

# ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

**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
<b>THEORY</b>						
1.	HS2161	<a href="#">Technical English – II*</a>	3	1	0	4
2.	MA2161	<a href="#">Mathematics – II*</a>	3	1	0	4
3.	PH2161	<a href="#">Engineering Physics – II*</a>	3	0	0	3
4.	CY2161	<a href="#">Engineering Chemistry – II*</a>	3	0	0	3
5. a	ME2151	<a href="#">Engineering Mechanics</a> (For non-circuit branches)	3	1	0	4
5. b	EE2151	<a href="#">Circuit Theory</a> (For branches under Electrical Faculty)	3	1	0	4
5. c	EC2151	<a href="#">Electric Circuits and Electron Devices</a> (For branches under I & C Faculty)	3	1	0	4
6. a	GE2151	<a href="#">Basic Electrical &amp; Electronics Engineering</a> (For non-circuit branches)	4	0	0	4
6. b	GE2152	<a href="#">Basic Civil &amp; Mechanical Engineering</a> (For circuit branches)	4	0	0	4
<b>PRACTICAL</b>						
7.	GE2155	<a href="#">Computer Practice Laboratory-II*</a>	0	1	2	2
8.	GS2165	<a href="#">Physics &amp; Chemistry Laboratory - II*</a>	0	0	3	2
9. a	ME2155	<a href="#">Computer Aided Drafting and Modeling Laboratory</a> (For non-circuits branches)	0	1	2	2

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

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

+ Offering English Language Laboratory as an additional subject (with no marks) during 2<sup>nd</sup> 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
<b>THEORY</b>						
1	PC3201	<a href="#">Transforms and Partial Differential Equations</a>	3	1	0	4
2	PC3202	<a href="#">Organic Chemistry</a>	3	0	0	3
3	PC3203	<a href="#">Environmental Science and Engineering</a>	3	0	0	3
4	PC3204	<a href="#">Industrial Chemical Technology</a>	3	0	0	3
5	PC3205	<a href="#">Electrical Drives and Control</a>	3	0	0	3
6	PC3206	<a href="#">Data Structures</a>	3	0	0	3
<b>PRACTICAL</b>						
7	PC3207	<a href="#">Organic Chemistry Laboratory</a>	0	0	3	2
8	PC3208	<a href="#">Electrical Machines Laboratory</a>	0	0	3	2
9	PC3209	<a href="#">Data Structures Laboratory</a>	0	0	3	2
		<b>TOTAL</b>	<b>18</b>	<b>1</b>	<b>9</b>	<b>25</b>

### SEMESTER IV

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
<b>THEORY</b>						
1	PC3210	<a href="#">Numerical Methods</a>	3	1	0	4
2	PC3211	<a href="#">Physical Chemistry</a>	3	0	0	3
3	PC3212	<a href="#">Material Technology</a>	3	0	0	3
4	PC3213	<a href="#">Process Calculations</a>	4	0	0	4
5	PC3214	<a href="#">Fluid Flow Operations</a>	3	0	0	3
6	PC3215	<a href="#">Mechanical Operations</a>	3	0	0	3
<b>PRACTICAL</b>						
7	PC3216	<a href="#">Physical Chemistry Laboratory</a>	0	0	3	2
8	PC3217	<a href="#">Fluid Flow Operations Laboratory</a>	0	0	3	2
9	PC3218	<a href="#">Mechanical Operations Laboratory</a>	0	0	3	2
		<b>TOTAL</b>	<b>19</b>	<b>1</b>	<b>9</b>	<b>26</b>

### SEMESTER V

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
<b>THEORY</b>						
1	PC3301	<a href="#">Special Functions</a>	3	1	0	4
2	PC3302	<a href="#">Heat Transfer</a>	4	0	0	4
3	PC3303	<a href="#">Mass Transfer Fundamentals</a>	4	0	0	4
4	PC3304	<a href="#">Engineering Thermodynamics</a>	4	0	0	4
5	PC3305	<a href="#">Natural Gas Engineering</a>	4	0	0	4
6	PC3306	<a href="#">Petroleum Exploration and Exploitation Techniques</a>	3	1	0	4
<b>PRACTICAL</b>						
7	PC3307	<a href="#">Heat Transfer Laboratory</a>	0	0	3	2
8	PC3308	<a href="#">Technical Analysis Laboratory</a>	0	0	3	2
9	PC3309	<a href="#">Communication and Soft Skills Laboratory</a>	0	0	3	1
		<b>TOTAL</b>	<b>22</b>	<b>2</b>	<b>9</b>	<b>29</b>

