNIT IV INORGANIC MATERIALS 9

Manufacture of cement and its properties – Special cement – Cement concrete – Reinforced and prestressed concrete – Properties and applications – Mixing and curing.

UNIT V CORROSION AND COATING 9

Basic theories and mechanism of corrosion – Types of corrosion – Application of corrosion theories in equipment design and fabrication – Anti-corrosion methods – Organic paints and coatings – Metal coatings – Ceramic coatings – Lining.

TOTAL: 45 PERIODS**TEXT BOOKS**

1. Van Vlack, L.H., "Elements of Material Science and Engineering", 6th Edition, Prentice Hall, 1989.
2. Raghavan V., "Materials Science and Engineering: A First Course", 5th Edition, Prentice Hall of India (P) Ltd., 2004.

REFERENCES

1. William, D. and Callister, J.R., "Materials Science and Engineering: An Introduction", 7th Edition, John Wiley and Sons, 2007.
2. Smith, W F. and Hashemi J., "Foundations of Materials Science and Engineering" 3rd Edition, McGraw-Hill, 2003.
3. Clauser, H.R., "Industrial and Engineering Materials ", McGraw-Hill, 1975.

PC3213	PROCESS CALCULATIONS	L	T	P	C
		4	0	0	4

UNIT I BASIC CHEMICAL CALCULATIONS 5

Units and Dimensions

Basic and derived units – Use of model units in calculations – Methods of expression – Compositions of mixture and solutions.

Gas Calculations 7

Ideal and real gas laws – Gas constant – Calculations of pressure, volume and temperature using ideal gas law – Use of partial pressure and pure component volume in gas calculations – Applications of real gas relationship in gas calculation.

UNIT II MATERIAL BALANCE 12

Stoichiometric principles – Application of material balance to unit operations like distillation – Evaporation, crystallisation, drying etc., – Material balance with chemical reaction – Limiting and excess reactants – Recycle – Bypass and purging – Unsteady state material balances.

UNIT III HUMIDITY AND SATURATION 12

Properties of atmospheric air – Humidity of air – Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity – Use of humidity in condensation and drying – Psychrometric chart, dew point – Wet and dry bulb thermometry.

UNIT IV FUELS AND COMBUSTION 12

Determination of composition by Orsat analysis of products of combustion of solid, liquid and gas fuels – Calculation of excess air from Orsat technique, problems on sulphur and sulphur burning compounds – Theoretical flame temperature.

UNIT V ENERGY BALANCE 6

Thermo Physics 6

Heat capacity of solids, liquids, gases and solutions – Use of mean heat capacity in heat calculations – Problems involving sensible heat and latent heats – Evaluation of enthalpy.

Thermo Chemistry 7

Standard heat of reaction, heats of formation, combustion, solution, mixing etc., – Calculation of standard heat of reaction – Effect of pressure and temperature on heat of reaction – Energy balance for systems with and without chemical reaction – Unsteady state energy balances.

TOTAL: 60 PERIODS

TEXT BOOKS

1. Bhatt, B.I. and Vora, S. M., "Stoichiometry", 4th Edition, Tata McGraw Hill Publishers Ltd., 2005.
2. Hougen, O.A., Watson, K.M. and Ragatz, R.A., "Chemical Process Principles", Vol. I, CBS Publishers and Distributors, 1995.

REFERENCES

1. Venkataramani, V. and Anantharaman, N., "Process calculations", Prentice Hall of India (P) Ltd., 2003.
2. Himmelblau, D., "Basic Principles and Calculations in Chemical Engineering", 6th Edition, Prentice Hall of India (P) Ltd., 2000.
3. Chohey, N.P. and Hicks, T.G., "Handbook of Chemical Engineering Calculations", 2nd Edition, McGraw Hill Inc., 1984.

CE3214	FLUID FLOW OPERATIONS	L	T	P	C
		3	0	0	3

UNIT I PROPERTIES OF FLUIDS AND CONCEPT OF PRESSURE 9

Introduction – Physical properties of fluids – Types of fluids – Fluid statics and its applications - Pressure – Density – Height relationships – Pressure measurement – Units and dimensions – Dimensional analysis – Dimensionless numbers.

UNIT II MOMENTUM BALANCE AND ITS APPLICATIONS 9

Kinematics of fluid flow – Stream line – Stream tube – Velocity potential – Newtonian and non-newtonian fluids – Time dependent fluids – Reynolds number experiment and significance –Continuity Equation – Momentum balance – Potential flow – Bernoulli's equation – Correction for fluid friction – Correction for pump work.

UNIT III FLOW OF INCOMPRESSIBLE FLUIDS THROUGH DUCTS 9

Flow of incompressible fluids in pipes – Laminar and turbulent flow through closed conduits –Velocity profile and friction factor for smooth and rough pipes – Heat loss due to friction in pipes and Fittings – Introduction to compressible flow – Isentropic flow through convergent and divergent nozzles and sonic velocity.

UNIT IV FLOW OF FLUIDS THROUGH SOLIDS 9

Form drag – Skin drag – Drag co-efficient – Flow around solids and packed beds – Friction factor for packed beds – Ergun's Equation – Motion of particles through fluids – Motion under gravitational and centrifugal fields – Terminal settling velocity – Fluidization – Mechanism – Types – General properties – Applications.

UNIT V TRANSPORTATION AND METERING 9

Measurement of fluid flow – Orifice meter – Venturi meter – Pitot tube – Rotameter – Weirs and notches – Hot wire anemometers – Transportation of fluids – Positive displacement pumps – Rotary and Reciprocating pumps – Centrifugal pumps – Performance and characteristics – Air lift and diaphragm pumps.

TOTAL: 45 PERIODS

TEXT BOOKS

1. McCabe, W.L., Smith, J.C. and Harriott, P., "Unit operations of Chemical Engineering", Seventh Edition, McGraw-Hill, 2004.
2. Coulson, J.M., and Richardson, J.F., "Coulson and Richardson's Chemical Engineering", Vol. I, 3rd Edition, Butterworth Heinemann Publishers, 2004.

REFERENCES

1. Bansal, R.K., "Fluid Mechanics and Hydraulic machines", Laxmi Publications (P) Ltd., 1995.
2. Nevers, N.D., "Fluid Mechanics for Chemical Engineers", McGraw-Hill, 1991.
3. De Nevers, L., "Fluid Mechanics for Chemical Engineers", McGraw-Hill, 1994.

CH3215	MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3
UNIT I	CHARACTERISTICS OF PARTICULATE SOLIDS, SIZE REDUCTION AND SCREENING				9
	Properties and characterization of particulate solids – Analysis, technical methods for measurement of size and surface area distribution of powder – Introduction to size reduction equipment – Determination of energy and power requirement in milling operations – Computer simulation techniques for mill performance – Mechanical classifiers – Screening equipment – Capacity and effectiveness.				
UNIT II	FILTRATION				9
	Filtration equipments – Filtration media and filter aids – Principles of filtration and clarification – Estimation of filtration parameters for compressible and incompressible cakes and calculations – Centrifugal filtration equipment and principles of operation.				
UNIT III	SETTLING AND SEDIMENTATION				9
	Separation based on the motion of particles through fluids – Gravity settling processes – Sedimentation – Kynch theory of sedimentation – Sedimentation thickeners – Rate of sedimentation and sedimentation zones in continuous thickeners – Design of thickeners and clarifiers – Principles of centrifugal sedimentation.				
UNIT IV	AGITATION AND MIXING				9
	Agitation and mixing of liquids – Agitation equipment – Axial and radial flow impellers and flow patterns in agitated vessels – Prevention of swirling – Power consumption in agitated vessels – Blending and mixing – Dispersion operations – Mixing of solids and pastes – Types of mixers.				
UNIT V	STORAGE AND CONVEYING OF SOLIDS				9
	Storage and conveying of solids – Bins, hoppers and silos – Flow out of bins – Design consideration of bins – Loading and unloading of solids – Bucket elevators – Apron conveyors – Belt conveyors – Types of belt conveyors – Selection considerations.				