### SEMESTER VI

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
<b>THEORY</b>						
1	PC3310	<a href="#">Process Dynamics and Control</a>	4	0	0	4
2	PC3311	<a href="#">Mass Transfer Operations</a>	3	1	0	4
3	PC3312	<a href="#">Principles of Chemical Kinetics</a>	4	0	0	4
4	PC3313	<a href="#">Equipment Design and Drawing I</a>	2	0	2	4
5	PC3314	<a href="#">Petrochemical Unit Processes</a>	4	0	0	4
6	PC3315	<a href="#">Petroleum Crude Processing Technology</a>	4	0	0	4
<b>PRACTICAL</b>						
7	PC3316	<a href="#">Process Dynamics and Control Laboratory</a>	0	0	3	2
8	PC3317	<a href="#">Petroleum Physical Properties Testing Laboratory</a>	0	0	3	2
9	PC3318	<a href="#">Mass Transfer Laboratory</a>	0	0	3	2
		<b>TOTAL</b>	<b>21</b>	<b>1</b>	<b>11</b>	<b>30</b>

### SEMESTER VII

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

### SEMESTER VIII

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
<b>THEORY</b>						
1	PC3409	<a href="#">Total Quality Management</a>	4	0	0	4
2	PC3410	<a href="#">Safety and Risk Management</a>	4	0	0	4
3		Elective II	3	0	0	3
<b>PRACTICAL</b>						
4	PC3411	<a href="#">Project Work</a>	0	0	12	12
		<b>TOTAL</b>	<b>11</b>	<b>0</b>	<b>12</b>	<b>23</b>

## LIST OF ELECTIVES

### ELECTIVE FOR SEMESTER III

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
<b>THEORY</b>						
1	PC3001	<a href="#">Process Modelling and Simulation</a>	3	0	0	3
2	PC3002	<a href="#">Transport Phenomena</a>	3	0	0	3
3	PC3003	<a href="#">Process Instrumentation</a>	3	0	0	3
4	PC3004	<a href="#">Fluidization Engineering</a>	3	0	0	3
5	PC3005	<a href="#">Petroleum Process Equipment Auxiliaries</a>	3	0	0	3
6	PC3006	<a href="#">Industrial Management</a>	3	0	0	3

### ELECTIVES FOR SEMESTER IV

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
<b>THEORY</b>						
1	PC3007	<a href="#">Energy Management in Chemical Industries</a>	3	0	0	3
2	PC3008	<a href="#">Novel Separation Process</a>	3	0	0	3
3	PC3009	<a href="#">Fertilizer Technology</a>	3	0	0	3
4	PC3010	<a href="#">Multicomponent Distillation</a>	3	0	0	3
5	PC3011	<a href="#">Combustion and Furnace Design</a>	3	0	0	3
6	PC3012	<a href="#">Polymer Technology</a>	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.

**MA2161****MATHEMATICS – II****L T P C****3 1 0 4****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", 3<sup>rd</sup> Edition, Laxmi Publications (p) Ltd., (2008).
2. Grewal. B.S, "Higher Engineering Mathematics", 40<sup>th</sup> 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", 3<sup>rd</sup> Edition, Pearson Education, (2007).
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 7<sup>th</sup> Edition, Wiley India, (2007).
4. Jain R.K and Iyengar S.R.K, "Advanced Engineering Mathematics", 3<sup>rd</sup> Edition, Narosa Publishing House Pvt. Ltd., (2007).

**PH2161**

**ENGINEERING PHYSICS – II**

**L T P C**  
**3 0 0 3**

**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<sub>c</sub> 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, 7<sup>th</sup> edition, Singapore (2007)
2. Charles P. Poole and Frank J.Owenn, '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).

**CY2161**

**ENGINEERING CHEMISTRY – II**

**L T P C**  
**3 0 0 3**

**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 -  $\text{Fe}^{2+}$  vs dichromate and precipitation –  $\text{Ag}^+$  vs  $\text{Cl}^-$  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 Prakashan 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 – Lame'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. Hibbeler, 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).

**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 IV TRANSIENT RESPONSE FOR DC CIRCUITS 12**  
Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input.

**UNIT V ANALYSING THREE PHASE CIRCUITS 12**  
Three phase balanced / unbalanced voltage sources – analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & un balanced – phasor diagram of voltages and currents – power and power factor measurements in three phase circuits.

**TOTAL: 60 PERIODS**

**TEXT BOOKS:**

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 6<sup>th</sup> edition, New Delhi, (2002).
2. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGraw Hill, (2007).

**REFERENCES:**

1. Paranjothi SR, "Electric Circuits Analysis," New Age International Ltd., New Delhi, (1996).
2. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, Tata McGraw-Hill, New Delhi (2001).
3. Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi, (1999).
4. Charles K. Alexander, Mathew N.O. Sadik, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, (2003).

**EC2151 ELECTRIC CIRCUITS AND ELECTRON DEVICES L T P C**  
(For ECE, CSE, IT and Biomedical Engg. Branches) **3 1 0 4**



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**  
(Common to branches under Electrical and I & C Faculty)

**L T P C**  
**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**

## **B – MECHANICAL ENGINEERING**

### **UNIT III POWER PLANT ENGINEERING 10**

Introduction, Classification of Power Plants – Working principle of steam, Gas, Diesel, Hydro-electric and Nuclear Power plants – Merits and Demerits – Pumps and turbines – working principle of Reciprocating pumps (single acting and double acting) – Centrifugal Pump.

### **UNIT IV IC ENGINES 10**

Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Boiler as a power plant.

### **UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 10**

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system – Layout of typical domestic refrigerator – Window and Split type room Air conditioner.

**TOTAL: 30 PERIODS**

#### **REFERENCES:**

1. Shanmugam G and Palanichamy M S, "Basic Civil and Mechanical Engineering", Tata McGraw Hill Publishing Co., New Delhi, (1996).
2. Ramamrutham. S, "Basic Civil Engineering", Dhanpat Rai Publishing Co. (P) Ltd. (1999).
3. Seetharaman S. "Basic Civil Engineering", Anuradha Agencies, (2005).
4. Venugopal K and Prahu Raja V, "Basic Mechanical Engineering", Anuradha Publishers, Kumbakonam, (2000).
5. Shantha Kumar S R J., "Basic Mechanical Engineering", Hi-tech Publications, Mayiladuthurai, (2000).

**GE2155**                      **COMPUTER PRACTICE LABORATORY – II**                      **L T P C**  
**0 1 2 2**

**LIST OF EXPERIMENTS**

- |   |           |
|---|-----------|
| <b>1. UNIX COMMANDS</b>   | <b>15</b> |
| Study of Unix OS - Basic Shell Commands - Unix Editor             |           |
| <b>2. SHELL PROGRAMMING</b>                                       | <b>15</b> |
| Simple Shell program - Conditional Statements - Testing and Loops |           |
| <b>3. C PROGRAMMING ON UNIX</b>                                   | <b>15</b> |
| Dynamic Storage Allocation-Pointers-Functions-File Handling       |           |

**TOTAL: 45 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  $\text{BaCl}_2$  vs  $\text{Na}_2\text{SO}_4$
4. Potentiometric Titration ( $\text{Fe}^{2+}$  /  $\text{KMnO}_4$  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**

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.



- Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill Company Ltd., 2007.

## REFERENCES

- Bali.N.P. and Manish Goyal., "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications (P) Ltd.
- Ramana.B.V., "Higher Engineering Mathematics" Tata McGraw Hill.
- Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
- Erwin Kreyszig, "Advanced Engineering Mathematics" 8th Edition, Wiley India, 2007.

**PC3202**

**ORGANIC CHEMISTRY**

**L T P C**  
**3 0 0 3**

### **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.

**PC3203****ENVIRONMENTAL SCIENCE AND ENGINEERING****L T P C  
3 0 0 3****UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES****9**

Definition, scope and importance – Need for public awareness – Forest resources – Use and over- exploitation – Deforestation – Case studies – Timber extraction – Mining – Dams and their ground water – Floods – Drought – Conflicts over water – Dams – Benefits and problems – Mineral resources – Use effects on forests and tribal people – Water resources – Use and over-utilization of surface 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.

**UNIT II ECOSYSTEMS AND BIODIVERSITY****9**

Concepts 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.

### **UNIT III ENVIRONMENTAL POLLUTION 9**

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 – Solid waste management:- Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management:- Floods, earthquake, cyclone and landslides.

### **UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9**

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 – 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 – Issues involved in enforcement of environmental legislation – Public awareness.

### **UNIT V HUMAN POPULATION AND THE ENVIRONMENT 9**

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.

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

Field study of common plants, insects and birds – Field study of simple ecosystems – Pond, river, hill slopes, etc.

Field study of local polluted site – Urban/rural/industrial/agricultural

**TOTAL: 45 PERIODS**

#### **TEXT BOOKS**

1. Masters, G.M., "Introduction to Environmental Engineering and Science", 2nd Edition, Pearson Education, 2004.
2. Miller, T.G. Jr., "Environmental Science", Wadsworth Publishing Company.
3. Townsend C., Harper, J. and Begon, M., "Essentials of Ecology", Blackwell Science, 2003.
4. Trivedi, R.K., and Goel, P.K., "Introduction to Air Pollution", Techno-Science Publications.