TOTAL: 45 PERIODS

TEXT BOOKS

1. McCabe, W.L., Smith, J.C. and Harriott, P., "Unit operations of Chemical Engineering", 7th Edition, McGraw Hill, 2004.
2. Badger, W.L., and Banchemo, J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.

REFERENCES

1. Raymond A. Kulweic., "Materials Handling Handbook", 3rd Edition, Wiley-Interscience Publications, 1985.
2. Richardson, J.F. and Harker J.H., "Coulson and Richardson's Chemical Engineering", Vol. II, 4th Edition, Butterworth Heineman, 2004.
3. Bhattacharaya., "Mechanical Operations", Khanna publishers, 2001.

CH3216

PHYSICAL CHEMISTRY LABORATORY

	L	T	P	C
	0	0	3	2
1. Molecular weight determination of Polymer by using a) Rast's Method b) Viscometer				
2. Partition Coefficient Studies For Benzene – Water system				
3. Phase rule Studies Simple Eutectic system				
4. Conductivity Studies a) Precipitation Titration b) Mixtures of acid – Strong Base Titration				
5. EMF Studies Estimation of Fe ²⁺ by Potentiometric Titration				
6. Kinetic Studies a) Kinetic studies of Persulphate – Iodide reaction b) Kinetic studies of Iodination of Acetone. c) Determination of Rate constant of Acid catalyst hydrolysis of an Ester.				
7. Polarimetry Studies - Kinetic study of Inversion of Cane sugar.				
8. Adsorption Studies - Freundlich Adsorption Isotherm				
9. Determination of Transition Temperature.				
10. Determination of Critical solution temperature for the Phenol - Water system.				
11. Determination of Saponification value of an oil.				
12. To determine the moisture & volatile contents in a given coal sample by proximate analysis.				
13. pH metric measurements a) To prepare buffer solutions and standardization of P ^H meter (P ^H 4 and 9) b) Determine the molarity of HCl by pH-metrically, using 0.1 M Sodium Hydroxide.				

TOTAL: 45 PERIODS

CE3217	FLUID FLOW OPERATIONS LABORATORY	L	T	P	C
		0	0	3	2

1. To verify Hagen-Poiseuille Equation.
2. To relate Reynolds Number and Friction factor.
3. To study the effect of coil diameter on Friction factor.
4. To evaluate the performance of Centrifugal pump and Reciprocating Pump
5. To verify Ergun's equation.
6. To determine the discharge coefficient of Orifice meter, Venturimeter and Rotameter.
7. To evaluate the performance of Weirs and Notches.
8. To characterize the behavior of Fluidized bed.
9. Losses due to friction in pipe lines and fittings
10. Reynold's Apparatus
11. Bernoulli's Theorem Apparatus
12. Efflux time Apparatus.
13. Calibration Test Rig for Pitot Tube
14. Flow Through Pipes, Minor Losses due to sudden expansion, Sudden Contraction

TOTAL: 45 PERIODS

CH3218	MECHANICAL OPERATIONS LABORATORY	L	T	P	C
		0	0	3	2

1. Screen Effectiveness
2. Jaw Crusher and Smooth roll crusher
3. Ball Mill
4. Vacuum Leaf Filter
5. Plate and Frame Filter press
6. Batch Sedimentation
7. Cyclone Separator
8. Terminal settling velocity - Stokes law Verification.
9. Rod mill
10. Hammer Mill
11. Vibrating Screen
12. Continuous Thickener
13. Plate & Frame Filter press
14. Belt conveyor
15. Drop weight crusher
16. Beaker Decantation

TOTAL: 45 PERIODS

PC3301

SPECIAL FUNCTIONS

L	T	P	C
3	1	0	4

UNIT I IMPROPER INTEGRALS AND SERIES SOLUTIONS 9

Improper integrals – Gamma and beta functions – Series solutions – Ordinary point – Regular singular point of second order linear ordinary differential equation – Series solution to a second order linear ordinary differential equation about an ordinary point and a regular singular point.

UNIT II BESSEL FUNCTIONS 9

Bessel's equation – Bessel functions – Recurrence relations – Orthogonality property – Generating function – Equations reducible to Bessel's equation – Modified Bessel functions.

UNIT III LEGENDRE POLYNOMIALS 9

Legendre's equation – Legendre polynomials – Rodrigue's formula generating function – Recurrence relations – Orthogonality property.

UNIT IV HERMITE AND LAGUERRE POLYNOMIALS 9

Hermite and Laguerre equations and their solutions – Polynomials – Rodrigue's formula – Generating functions – Recurrence relations – Orthogonality property.

UNIT V BOUNDARY VALUE PROBLEMS 9

Solution of boundary value problems involving Bessel functions and Legendre polynomials.

L: 45 T: 15 TOTAL: 60 PERIODS

TEXT BOOKS

1. Andrews, L.A., "Special Functions for Scientists and Engineers", McGraw – Hill, 1992.
2. Narayanan, S., Manicavachagam Pillay and Ramanaiah.G, "Advanced Mathematics for Engineering Students", Vol. II, S.Viswanathan Printers Private Limited, 1985.

REFERENCES

1. Grewal, B.S., "Higher Engineering Mathematics", Khanna Publishers, 2005.
2. Jain, R.K. and Iyengar, S.R.K., "Advanced Engineering Mathematics", Narosa Publishing House, 2002.
3. Bali, N.P. and Narayana Iyengar, N.Ch., "A Textbook of Engineering Mathematics", 6th Edition, Laxmi Publications (P) Ltd., 2004.

UNIT I CONDUCTION 12

Modes of heat transfer – Steady and unsteady state heat transfer – Concept of heat conduction – Fourier's law of heat conduction – General heat conduction equation in spherical coordinates – One-dimensional steady state heat conduction equation for flat plate, hollow cylinder, hollow sphere – Analogy between flow of heat and flow of electricity – Effect of temperature on thermal conductivity – Critical insulation thickness – Transient heat conduction – Lumped heat parameter model.

UNIT II CONVECTION 12

Concept of heat transfer by convection – Natural and forced convection – Concept of LMTD – Local and overall heat transfer coefficient – Application of dimensional analysis for convection – Empirical Equations for forced convection under laminar, transient and turbulent conditions – Empirical equations for natural convection – Influence of boundary layer on heat transfer – Heat transfer through packed and fluidized beds – Heat transfer with phase change: boiling, vaporization and condensation.

UNIT III RADIATION 12

Concept of thermal radiations – Black body concept – Stefan Boltzman's law – Emissive power – Black body radiation – Emissivity – Planck's law – Radiation between black surfaces – Gray surfaces – Radiation shields – Radiation applications – Pipe still heaters.

UNIT IV HEAT EXCHANGERS 12

Heat exchanger types – Parallel and counter flow heat exchangers – Overall heat transfer coefficient – Log mean temperature difference for single pass – Correction factor for multi pass heat exchangers – Heat exchanger effectiveness – Number of transfer units – Chart for different configurations – Dirt factor.

UNIT V EVAPORATORS 12

Evaporation – Single effect and multiple effect evaporation – Boiling point elevation – Effect of liquid head – Capacity and economy of multiple effect evaporators – Evaporation equipments.

TOTAL: 60 PERIODS**TEXT BOOKS**

1. Kumar, D.S., "Heat and Mass Transfer", 5th Edition, S.K. Kataria and Sons, 2000.
2. McCabe, W.L. and Smith, J.C., "Unit Operations in Chemical Engineering", 5th Edition. McGraw Hill Publishing Co., 2001.

REFERENCES

1. Kern, D.Q., "Process Heat Transfer", Tata McGraw Hill Publishing Co., 1990.
2. Hollman, "Heat Transfer", 8th Edition, McGraw Hill, 1997.
3. Kreith, F., "Principles of Heat Transfer", 4th Edition, Harper and Row, 1976.

UNIT I DIFFUSION 12

Diffusion in fluids – Molecular and eddy diffusion – Measurement and calculation of diffusivities – Ordinary diffusion in multi component gaseous mixtures – Diffusion in solids – Molecular and Knudsen diffusion in solids – Theories of mass Transfer – Film theory, penetration theory and surface renewal theories of mass transfer.

UNIT II INTERPHASE MASS TRANSFER 12

Interphase Mass Transfer – Local and overall mass transfer coefficients – Steady state co current and counter current mass transfer process – Stage and stage efficiencies – Concept of NTU and HTU – Equilibrium and operating lines – J_D Factor – Equipments for gas-liquid contact operations – Bubble columns – Tray towers and packed towers.

UNIT III ABSORPTION 12

Gas Absorption: Principles of absorption and desorption – Selection of solvents for absorption – Tray tower absorber – Absorption factor – Calculation of number of theoretical stages – Murphree efficiency – Point efficiency – Tray efficiency and overall tray efficiency – Calculation of actual number of trays.

Packed tower absorber – Tower packing and characteristics – Calculation of NTU, HTU, HETP and height of absorption towers – Absorption with chemical reactions.

UNIT IV DRYING 12

Drying – Principle and definitions – Estimation of drying rates, drying rate curve – Critical and equilibrium moisture content – Calculation of drying time under constant drying conditions – Different types of dryers.

UNIT V HUMIDIFICATION AND CRYSTALLIZATION 12

Humidification – Definitions, psychometric charts – Wet bulb temperature – Methods of humidification – Types of cooling towers, spray chambers and spray ponds.

Crystallization – Factors governing nucleation and crystal growth – Theory of Crystallization – Classification of crystallizer and their applications – Product size distribution.

TOTAL: 60 PERIODS**TEXTBOOKS**

1. McCabe,W.L., Smith, J.C. and Harriot,P., "Unit Operations of Chemical Engineering", 6th Edition, McGraw – Hill Book Co., 2001.
2. Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw – Hill Book Co., 1980.

REFERENCES

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering", Vol.I, II and III, Pergamon Press, 1977.
2. Bennett, C.O. and Myers, J.E., "Momentum, Heat and Mass Transfer", McGraw Hill Book Company, 3rd Edition, 1983.
3. Christie J. Geankopolis, "Transport Processes and Unit Operations", 3rd Edition, Prentice Hall of India Pvt. Ltd, 2000.

PC3304	ENGINEERING THERMODYNAMICS	L	T	P	C
		4	0	0	4

UNIT I FUNDAMENTAL CONCEPTS AND FIRST LAW OF THERMODYNAMICS 12

Scope of thermodynamics – Basic concepts – Thermodynamic system – State and equilibrium – Process and cycles – Temperature and zeroth law of thermodynamics – Properties of pure substances – First law of thermodynamics – First law analysis of closed systems and control volumes and its application.

UNIT II ENTROPY AND THE SECOND LAW OF THERMODYNAMICS 12

The Clausius inequality – Entropy – Causes of entropy change – Entropy change of pure substances – Thermal energy reservoirs – Heat engines – Perpetual motion machines – Reversible and irreversible processes – The Carnot cycle and principles – The Carnot Heat engine – The second law efficiency – Second law analysis of open and closed systems.

UNIT III REFRIGERATION, VAPOR and COMBINED POWER CYCLES 12

Refrigerators and Heat pumps – The Carnot refrigerator and heat pumps – The reversed Carnot cycle – Ideal and Actual vapor compression Refrigeration cycle – Selection of right refrigerants – Heat pumps – Absorption refrigerator system – The Carnot vapor cycle – Rankine cycle – Cogeneration – Second law analysis of vapor power cycles.

UNIT IV PVT RELATIONS AND THERMODYNAMIC RELATIONS 12

PVT relations for gases and liquids – Equations of state – Cubic equations of state – Thermodynamic properties from equations of state – Compressibility factor – Generalized properties of fluids – Law of corresponding state – Acentric factor – gas mixtures.

Thermodynamic relations – Maxwell's relations – Estimation of thermodynamic properties – Thermodynamic properties of homogeneous mixtures – Partial molar properties, Fugacity and fugacity coefficients – Lewis and Randall rule – Property changes of mixing, activity – Excess properties, activity coefficients.

UNIT V PHASE EQUILIBRIA AND CHEMICAL REACTION EQUILIBRIA 12

Phase equilibria – Pure component and mixtures – Van Laar, Margules equation – Group contribution method – Gibb's Duhem equation – Consistency tests – Partially miscible and immiscible systems – Azeotropes – Retrograde condensation – Thermodynamic diagrams.

Chemical equilibria – Heat effects – industrial reactions – Free energy calculations – Homogeneous and heterogeneous reactions – Equilibrium composition.

TOTAL: 60 PERIODS

TEXT BOOKS

1. Smith, J.M. and Van Ness, "Introduction to Engineering Thermodynamics", 5th Edition, McGraw Hill, 1996.
2. Narayanan, K.V., "A Text Book of Chemical Engineering Thermodynamics", Prentice Hall of India, 2002.

REFERENCES

1. Hougen and Watson, "Chemical Process Principles" Vol. II, CBS Publishers, 2002.
2. Kyle, "Chemical and Process Thermodynamics", 2nd Edition, Prentice Hall of India, 2000.
3. Rao, Y.V.C., "Chemical Engineering Thermodynamics", Universities Press, 1997.

PE3305	NATURAL GAS ENGINEERING	L	T	P	C
		4	0	0	4

UNIT I PROPERTIES AND COMPOSITION OF NATURAL GAS 12

Natural gas origin – Composition of natural gas – Sources of Natural gas – Thermodynamics properties – Compressibility factor and chart for natural gas – Heating value and flammability limit of natural gas.

UNIT II ESTIMATION AND PRODUCTION OF NATURAL GAS 12

Estimation of gas reserves by volumetric method – Production of natural gas – Pressure decline method – Problems in the production of natural gas – Field separation.

UNIT III GAS FROM CONDENSATE OIL FIELDS 12

Processing of condensate well fluids – Cycling of gas condensate reservoirs – Sweep patterns – Katy cycling plant.

UNIT IV ACID GAS TREATING OF NATURAL GAS 12

Acid gas removal: Metal oxide process – Slurry process – Amine process – Carbonate washing process – Methanol based process and other process – Sulphur recovery process.

UNIT V DEHYDRATION OF NATURAL GAS AND NGL RECOVERY 12

Dehydration: Glycol dehydration – Solid desiccant dehydration.

NGL Recovery: Refrigeration process – Lean oil absorption process – Solid bed adsorption and membrane separation process – NGL fractionation.

TOTAL: 60 PERIODS

TEXT BOOKS

1. Katz and Lee "Hand Book of Natural Gas Engineering" McGraw Hill, 1968.
2. Lyons, W.C., "Standard Handbook of Petroleum and Natural Gas Engineering", Vol. 2, Gulf Professional Publishing, Elsevier Inc., 2006.

REFERENCES

1. Katz, D. L. and Lee, R.L., "Natural Gas Engineering", McGraw Hill, 1990.
2. Dring, M.M., "The Natural Gas Industry – A Review of World Resources and Industrial Applications", Butterworth, 1974.
3. Saied Mokhatab, William A. Poe, and James G. Speight, "Handbook of Natural Gas Transmission and Processing", Gulf Professional Publishing, Elsevier Inc., 2006.

CH3307**HEAT TRANSFER LABORATORY**

	L	T	P	C
1. Determination of heat transfer coefficient using composite wall.	0	0	3	2
2. Determination of heat transfer coefficient using convection apparatus.				
3. Determination of Stefan Boltzman constant using Stefan Boltzman apparatus.				
4. Determination of condensing Heat transfer coefficient using vertical condenser.				
5. Determination of condensing heat transfer coefficient using horizontal condenser.				
6. Study the effect of coil diameter on heat transfer coefficient.				
7. Determination of overall heat transfer coefficient using shell and tube heat exchanger.				
8. Determination of overall heat transfer coefficient using double pipe heat exchanger.				
9. Determination of overall heat transfer coefficient using plate type heat exchanger.				
10. Study the effect of evaporation using jacketed pan evaporator and open pan evaporator.				

TOTAL: 45 PERIODS**CH3308****TECHNICAL ANALYSIS LABORATORY**

	L	T	P	C
1. Oil Analysis: a) Acid value b) Saponification value c) Iodine value	0	0	3	2
2. Soap Analysis: a) Moisture and Volatile matter b) Fatty acid content of Soap c) Total Alkali d) Free alkali or free fatty acid				
3. Determination of CaO in the given sample of commercial lime.				