#### **REFERENCES**

1. Erach, B., "The Biodiversity of India", Mapin Publishing Pvt. Ltd., Ahmedabad, India.
2. Trivedi, R.K., "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol-I and II, Envio Media.

- Cunningham, Cooper, W.P. and Gorhani, T.H., "Environmental Encyclopedia", Jaico Publishing House, Mumbai, 2001.
- Wages, K.D., "Environmental Management", W.B. Saunders Co., Philadelphia, USA, 1998.

<b>PC3204</b>	<b>INDUSTRIAL CHEMICAL TECHNOLOGY</b>	<b>L T P C</b> <b>3 0 0 3</b>
<b>UNIT I</b>	<b>ALKALIES</b>	<b>9</b>
Chloro-alkali industries – Manufacture of soda ash – Caustic soda – Chlorine.		
<b>UNIT II</b>	<b>ACIDS</b>	<b>9</b>
Manufacture of sulphuric acid – Hydrochloric acid – Phosphoric acid – Nitric acid.		
<b>UNIT III</b>	<b>GLASSES</b>	<b>9</b>
Manufacture of glasses – Special glasses – Ceramics and refractories – Paints and pigments.		
<b>UNIT IV</b>	<b>INDUSTRIAL GASES</b>	<b>9</b>
Manufacture of carbon dioxide – Nitrogen – Hydrogen – Oxygen and acetylene.		
<b>UNIT V</b>	<b>FERTILIZERS</b>	<b>9</b>
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**

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

#### **REFERENCES**

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

**PC3205**                      **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.

<b>UNIT I</b>	<b>FUNDAMENTALS OF ALGORITHMS</b>	<b>8</b>
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.		
<b>UNIT II</b>	<b>FUNDAMENTALS OF DATA STRUCTURES</b>	<b>9</b>
Arrays – Structures – Stacks – Definition and examples – Representing stacks – Queues and lists – Queue and its representation – Applications of stack – Queue and linked lists.		
<b>UNIT III</b>	<b>TREES</b>	<b>10</b>
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.		
<b>UNIT IV</b>	<b>GRAPHS AND THEIR APPLICATIONS</b>	<b>9</b>
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.		
<b>UNIT V</b>	<b>STORAGE MANAGEMENT</b>	<b>9</b>
General lists – Operations – Linked list representation – Using lists – Freeing list nodes – Automatic list management : Reference count method – Garbage collection – Collection and compaction.		
		<b>TOTAL: 45 PERIODS</b>

**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.

<b>PC3207</b>	<b>ORGANIC CHEMISTRY LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>
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				
<b>TOTAL: 45 PERIODS</b>					

<b>PC3208</b>	<b>ELECTRICAL MACHINES LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>
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**

<b>PC3209</b>	<b>DATA STRUCTURES LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

**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**

<b>PC3210</b>	<b>NUMERICAL METHODS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**UNIT I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 9**

Linear interpolation methods (method of false position) – Newton’s method – Solution of linear system by Gaussian elimination and Gauss-Jordon methods – Iterative methods – Gauss Jacobi and Gauss-Seidel methods – Inverse of a matrix by Gauss-Jordan method – Eigen value of a matrix by power method.

**UNIT II INTERPOLATION AND APPROXIMATION 9**

Lagrangian polynomials – Divided differences – Interpolating with a cubic spline – Newton's forward and backward difference formulae.

<b>UNIT III</b>	<b>NUMERICAL DIFFERENTIATION AND INTEGRATION</b>	<b>9</b>
Derivatives from difference tables – Divided differences and finite differences – Numerical integration by trapezoidal and simpson's 1/3 and 3/8 rules – Romberg's method – Double integrals using trapezoidal and simpson's rules.		
<b>UNIT IV</b>	<b>INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS</b>	<b>9</b>
Single step methods – Taylor series method – Euler's method – Modified and improved Euler's method – Fourth order runge-kutta method for solving first and second order equations – Multi-step methods – Milne's and adam's predictor and corrector methods.		
<b>UNIT V</b>	<b>BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS</b>	<b>9</b>
Finite difference solution of second order ordinary differential equation – Finite difference solution of one dimensional heat equation by implicit and explicit methods – One dimensional wave equation and two dimensional laplace and poisson equations.		