4. Analysis of water:
 - a) Total solids including suspended matter
 - b) pH
 - c) Conductivity
 - d) Alkalinity
 - e) Permanent Hardness
 - f) Temporary Hardness

5. Cement Analysis
 - a) Loss on ignition
 - b) Insoluble residue
 - c) Estimation of SO_3 , Silica (SiO_2), Lime (CaO), Magnesia (MgO), Iron and Aluminium Oxides (R_2O_3).

6. Estimation of Nitrogen by Kjeldahl method

7. Estimation of metal ions (Copper, Nickel, Chromium).

8. Effluent water Analysis (COD, BOD, DO, TDS, TSS)

9. Estimation of available chlorine in the given bleaching powder

TOTAL: 45 PERIODS

GE3318 COMMUNICATION SKILLS AND SOFT SKILLS LAB

**L T P C
0 0 2 1**

AIM:

To enhance the overall capability of students and to equip them with the necessary Communication Skills and Soft Skills that would help them excel in their profession.

OBJECTIVES:

- To equip students of engineering and technology with effective speaking and listening skills in English.
- To help them develop their soft skills and interpersonal skills, which will make the transition from college to workplace smoother and help them excel in their job.
- To enhance the performance of students at Placement Interviews, Group Discussions and other recruitment exercises.

I. PC based session

A. Career Lab (15 periods) Viewing and discussing audio-visual materials

UNIT III LIQUID – LIQUID EXTRACTION**9**

Description of liquid extraction – Terminologies – Application of ternary liquid equilibrium – Representation in equilateral triangular co-ordinate of different type systems – Effect of temperature – Criteria for selection of solvent – Stage wise and continuous contact extractors – Types of extractors and their brief description – Stage wise contact – Cross and counter current extraction – Graphical method of determining number of stages – composition and minimum solvent requirement.

UNIT IV ADSORPTION**9**

Types of adsorption – Nature of adsorbents – Adsorption equilibria – Adsorption hysteresis adsorption isotherms – Effect of temperature and pressure – Freundlich equation – Stage wise adsorption: Single and multistage crosscurrent adsorption – Multistage countercurrent adsorption – Break through curves and rates of adsorption – Calculations of composition and number of stages.

UNIT V LEACHING**9**

Solid liquid extraction: Description of leaching operations and technologies – Applications of leaching – Preparation of solid – Methods of Operation and classification of equipment – Solid – Liquid Equilibrium in leaching – Multi stage cross and counter current leaching – Calculation of composition and number of stages.

L: 45 T: 15 TOTAL: 60 PERIODS**TEXT BOOKS**

1. McCabe, W.L., Smith, J.C. and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edition, McGraw Hill Book Co., 2001.
2. Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., 1980.

REFERENCES

1. Coulson, M. and Richardson, J.F., "Chemical Engg.", Vol-II, 3rd Edition, Pergamon Press, 1987.
2. Alan S. Foust., Leonard A. Wenzel., Curtis W. Clump., Louis Maus., and L.Bryce Andersen, "Principles of Unit Operations", 2nd Edition, John Wiley and Sons (Asia) Pvt. Ltd, 1994.
3. Geankopolis, C.J., "Transport Processes in Chemical Operations", 3rd Edition, Prentice Hall of India, 1996.

PC3312	PRINCIPLES OF CHEMICAL KINETICS	L	T	P	C
		4	0	0	4

UNIT I REACTION KINETICS 12

Chemical kinetics – Classification of chemical reactions – Concentration and temperature dependent term of rate equation – Arrhenius, collision and transition state theory – Searching for a mechanism.

UNIT II INTERPRETATION OF BATCH REACTOR DATA 12

Integral and differential methods of analysis – Half-life method – Zero-order reaction – Empirical rate equation of n^{th} order – Irreversible first and second order reactions for variable and constant volume systems.

UNIT III VARIOUS TYPES OF REACTOR DESIGN 12

Ideal Reactors – Batch Reactor – Plug flow reactor – Mixed flow reactor – Space time – Space velocity – Performance equations and their graphical representation.

UNIT IV HEAT EFFECTS 12

Temperature and pressure effects on single and multiple reactions – Adiabatic – Non-adiabatic – Isothermal and non-isothermal operations.

UNIT V DESIGN OF REACTOR FOR SINGLE and MULTIPLE REACTIONS 12

Single reactions – Size comparison of single reactors – Recycle reactor – Autocatalytic reactions. Multiple reactions – Irreversible reactions in series and parallel.

TOTAL: 60 PERIODS

TEXT BOOKS

1. Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition, John Wiley, 1999.
2. Fogler, W., "Chemical Reaction Engineering", 3rd Edition, Prentice Hall of India, 1999.

REFERENCES

1. Smith, J.M., "Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, , 1981.
2. Dawande, S.D., "Principles of Reaction Engineering", 1st Edition, Central Techno Publications, 2001.
3. Richardson, J.F. and Peacock, D.G., "Coulson Richardson, Chemical Engineering." Vol. III, 3rd Edition, Asian Books (P) Ltd.

PC3313	EQUIPMENT DESIGN AND DRAWING I	L	T	P	C
	(To Consider as Practical Subject for Examination Purpose)	2	0	2	4

UNIT I	DESIGN OF PIPE FITTINGS AND JOINTS	9
Design and schematic of simple bolts and screws – Riveted joints – Design and drawing of shafts and couplings.		
UNIT II	DESIGN OF REACTION VESSEL AND STORAGE TANK	9
Design and schematic of storage tank, (vertical and horizontal) supports, agitated vessel.		
UNIT III	DESIGN OF HIGH PRESSURE SYSTEMS	9
Design of high pressure vessels and reactors.		
UNIT IV	DESIGN OF PHASE SEPARATION EQUIPMENT	9
Design of physical separation equipments such as cyclones, centrifuges, thickeners, filtration equipment		
UNIT V	DRAWING OF HEAT EXCHANGERS AND COLUMNS	9
Drawing of physical process equipments such as double pipe heat exchangers – Shell and tube heat exchangers – Plate and frame heat exchangers – Distillation columns and reactors.		

L: 45 P: 15 TOTAL: 60 PERIODS

TEXT BOOKS

1. Dawande, S.D., "Process Design of Equipments" Central Techno Publishers.
2. Perry, R. H., "Chemical Engineers Handbook", 7th Edition, McGraw Hill, 1998.

REFERENCES

1. Coulson, J. M. and Richardson, J. F., "Chemical Engineering", Vol 6, Butterworth Heinmann, 2000.
2. Walas, S.M., "Chemical Process Equipment" Butterworth Heinmann, 1998.
3. Joshi, M. V., "Process Equipment Design", 2nd Edition, Mac Millan Press, 1996.
4. Brownell, L. E. and Young, E.H., "Process Equipment Design", John Wiley, 1968.

Note: Necessary Data Book is to be issued while conducting Practical Examination

PC3314	PETROCHEMICAL UNIT PROCESSES	L	T	P	C
		4	0	0	4

UNIT I FEED STOCK AND SOURCE OF PETROCHEMICALS 12

Overview of Petrochemical Industry – The key growth area of India, Economics – Feed stock selections for Petrochemicals – Steam cracking of Gas and Naphtha to produce Olefins, Diolefins and Production of Acetylene – Cracker product separation and BTX separation.

UNIT II NTHESIS GAS PRODUCTION 12

Steam reforming of Natural gas – Naphtha and Heavy distillate to produce Hydrogen and Synthesis gas – Production of Methanol – Oxo process.

UNIT III UNIT PROCESSES I 12

Fundamental and Technological principled involved in Alkylation – Oxidation – Nitration and Hydrolysis.

UNIT IV UNIT PROCESSES II 12

Fundamental and Technological principled involved in Sulphonation, Sulfation and Isomerisation.

UNIT V UNIT PROCESSES III 12

Fundamental and Technological principles involved in Halogenation and Esterification

TOTAL: 60 PERIODS

TEXT BOOKS

1. Bhaskara Rao, B.K., "A Text on Petrochemicals", Khanna Publishers, 2000.
2. Sukumar Maiti, "Indroduction to Petrochemicals", 2nd Edition, Oxford and IBH Publishers, 2002.

REFERENCES

1. Margaret Wells, "Handbook of Petrochemicals and Processes", 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., "Chemistry of Petrochemical Processes", 2nd Edition, Gulf Publishing Company, 2000.
3. Dryden, C.E., "Outlines of Chemical Technology", 2nd Edition, Affiliated East-West Press, 1993.

PC3316	PROCESS DYNAMICS AND CONTROL LABORATORY	L	T	P	C
		0	0	3	2

1. ON-OFF control of thermal process
2. Flow control loop and Flow Transmitter
3. Level Control loop and Level Transmitter
4. Pressure control loop and Pressure Transmitter
5. Control valve characteristics
6. Verifying the response of Non-Interacting and interacting level System
7. Optimum controller setting using Ziegler's Nichols Methods
8. Optimum Controller Tuning on Level Process Station
9. pH control system
10. First order and second order system
11. Computer controlled heat exchanger (Shell and tube and Double pipe)
12. Pneumatic control valve positioned trainer
13. Cascade control trainer
14. I/P and P/I converter

***Minimum 10 experiments shall be offered.**

TOTAL: 45 PERIODS

PC3317	PETROLEUM PHYSICAL PROPERTIES TESTING LABORATORY	L	T	P	C
		0	0	3	2

1. Determination of flash point by Pensky Marten Closed Cup Apparatus
2. Determination of flash point by Abel Open cup Apparatus
3. Determination of Kinematic Viscosity by Redwood viscometer
4. Determination of Kinematic Viscosity by Saybolt viscometer
5. Determination of Kinematic Viscosity by Engler viscometer
6. Determination of Kinematic Viscosity by U tube viscometer
7. API gravity determination
8. Moisture determination by Dean and Stark Method
9. Water estimation by Karl-Fischer conductometer Apparatus

10. ASTM Distillation
11. Vacuum Distillation
12. Determination of Calorific Value by Junker's Gas Calorific meter.
13. Reid Vapor Pressure Estimation
14. Calorific value by Bomb calorimeter
15. Melting point test

TOTAL: 45 PERIODS

CH3318

MASS TRANSFER LABORATORY

L	T	P	C
0	0	3	2

1. Simple distillation
2. Steam distillation
3. Packed column distillation
4. Bubble cap distillation
5. Diffusivity measurements
6. Liquid-liquid extraction
7. Vacuum Dryer
8. Tray dryer
9. Rotary dryer
10. Surface Evaporation
11. Stage wise Leaching
12. Vapor-Liquid Equilibrium
13. Ternary Liquid
14. Sublimation of Naphthalene
15. Wetted Wall Column

*** Minimum 10 experiments shall be offered.**

TOTAL: 45 PERIODS

PC3401	EQUIPMENT DESIGN AND DRAWING II	L	T	P	C
	(To Consider as Practical Subject for Examination Purpose)	2	0	2	4

UNIT I THERMODYNAMIC PROPERTIES EVALUAION FOR DESIGN 9

Physical properties evaluation, Thermodynamic properties of gases and binary mixtures – Methods of calculations –Vapor-liquid equilibrium data for ideal and non-ideal mixtures. Bubble points and dew points, flash distillation calculation.

UNIT II HEAT EXCHANGER DESIGN 9

Design of double pipe heat exchangers, Heat exchanger types and its selection – shell and tube heat exchangers and Condensers – Effectiveness – NTU method of heat exchanger analysis.

UNIT III EVAPORATOR DESIGN 9

Steam – Uses of steam – Outstanding qualities of steam – BPE – Duhring's rule – Principle of multiple effect evaporation – Temperature driving force – Evaporators types and its selection – Design of single and multiple effect evaporators.

UNIT IV COLUMN DESIGN 9

Design of distillation columns and Absorption columns.

UNIT V PUMPS, FANS AND COMPRESSORS 9

Pumps, fans and compressors – Types and its applications – Characteristics – Piping and pressure drop calculations – Performance analysis of pumps, fans and compressors.

L: 45 P: 15 TOTAL: 60 PERIODS

TEXT BOOKS

1. Ernest E. Ludwig., "Applied Process Design for Chemical and Petrochemical Plants", Vol.I, II and III, Gulf Professional Publishing, 2002.
2. D. Q. Kern, "Process Heat Transfer", Tata McGraw Hill Publishing Co., New Delhi, 1990.

REFERENCES

1. Coulson, M. and Richardson, J.F., "Chemical Engineering", Vol.6, 3rd Edition, Pergamon Press, 1987.
2. Robert H. Perry and Don W. Green, "Perry's Chemical Engineer's Hand Book", 7th Edition, Mc Graw Hill – International, 1997.
3. Van Winkle, "Distillation Operations", McGraw Hill Publications, 1987.

Note: Necessary Data Book is to be issued while conducting Practical Examination

PC3402	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	1	0	4

UNIT I NON – IDEAL REACTORS 9

Residence time distribution function and its measurement – Characteristics of tracer – Mean residence time – Conversion in non-ideal flow reactors.

UNIT II HETEROGENEOUS PROCESS AND SOLID CATALYSIS 9

Rate equation for heterogeneous reactions – Nature of catalysis – Adsorption isothermal and rates of adsorption – Desorption and surface reaction analysis of rate equation – Rate controlling steps.

UNIT III GAS – SOLID CATALYTIC REACTORS 9

Characteristics of catalyzed reactions – Mechanism of solid catalyzed reactions – Pore diffusion resistance combined with surface kinetics – Performance equations for reactors containing porous catalysts.

UNIT IV GAS – SOLID NON – CATALYTIC REACTORS 9

Selection of the kinetic model – Progressive – conversion model, shrinking – core model – Shrinking-core model for spherical particles of unchanging size – Shrinking-core model for cylindrical particles of unchanging size.

UNIT V GAS – LIQUID REACTIONS 9

Various ways of carrying out gas – liquid reactions catalyzed by solids – General rate equation – Resistances in series in the gas – liquid reaction on catalyst surface.

L: 45 T: 15 TOTAL: 60 PERIODS

TEXT BOOKS

1. Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition, Wiley Asian Edition, 1990.
2. Smith, J.M., "Chemical Engineering Kinetics", 2nd Edition, McGraw Hill, 1984.

REFERENCES

1. Scott Fogler, H., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India, 2009
2. Gavanhe, K.A., "Chemical Reaction Engineering I", Nirali Prakashan Publishers, 2007.
3. Dawande, D., "Principles of Reaction Engineering", 1st Edition, Central Techno Publications, 2001.

UNIT I FIRST GENERATION PETROCHEMICALS I 12

Alternate routes with flow diagram for production of methane, ethane, propane, ethylene, propylene, butylenes, acetylene, naphthalene. Chemicals from methane, ethane, propane, ethylene, propylene, butylenes, acetylene.

UNIT II FIRST GENERATION PETROCHEMICALS II 12

Alternate routes with flow diagram for production of butadiene, related dienes, aromatics – Benzene, toluene, xylene – Chemicals from butadiene, related dienes, aromatics – Benzene, toluene, xylene.

UNIT III SECOND GENERATION PETROCHEMICALS 12

Alternate routes with flow diagram for production of ethylene glycol, VCM, acrylonitrile, phenol, caprolactum, adipic acid, hexamethylene diamine, DMT, TPA, maleic anhydride, styrene.

UNIT IV THIRD GENERATION PETROCHEMICALS I 12

Polymerization – Modes and techniques – Production of polyethylene – LDPE, HDPE, polypropylene, poly butadiene rubber, SBR, polystyrene, SAN, ABS.

UNIT V THIRD GENERATION PETROCHEMICALS II 12

Polyacrylonitrile, polyvinyl chloride, polycarbonates, nylon 6, nylon 66, polyesters, formaldehyde resins, explosives, dyes.