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

**TEXT BOOKS**

1. Gerald, C.F. and Wheatley, P.O., "Applied Numerical Analysis", 6th Edition, Pearson Education, 2005.
2. Venkatraman, M.K., 'Numerical Methods', National Publication Company, 1991.

**REFERENCES**

1. Jain, M.K., Iyengar S.R.K. and Jain R.K., "Numerical Methods for Scientific and Engineering Computation" Fourth Edition, New Age International Publishers, 2003.
2. Kandasamy, P., Thilakavathy K. and Gunavathy K., "Numerical Methods", 2nd Edition, S.Chand and Co., 2003.
3. Bali, N.P. Narayana Iyengar, N.Ch., "A Textbook of Engineering Mathematics", Laxmi Publications (P) Ltd., New Delhi, 6th Edition, 2004.

<b>PC3211</b>	<b>PHYSICAL CHEMISTRY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

<b>UNIT I</b>	<b>GASEOUS STATE</b>	<b>9</b>
Van der Waals equation – Law of equipartition principle – Translational, rotational and vibrational energies of molecules – Joule-Thomson effect – Liquefaction of gases – Critical constants.		
<b>UNIT II</b>	<b>CHEMICAL REACTION EQUILIBRIA</b>	<b>9</b>
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.

**PC3212 MATERIAL TECHNOLOGY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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. Clauster, H.R., "Industrial and Engineering Materials ", McGraw-Hill, 1975.

<b>PC3213</b>	<b>PROCESS CALCULATIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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**

**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.

<b>PC3214</b>	<b>FLUID FLOW OPERATIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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.

<b>PC3215</b>	<b>MECHANICAL OPERATIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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.

**PC3216****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  $\text{Fe}^{2+}$  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  $\text{P}^{\text{H}}$ meter ( $\text{P}^{\text{H}}$ 4 and 9)
  - b) Determine the molarity of HCl by pH-metrically, using 0.1 M Sodium Hydroxide.

**TOTAL: 45 PERIODS****PC3217****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**

<b>PC3218</b>	<b>MECHANICAL OPERATIONS LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

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

<b>PC3301</b>	<b>SPECIAL FUNCTIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**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 Function for Scientist 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.



2. Bennett, C.O. and Myers, J.E., "Momentum, Heat and Mass Transfer", McGraw Hill Book Company, 3rd Edition, 1983.
3. Christie J. Geankoplis, "Transport Processes and Unit Operations", 3rd Edition, Prentice Hall of India Pvt. Ltd, 2000.

<b>PC3304</b>	<b>ENGINEERING THERMODYNAMICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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.

<b>PC3305</b>	<b>NATURAL GAS ENGINEERING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>UNIT I</b>	<b>PROPERTIES AND COMPOSITION OF NATURAL GAS</b>				<b>12</b>
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.					
<b>UNIT II</b>	<b>ESTIMATION AND PRODUCTION OF NATURAL GAS</b>				<b>12</b>
Estimation of gas reserves by volumetric method – Production of natural gas – Pressure decline method – Problems in the production of natural gas – Field separation.					
<b>UNIT III</b>	<b>GAS FROM CONDENSATE OIL FIELDS</b>				<b>12</b>
Processing of condensate well fluids – Cycling of gas condensate reservoirs – Sweep patterns – Katy cycling plant.					
<b>UNIT IV</b>	<b>ACID GAS TREATING OF NATURAL GAS</b>				<b>12</b>
Acid gas removal: Metal oxide process – Slurry process – Amine process – Carbonate washing process – Methanol based process and other process – Sulphur recovery process.					
<b>UNIT V</b>	<b>DEHYDRATION OF NATURAL GAS AND NGL RECOVERY</b>				<b>12</b>
Dehydration: Glycol dehydration – Solid desiccant dehydration.					



Seismic technology – Sniffer survey – Drilling technology – Off-share rigs – Primary and secondary enhanced oil recovery techniques and methods – Major well complication and Remedies.

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

**TEXT BOOKS**

1. Bhagwan Sahay “Petroleum Exploration and Exploitation Practices” Allied Publishers Ltd., Chennai, 1994.
2. Richard Dawe, “Modern Petroleum Technology”, Vol.I, Upstream, 6th Edition, John and Wiley Sons Ltd, 2000.

**REFERENCES**

1. Howard B. Bradley, “Petroleum Engineering Handbook”, Society of Petroleum Engineers, 1987.
2. [Norman J. Hyne](#)., “Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production”, 2nd Edition, Pennwell Books, 2001.
3. Shay B., “Wellsite Geological Techniques for Petroleum Exploration” Allied Publishers Ltd., 1991.