TOTAL: 60 PERIODS**TEXT BOOKS**

1. Bhaskara Rao, B.K., "A Text on Petrochemicals", Khanna Publishers, 2000.
2. Sukumar Maiti, "Introduction to Petrochemicals", 2nd Edition, Oxford and IBH Publishers, 2002.

REFERENCES

1. Margaret Wells, "Handbook of Petrochemicals and Processes", 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., "Chemistry of Petrochemical Processes", 2nd Edition, Gulf Publishing company, 2000.
3. Dryden, C.E., "Outlines of Chemical Technology", 2nd Edition, Affiliated East-West Press, 1993.

PC3404	PETROLEUM SECONDARY PROCESSING TECHNOLOGY	L	T	P	C
		4	0	0	4

UNIT I SECONDARY PROCESSING 12

Need and significance – Types and functions of secondary processing – Visbreaking – Processes, operating parameters and advantages – Coking – Operating parameters and advantages.

UNIT II CRACKING 12

Thermal cracking – Processes, operating parameters, feed stock selection and product yields – Advantages – Free radical mechanism.

Fluid catalytic cracking – processes, operating parameters, feed stock selection and product yields – Advantages – Catalyst used and regeneration – Cation mechanism.

UNIT III HYDROCRACKING AND HYDROTREATING 12

Hydrocracking, principles, process requirements, product yields and qualities and residcracking – Hydrotreating – Sulphur removal, aromatics removal, hydrofinishing.

UNIT IV REFORMING 12

Reforming – Principles, processes, operating parameters – Catalyst types, performance, effects of operating parameters – Feed quality and regeneration.

UNIT V OTHER PROCESSES 12

Isomerisation – Processes, operating parameters, advantages – Alkylation – Processes, operating parameters, advantages – Polymerization – Processes, operating parameters, advantages.

TOTAL: 60 PERIODS

TEXT BOOKS

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers, 2007
2. Bhaskara Rao, B.K., "Modern Petroleum Refining Processes", 4th Edition, Oxford and IBH Publishing Company Pvt. Ltd, 2002.

REFERENCES

1. Gary, J. H. and Handwerk, G.E., "Petroleum Refining Technology and Economics", 4th Edition, Marcel Dekker Inc., 2001.
2. Nelson, W.L., "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited, 1985.
3. Hobson, G.D., "Modern Petroleum Refining Technology", 5th Edition, John Wiley Publishers, 1984.

PC3405	WATER TREATMENT AND MANAGEMENT	L	T	P	C
		4	0	0	4

UNIT I INTERNAL TREATMENT PROCESS 12

Character and properties – Water problem and solution – Water Sedimentation - Coagulation – Filtration – Disinfection – Theory, necessity, process, equipment, application, location, limitation.

UNIT II EXTERNAL TREATMENT PROCESS 12

Softening by Ion – exchange process, Demineralization – Cation exchange materials – Removal of ion, Manganese, odour, colour taste – Deaeration – Oxidation – Fluoridation – Dealkalisation – Desalination by Reverse osmosis.

UNIT III BOILER WATER AND COOLING WATER 12

Concept – Importance – Location – Commonly used desalination process – Distillation – Electrodialysis – Reverse osmosis – Freezing – Solar distillation- Purpose – Problem associated with water quality and equipment – Steam system fundamentals – Hot water closed system – Measurement and control of pH, corrosion, fouling – Microbial analysis – Ozone control – Study of microorganism – Energy efficient operations and maintenance.

UNIT IV WASTE WATER TREATMENT 12

Waste water in Industry- Home and Agriculture – Various waste water treatment processes – Optimization – Benefits and costs – Microbial and sanitation water treatment – Biofilm formation and removal – Microbial trend analysis – Pretreatment system and equipment.

UNIT V WATER MANAGEMENT IN INDIA 12

Water resources and planning – Water policy – Indian scene – Main aspects of water management – Hydrological cycle – Hydrosphere – Water transport – Water exchange – Causes and problems in irrigation, rural water, urban water – Water conservation resource management – Rain Harvesting.

TOTAL: 60 PERIODS

TEXT BOOKS

1. P.C.Bansil "Water Management in India", Concept Publishing company, New Delhi, First Edition, 2004.
2. G.S.Bridie and J.S.Bridie "Water Supply and Sanitary Engineering", Dhanpat Raj Publishing company (P) Ltd., New Delhi, 7th Edition, 2003.

REFERENCES

1. Austin G.T., "Shreve's Chemical Process Industries", Fifth Edition, McGraw Hill, 1998.
2. S.C. Rangwala, "Water supply and Sanitary Engineering", Eighteenth Edition, Charotar Publishing House, 2003.
3. Pandey G.N., "Text Book of Chemical Technology", Vikas Publishing House Pvt. Ltd., New Delhi, 1992.

PC3406	PETROCHEMICAL ANALYSIS LABORATORY	L	T	P	C
		0	0	3	2

1. Sulphur content determination
2. Flue gas Analysis – Orsat Apparatus
3. Aromatic Content determination
4. Hydrogen sulphide content determination
5. Mercaptan as sulphur estimation apparatus
6. Determination of Lead, Acid and Salt content
7. Oil separation from lubricating Grease (Oil Separation Apparatus)
8. Analysis of petrochemicals using UV spectrophotometer
9. Analysis of petrochemicals using NMR with MS
10. Analysis of petrochemicals using Gas chromatography
11. Biodegradation of petrochemicals
12. Bioremediation of petrochemicals
13. Refractive index of petrochemicals
14. Determination of moisture content – KF titrator
15. Total acidity determination

TOTAL: 45 PERIODS

PC3407	PETROLEUM PRODUCT TESTING LABORATORY	L	T	P	C
		0	0	3	2

1. Determination of aniline point and diesel index
2. Softening point of bitumen by ring and ball method
3. Ductility and penetration number of bitumen
4. Rust preventing characteristics of lube oil
5. Drop point of greases
6. Cloud and pour point determination
7. Smoke point determination
8. Copper corrosion testing of petroleum products
9. Sediment content of crude oil and fuel oils
10. Coking tendency of oil
11. Saybolt color of petroleum products / loviband tintometer
12. Water separability of petroleum products
13. Refractive index of petroleum products
14. Hydrocarbon types in petroleum products
15. Carbon residue determination
16. Oxidation stability of gasoline and ATF
17. Bearing and grease noise characteristics

TOTAL: 45 PERIODS

UNIT III TQM TOOLS & TECHNIQUES I 9
 The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV TQM TOOLS & TECHNIQUES II 9
 Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

UNIT V QUALITY SYSTEMS 9
 Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL : 45 PERIODS

TEXT BOOK

1. Dale H.Besterfield, et al., “Total Quality Management”, Pearson Education Asia, Third Edition, Indian Reprint (2006).

REFERENCES

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South-Western (Thomson Learning), 2005.
2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.
3. Suganthi, L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006.
4. Janakiraman, B and Gopal, R.K, “Total Quality Management – Text and Cases”, Prentice Hall (India) Pvt. Ltd., (2006).

PC3410	SAFETY AND RISK MANAGEMENT	L	T	P	C
		4	0	0	4

UNIT I INDUSTRIAL SAFETY 15
 Concepts of safety – Hazard classification chemical, physical, mechanical, ergonomics, biological and noise hazards – Hazards from utilities like air, water, steam.

UNIT II HAZARD IDENTIFICATION AND CONTROL 15
 HAZOP, job safety analysis – Fault tree analysis – Event tree analysis – Failure modes and effect analysis and relative ranking techniques – Safety audit – Plant inspection – Past accident analysis.

UNIT III RISK MANAGEMENT 15
 Overall risk analysis – Chapains model, E and FI model– Methods for determining consequences effects: Effect of fire, Effect of explosion and toxic effect – Disaster management plan – Emergency planning – Onsite and offsite emergency planning – Risk management – Gas processing complex, refinery – First aids.

UNIT IV SAFETY PROCEDURES 7

Safety in plant design and layout – Safety provisions in the factory act 1948 – Indian explosive act 1884 – ESI act 1948 – Advantages of adopting safety laws.

UNIT V SAFETY IN HANDLING AND STORAGE OF CHEMICALS 8

Safety measures in handling and storage of chemicals – Fire chemistry and its control – Personnel protection – Safety color codes of chemicals.

TOTAL: 60 PERIODS

TEXT BOOKS

1. Blake, R.P., "Industrial Safety", Prentice Hall, 1953.
2. Lees, F.P., "Loss Prevention in Process Industries", 2nd Edition, Butterworth Heinemann, 1996.

REFERENCES

1. Geoff Wells, "Hazard Identification and Risk Assessment", I.ChE.
2. John Ridley and John Channing, "Safety at Work", 6th Edition. Butterworth-Heinemann, 2003.
3. Raghavan, K.V. and Khan, A.A., "Methodologies in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.

PC3411	PROJECT WORK	L	T	P	C
		0	0	12	12

The project may be considered as the ultimate exercise presented to the final semester student before graduation to measure accumulated engineering knowledge and experience. At the same time, the project itself should provide the students with some new skills, innovation and information, and strengthen the acquired ones.

The project programme consists of different assignment, allotted time, submission of report under internal faculty guidance and evaluation by external member along with internal faculty.

The activities performed during a project may cover one or more of the following;

- Data collection
- Critical literature review
- Laboratory experience and tests
- Mathematical modeling
- Software application
- Industrial visits
- Design and/or assembly
- Process analysis

The major project may be assigned to a group of two students. The project topic allotted may be of theoretical, experimental or industrial projects to be carried out under the supervision of internal guide and external guide (in case of industrial projects).

Major projects are to be executed strictly as per the project schedule prepared during VIII semester. A committee of departmental faculty members comprising the project guide, one more faculty member and the head of department will monitor and review the progress achieved by the student at various stages. The internal assessment will be done by the committee based on the progress achieved on completion of the project work.

On completion of the project work, each student has to prepare a project report and submit the same in triplicate to the department. The project work and the report will be evaluated by the internal assessment committee for a total of 100 marks. The external university examination, which carries a total of 100 marks, will have report evaluation and viva voce examination conducted by a committee of one external examiner and one internal examiner appointed by the university

CH3002	PROCESS MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION ON MODELS 9

Introduction – Models and model building – Principles of model formulation – Fundamental laws – continuity equation – Energy equation – Equations of motion – Transport equation – Equations of state – Equilibrium and kinetics – Classification of mathematical models.

Numerical solutions of model equations – Linear and non linear algebraic equations in one and more than one variables.

UNIT II LUMPED PARAMETER MODELS 9

Formulation and solution techniques to be discussed for vapour liquid equilibrium models – Dew point and flash calculations for multicomponent systems – Distillation operations, batch and continuous distillation models – Tank models – Mixing tank – Stirred tank with heating – CSTR with multiple reactions – Non-isothermal CSTR – Multiplicity and stability control at the unsteady state – Non-ideal CSTR models – Multi-Parameter models with dead space and bypassing – Staged operation.

UNIT III DISTRIBUTED PARAMETER MODELS(STEADY STATE) 9

Formulation and solution of split boundary value problems – Shooting technique, quasi-linearization techniques, counter current heat exchanger, tubular reactor with axial dispersion, counter current gas absorber

Pipe line gas flow – Tubular permeation process – Pipe line flasher.

UNIT IV UNSTEADY STATE DISTRIBUTED PARAMETER MODELS 9

Solution of partial differential equations using finite difference method – Convective problems, diffusive problems – Combined convective and diffusive problems – Unsteady state conduction and diffusion, unsteady state heat exchangers – Dynamics of tubular reactor with dispersion – Transfer function models for distributed parameter systems.

UNIT V MODEL PARAMETERS ESTIMATION 9

Introduction – Method of least squares, curve fitting, parameter estimation of dynamic transfer function models – Least square and recursive least square methods – Parameter estimation of RTD models – Moments method.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Ramirez, W.F., "Computational Methods in Process Simulation", Butterworth Publishers, 1989.
2. Roger E. Franks, "Modelling and Simulation in Chemical Engineering", John Wiley and Sons, 1972.

REFERENCES

1. Luyben, W.L., "Process Modelling, Simulation and Control for Chemical Engineers", 1990.
2. Santhos Kumar Gupta, "Numerical Methods for Engineers", Tata McGraw Hill, 1995.
3. Seinfeld and Lapidus, "Mathematical Methods in Chemical Engineering", Prentice Hall, 1974.

CH3003	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

UNIT I FUNDAMENTALS OF TRANSPORT PHENOMENA 9

The nature of transport phenomena: Importance, mechanism, driving force, analogous nature – Conservation laws – Method of study: differential, integral and experimental methods – Phenomenological laws of transport properties – Newtonian and non Newtonian fluids – Rheological models – Effect of pressure and temperature on viscosity.

UNIT II ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) 9

General methods of shell balance approach to transfer problems – Momentum flux and velocity distribution for flow of Newtonian fluids in pipes, planes, slits and annulus – Heat flux and temperature distribution for heat sources such as electrical, viscous – Mass flux and concentration profile for diffusion in stagnant gas systems involving reaction.

UNIT III EQUATION OF CHANGE AND THEIR APPLICATIONS 9

Development of the equation of change for isothermal systems, non-isothermal systems and multicomponent system – Use of equation of change for flow in a circular pipe – Rotating liquid – Temperature distribution in a rotating cylinder with viscous dissipation and flow of a newtonian fluid with constant energy flux – Concentration profile in a tubular reactor and gas diffusion through a solid – Dimensional analysis of the equation of change – Equation of motion for forced and free convection.

UNIT IV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9

Time smoothed equation of change for velocity and temperature distribution – Time smoothed velocity distribution near a wall and circular jet – Time smoothed temperature profile near a wall, turbulent flow in pipes and jets – Time smoothed concentration and equation of continuity with application to turbulent mixing and reaction – Boundary layer theory, thickness, velocity separation and flow around objects, flat plate, application of penetration theory for high mass transfer rate.

UNIT V ANALOGIES BETWEEN TRANSPORT PROCESSES 9

Importance of analogy – Development and applications of analogies between momentum – Heat and mass transfer – Reynolds, Prandtl, Von Karman and Colburn analogies.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Bird, R.B., Stewart, W.E. and Light Foot, E.N., "Transport Phenomena" John Wiley and sons, 2002.
2. Welty, J.R., Wick, C.E., and Wilson, R.E., "Fundamentals of Momentum, Heat and Mass Transfer", John Wiley Sons, 2002.

REFERENCES

1. Thomson, W. J., "Introduction to Transport Phenomena", Pearson Education Asia, 2000.
2. Griskey, R.G., "Transport Phenomena and Unit Operations", Wiley-Interscience, 2002.
3. Beek, W.J., Muttzall, K.M.K. and Van Heuven, J.W., "Transport Phenomena", 2nd Edition, John Wiley and Sons, Ltd., 2000.

PC3003	PROCESS INSTRUMENTATION	L	T	P	C
		3	0	0	3

UNIT I PHYSICAL PROPERTY MEASUREMENT 9

Density and specific gravity – Viscosity and consistency – Refractive index analyzers – Boiling point – Flash point analyzers – Thermal conductivity.

UNIT II TEMPERATURE MEASUREMENT 9

Differential expansion and fluid expansion types – Resistance thermometers – Thermoelectric pyrometers – Radiation pyrometers – Optical pyrometers – Pyrometric cones – Ultrasonic thin wire thermometer.

UNIT III PRESSURE MEASUREMENT 9

Absolute pressure – Gauge pressure and vacuum – Liquid types and spring balanced types – Differential pressure – Manometer types – Simple U tube and inclined tube manometer and sealed bell types – Pressure transmitters.

UNIT IV FLOW MEASUREMENT 9

Volumetric meters – Variable head meters – Orifice meter – Venturi meter – Pitot tube – Closed channel and open channel types – Variable area meters – Velocity and current meters – Anemo meter – Ultrasonic flowmeter – Mass meters.