**PC3307**

**HEAT TRANSFER LABORATORY**

	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
1. Determination of heat transfer coefficient using composite wall.	<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>
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**

<b>PC3308</b>	<b>TECHNICAL ANALYSIS LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
1.	Oil Analysis: a) Acid value b) Saponification value c) Iodine value	<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>
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 <sub>3</sub> , Silica (SiO <sub>2</sub> ), Lime (CaO), Magnesia (MgO), Iron and Aluminium Oxides (R <sub>2</sub> O <sub>3</sub> ).				
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**



Lab session # 12: Prioritizing and time planning exercises. Learning Material: Managing Time Multimedia Program CD

Lab session # 13: Taking a Personality Typing/ Psychometric Test Learning Material: 200 Psychometric Test prepared by the CUIIC, Anna University Chennai

Lab session # 14: Critical and creative thinking exercises.

Lab session # 15: Improving body language and cross – cultural communication with pictures. Learning material: Body Language (S. Chand and Co.)

For a detailed plan, refer to the topics given below;

### **UNIT I LISTENING AND SPEAKING PRACTICE IN COMMUNICATIVE FUNCTIONS 9**

Introductions and meetings – Talking about studies and/ or job – Expressing likes and dislikes – Describing daily routines and current activities – Talking about past states and events – Talking about future plans and intentions – Expressing preferences – Giving reasons – Expressing opinions, agreement and disagreement – Seeking and giving advice – Making suggestions

### **UNIT II SPEAKING APPLICATIONS 9**

Making an oral presentation – Preparing the presentation – Performing the presentation – Beginning – Language – Visual aids and body language – Voice – Ending – Questions – Telephone conversations – Group Discussion and Interview

### **UNIT III UNDERSTANDING AND PREPARING FOR INTERNATIONAL ENGLISH LANGUAGE EXAMINATIONS 9**

Graded Examinations in Spoken English (GESE) – Spoken English for Work (SEW) – International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Business English Certificate (BEC)

### **UNIT IV SOFT SKILLS (1) 9**

Preparing for and dealing with change – Motivation, goal – setting and self – esteem – Managing time and stress – Career and life planning – Team work – Leadership traits

### **UNIT V SOFT SKILLS (2) 9**

Multiple intelligences – Learning styles and personality typing – Critical and creative thinking – People, cultures and self – intercultural communication

**TOTAL: 45 PERIODS**

### **RESOURCES**

1. Kamallesh Sadanand and Susheela Punitha, “Spoken English: A Foundation Course” for Speakers of Indian Languages, Part 2 Audio CD,; Orient Longman, 2008
2. Malcome Goodale, “Professional Presentations”, (VCD): Cambridge University Press, 2005

3. Barbara Garside and Tony Garside, Essential Telephoning in English (Audio CD), Cambridge: Cambridge University Press, 2002
4. Hari Mohan Prasad and Rajnish Mohan, How to Prepare for Group Discussion and Interview (Audio Cassette) Tata McGraw – Hill Publishing
5. Graded Examinations in Spoken English and Spoken English for Work downloadable materials from Trinity College,
6. International English Language Testing System Practice Tests, CUP
7. Business English Certificate Materials, Cambridge University Press
8. Personality Development (CD – ROM), Times Multimedia,
9. Interactive Multimedia Programs on Managing Time and Stress
10. Robert M. Sherfield and et al “Developing Soft Skills” 4<sup>th</sup> edition, : Pearson Education, 2009

<b>PC3310</b>	<b>PROCESS DYNAMICS AND CONTROL</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
			<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**UNIT I      FIRST ORDER SYSTEMS      12**

Linear open to loop systems – Laplace transformation – Transform of standard functions – First order and linearised first order systems – Response to various disturbances – Inversion – Theorems in laplace transformation – Applications.

**UNIT II      HIGHER ORDER SYSTEMS      12**

First order in series – Linearization and its application in process control – Higher order systems – Second order and Transportation lag – Response to various disturbances.

**UNIT III      CLOSED LOOP CONTROL SYSTEMS      12**

Closed loop control systems – Development of block diagram for feed – back control systems – Servo and regulator problems – Transfer function for controllers and final control element – Principles of pneumatic and electronic controllers – Transient response of closed-loop control systems and their stability.

**UNIT IV      FREQUENCY RESPONSE      12**

Introduction to frequency response of closed-loop systems – Routh analysis – Control system design by frequency – Bode diagram – Stability criterion – Tuning of controller settings.

**UNIT V      SPECIAL CONTROLS      12**

Cascade – Feed forward and ratio control – Dead time compensation – Internal model control – Control valves – Process identification.