UNIT V LEVEL MEASUREMENT 9

Measurement of head and level – Float methods – Hydrostatic pressure methods – Gauge glass automatic detector – Ultrasonic probe – Electronic level gauge – Continuous capacitance gauge.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Nakra, B.C. and Chaudhry, K.K., "Instrumentation, Measurement and Analysis", 2nd Edition, Tata McGraw-Hill, 2004.
2. Singh, S.K., "Industrial Instrumentation and Control", 2nd Edition, Tata McGraw – Hill, 2007.

REFERENCES

1. Doebelin, E.O., "Measurement System Application and Design", 4th Edition, McGraw Hill, 1998.
2. Patranabis, D., "Principles of Industrial Instrumentation", 2nd Edition, Tata McGraw – Hill, 2007.
3. Sawhney, A.K., "A Course in Electrical, Electronics Measurement and Instrumentation", Dhanpat Rai and sons, 1999.

CH3004 FLUIDIZATION ENGINEERING L T P C
3 0 0 3

UNIT I BASICS OF FLUIDIZATION 9

Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozneykarman – On set of fluidization – Properties of fluidized beds – Development of fluidization from fixed bed.

UNIT II FLUIDIZED BED TYPES 9

Minimum fluidization conditions – Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

UNIT V ECONOMIC BALANCE IN ENERGY CONSUMPTION 9

Cost analysis – Capacity – Production rate – System rate – System cost analysis – Corporate models – Production analysis and production using fuel inventories – Input-output analysis – Economics – Tariffs.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Krentz, J. H., "Energy Conservation and Utilisation", Allyn and Bacur Inc., 1976.
2. Gramlay, G. M., "Energy", Macmillon Publishing Co., 1975.

REFERENCES

1. Rused C.K., "Elements of Energy Conservation", McGraw – Hill Book Co., 1985.
2. Judson King; "Separation Processes", McGraw – Hill Book Co., 1985.
3. Samir Sarkar, "Fuels and Combustion", 2nd Edition, Orient Longman Publication, 1988.

PC3008	NOVEL SEPARATION PROCESS	L	T	P	C
		3	0	0	3

UNIT I MEMBRANE SEPARATIONS 9

Types and choice of membranes – Plate and frame membranes, tubular membranes, spiral wound membranes, hollow fibre membrane and their relative merits, membrane reactors, membrane permeators involving Dialysis – Reverse osmosis – Ultrafiltration – Donnan dialysis.

UNIT II SEPARATIONS BY ADSORPTION TECHNIQUES 9

Types of adsorption – Nature of adsorbents – Adsorption equilibria – Adsorption hysteresis adsorption isotherms – Effect of temperature and pressure – Freundlich equation – Stagewise adsorption – Single and multistage crosscurrent adsorption – Break through curves and rates of adsorption.

UNIT III CHROMATOGRAPHY TECHNIQUES 9

Affinity chromatography, immuno chromatography and Ion exchange chromatography – Introduction – Principles – Types of equipment – Commercial processes – Applications.

UNIT IV IONIC SEPARATIONS 9

Electrophoresis – Introduction – Electrokinetics – The electrical double layer – Zeta potential and electrophoresis – Laboratory methods – Analytical and Preparative methods – Applications Electrodialysis – Principles and applications.

UNIT V MISCELLANEOUS FERTILISERS 9

Mixed fertilizers and granulated mixtures- Biofertilisers- Nutrients- Secondary nutrients and micro nutrients- Fluid fertilizers- Controlled release fertilizers- Controlled release fertilizers.

TOTAL: 45 PERIODS

TEXT BOOKS

1. "Handbook of fertiliser technology", Association of India, New Delhi, 1977.
2. Menon, M.G.; "Fertiliser Industry - An Introductory Survey", Higginbothams Pvt. Ltd., 1973.

REFERENCES

1. Sauchelli, V.; "The Chemistry and Technology of Fertilisers", ACS MONOGRAPH No. 148, Reinhold Publishing Cor., 1980.
2. Fertiliser Manual, "United Nations Industrial Development Organisation", United Nations, 1967.
3. Slack, A.V.; Chemistry and Technology of Fertilisers, Interscience, 1966.

PC3010	MULTICOMPONENT DISTILLATION	L	T	P	C
		3	0	0	3

UNIT I THERMODYNAMIC PRINCIPLES 9

General considerations in the design of columns – Column sequencing – Heuristics for column sequencing – Key components – Distributed components – Non-Distributed components – Adjacent keys.

Fundamental Thermodynamic principles involved in the calculation of vapor – liquid equilibria and enthalpies of multi component mixtures – Use of multiple equation of state for the calculation of K values – Estimation of the fugacity coefficients for the vapor phase of polar gas mixtures – calculation of liquid – phase activity coefficients.

UNIT II THERMODYNAMIC PROPERTY EVALUATION 9

Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.

UNIT III MINIMUM REFLUX RATIO FOR MCD SYSTEM 9

Definition of minimum reflux ratio – calculation of R_m for multi component distillation – Underwood method – Colburn method.

UNIT III TUBESTILL HEATERS 9

Types of stills – Radiant and convection heat recovery sections – Radiant absorption rate – Lobo-Evans method – distribution of radiant heat – Rate of heat absorption in the convection section – Pipe still losses – Pipe still design – Pressure drop in Pipe stills – Gas and oil fired burner design, Refractory lining – Air pre-heater and economizer design – Furnace efficiency and safety.

UNIT IV HEAT TREATMENT FURNACE 9

Muffle Furnace – Bogey hearth furnace – Rotary hearth furnaces – Open hearth furnaces – Retards – Kilns – Horizontal and Vertical tube furnaces.

UNIT V BURNER DESIGN 9

Ignition – Concept of ignition - Functional requirements of burners – Ignitors – Auto ignitors – Ignition temperature – Various types of ignitors. Flame propagation – Deflagration – Flammability limits – Flame blow out and flash back – Flame quenching. Various methods of flame stabilization – Incorporation in burner design – Swirl number and its significance – Basic features and types of solid, liquid and gaseous fuel burner – Design considerations of different types of coal – Oil and gas burners – Atomization for oil burners – Recuperative burners – Regenerative burners – Domestic burners – Properties of solid, liquid and gaseous fuels with reference to suitability for a given burner type – selection of an appropriate type of burner and design of the burner for a specified duty.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Samir Sarkar, "Fuels and Combustion", 2nd Edition, Orient Longman Publication, 1988.
2. John Griswold, "Fuel Combustion and Furnaces", McGraw Hill, 1996.

REFERENCES

1. Bhatt, B.I. and Vora, S.M., "Stoichiometry", 3rd Edition., TMH, 1976.
2. Gupta, O.P., "Elements of Fuels, Furnaces and Refractories", Khanna Publishers, 2007.
3. Rai, G.N., "Non Conventional Energy Sources," Khanna Publishers, 1999.

UNIT I CHARACTERISTICS, ANALYSIS OF POLYMERS**9**

The science of large molecules – Theory of polymer solutions – Measurement of molecular weight and size – Analysis and testing of polymers.

UNIT II POLYMER MATERIAL STRUCTURE AND PROPERTIES**9**

Deformation, flow and melt characteristics – Morphology and order in crystalline polymers – Rheology and the mechanical properties of polymers – Polymer structure and physical properties.

UNIT III POLYMER SYNTHESIS AND REACTION ENGINEERING**9**

Condensation polymerization – Addition polymerization – Ionic and coordination polymerization – Copolymerisation – Polymerization conditions and polymer reactions.

UNIT IV INDUSTRIAL POLYMERS: MANUFACTURING PROCESS AND APPLICATIONS**9**

Hydrocarbon plastics and elastomers – Other carbon chain polymers – Heterochain thermoplastics, thermosetting resins.

UNIT V PROCESSING OF POLYMERS: PLASTICS, FIBRES AND ELASTOMERS**9**

Polymers developed for synthetic plastics, fibres and elastomer applications – Plastics technology – Fiber technology – Elastomer technology.

TOTAL: 45 PERIODS**TEXT BOOKS**

1. Billmeyer Jr, F.W., "Text Book of Polymer Science", 3rd Edition, Wiley Inter Science, 1984.
2. Gowarikar, V.R., Viswanathan, N.V. and Heaved Sridhar, "Polymer science", 1st Edition, New Age International Ltd, 2003.

REFERENCES

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