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  $n^{\text{th}}$  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.

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

**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**

<b>PC3314</b>	<b>PETROCHEMICAL UNIT PROCESSES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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 Alkylolation – 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, "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.

<b>PC3315</b>	<b>PETROLEUM CRUDE PROCESSING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>TECHNOLOGY</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

<b>UNIT I</b>	<b>GENERAL</b>				<b>12</b>
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Origin – Exploration and production of petroleum – Types of crudes, crude composition – Characteristics and classification – Crude oil properties – Indigenous and imported crudes – Crude availability Vs demands.

<b>UNIT II</b>	<b>TESTING OF PETROLEUM PRODUCTS</b>				<b>12</b>
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IS 1448: Standard – Testing of Petroleum crude – Products: Specifications and their Significance.

<b>UNIT III</b>	<b>CRUDE PROCESSING</b>				<b>12</b>
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Pretreatment of crude for Refining – Dehydration and desalting – Atmospheric distillation, Vacuum distillation of residue products – Types of trays, flow pattern in the trays – Reflux types and its significance.

<b>UNIT IV</b>	<b>LUBE DISTILLATE TREATMENT TECHNIQUES</b>				<b>12</b>
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Treatment techniques for vacuum distillates with different processes like solvent extraction – Deasphalting, dewaxing, hydrofining, catalytic dewaxing and clay contact process – Production of lubricating oils.

<b>UNIT V</b>	<b>BITUMEN PROCESSING and FINAL TREATMENT TECHNIQUES</b>				<b>12</b>
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Asphalt manufacture, Air blowing technology, Bitumen Types and their properties, Acid gas removal and sulphur removal techniques.

**TOTAL: 60 PERIODS**

**TEXT BOOKS**

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers. .

- Bhaskara Rao, B.K., "Modern Petroleum Refining Processes", 3rd edition, Oxford and IBH Publishing Company Pvt. Ltd.

## REFERENCES

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

<b>PC3316</b>	<b>PROCESS DYNAMICS AND CONTROL</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>LABORATORY</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

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

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

**TOTAL: 45 PERIODS**

<b>PC3317</b>	<b>PETROLEUM PHYSICAL PROPERTIES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>TESTING LABORATORY</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

- 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**

**PC3318**

**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**

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

**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. 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.

<b>PC3403</b>	<b>PETROCHEMICAL DERIVATIVES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

### **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.

<b>PC3404</b>	<b>PETROLEUM SECONDARY PROCESSING TECHNOLOGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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.



## 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.

<b>PC3406</b>	<b>PETROCHEMICAL ANALYSIS LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>
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**

<b>PC3407</b>	<b>PETROLEUM PRODUCT TESTING LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>
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				



management – Quality council, quality statements – Strategic planning – Deming philosophy – Barriers to TQM implementation.

**UNIT II TQM PRINCIPLES 12**

Customer satisfaction – Customer perception of quality – Customer complaints – Service quality – Customer retention – Employee involvement – Motivation – Empowerment – Teams – Recognition and reward – Performance appraisal – Benefits, continuous process improvement – Juran trilogy – PDSA cycle – 5S, kaizen – Supplier partnership – Partnering, sourcing – Supplier selection – supplier rating – Relationship development – Performance measures – Basic concepts – Strategy – Performance measure.

**UNIT III STATISTICAL PROCESS CONTROL (SPC) 12**

The seven tools of quality, statistical fundamentals – Measures of central tendency and dispersion, population and sample, normal curve – Control charts for variables and attributes – Process capability– Concept of six sigma – New seven management tools.

**UNIT IV TQM TOOLS 12**

Benchmarking – Reasons to benchmark – Benchmarking process – Quality function deployment (QFD) – House of quality, QFD process – Benefits, taguchi quality loss function – Total productive maintenance (TPM) – Concept – Improvement needs – FMEA – Stages of FMEA.

**UNIT V QUALITY SYSTEMS 12**

Need for ISO 9000 and other quality systems, ISO 9000:2000 quality system – Elements – Implementation of quality system – Documentation, quality auditing – QS 9000, ISO 14000 – Concept, requirements and benefits.

**TOTAL: 60 PERIODS**

**TEXT BOOKS**

1. Besterfield, D.H., “Total Quality Management”, Prentice Hall of India Pvt. Ltd., 3rd Edition, 2007.
2. Kanishka Bedi, “Quality Management”, Oxford Press, 2006.

**REFERENCES**

1. Shridhara Bhat, K., “Total Quality Management”, Himalaya Publishing House, 1st Edition, 2002.
2. Lal, H., “Total Quality Management – A Practical Approach”, New Age International Publishers, 2004.
3. Nagarajan, R.S., “Total Quality Management”, New Age International Publishers, 2005.

<b>PC3410</b>	<b>SAFETY AND RISK MANAGEMENT</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

<b>UNIT I</b>	<b>INDUSTRIAL SAFETY</b>	<b>15</b>
Concepts of safety – Hazard classification chemical, physical, mechanical, ergonomics, biological and noise hazards – Hazards from utilities like air, water, steam.		
<b>UNIT II</b>	<b>HAZARD IDENTIFICATION AND CONTROL</b>	<b>15</b>
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.		
<b>UNIT III</b>	<b>RISK MANAGEMENT</b>	<b>15</b>
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.		
<b>UNIT IV</b>	<b>SAFETY PROCEDURES</b>	<b>7</b>
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.		
<b>UNIT V</b>	<b>SAFETY IN HANDLING AND STORAGE OF CHEMICALS</b>	<b>8</b>
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.

<b>PC3411</b>	<b>PROJECT WORK</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>12</b>	<b>12</b>

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

<b>PC3001</b>	<b>PROCESS MODELLING AND SIMULATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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.

**PC3002**

**TRANSPORT PHENOMENA**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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            9**  
**(SHELL BALANCE)**

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.







<b>PC3006</b>	<b>INDUSTRIAL MANAGEMENT</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**UNIT I PERSONNEL MANAGEMENT 9**

Principles and functions – Handling union – Negotiation process – Labour legislation in India – Managerial decision making process, tools and techniques – Role of employee through empowerment – Industrial management program – Public relation.

**UNIT II TQM TOOLS AND TECHNIQUES 9**

Bench marking process – Concept, reason, application – Quality function deployment and its benefits – Study of manufacturing costs and techniques for financial control – Tools and techniques for six sigma philosophy – Tacuchi law functions – Statistical process control.

**UNIT III QUALITY AND ENVIRONMENTAL MANAGEMENT SYSTEMS 9**

Philosophy of total quality management – ISO registration procedure and benefits – Concepts of ISO 9000, 14000, 18000 standards – Internal quality audit – Quality improvement and customer satisfaction – Importance of documentation procedure – Plant safety and industrial hygiene.

**UNIT IV ENGINEERING ECONOMICS 9**

Micro and macro economics – Accounting procedures and preparation of financial statements – Principles of lean manufacturing philosophy – Study of global market – Methods to overcome competitiveness.

**UNIT V PROCESS ECONOMICS 9**

Amortisation – Capital recovery – Depreciation – Economics of selecting alternatives – Rate of return and payout time – Budgeting – Operation management – Strategic analysis – Problem solving techniques – Preparation of technical reports – Process Improvement.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. Peters and Timmer haus, "Plant Design and Economics for Chemical Engineering", 4th Edition, McGraw Hill Book Co., 1991.
2. Arun Monappa and Mirza S. Saiyadain, "Personnel Management", 2nd Edition, Tata McGraw – Hill Publishing Company Ltd.

**REFERENCES**

1. Kermath Case, J.A. and David prat., "Principle of Engineering Economics", 4th Edition, John - Wiley publishers, 1997.
2. Schwyer H.E., "Process Engineering Economics", 1st Edition, McGraw Hill Book Co., 1962.
3. Shridharan Bhat,K., "Total Quality Management", 1st Edition, Himalaya Publishing house, 2002.

<b>PC3007</b>	<b>ENERGY MANAGEMENT IN CHEMICAL INDUSTRIES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**UNIT I ENERGY RESOURCES – A GLOBAL VIEW 9**

Energy sources – Coal oil, natural gas – Nuclear energy – Hydro electricity – Other fossil fuels – Geothermal – Supply and demand – Depletion of resources of resources – Need for conservation – Uncertainties – National and international issues.

**UNIT II ENERGY AND ENVIRONMENT 9**

Energy – Various forms – Energy storage – Structural properties of environment – Bio-geo – chemical cycles – Society and environment population and technology.

**UNIT III MANAGEMENT OF ENERGY CONSERVATION IN CHEMICAL INDUSTRIES 9**

Chemical industries – Classification – Conservation in unit operation such as separation – Cooling tower – Drying – Conservation applied to refineries, petrochemical, fertilizers, cement, pulp and paper, food industries – Chloroalkali industries – Conservation using optimization techniques.

**UNIT IV ENERGY ALTERNATIVES 9**

Sources of continuous power – Wind and water – Geothermal – Tidal and solar power – MHD, fuel cells – Hydrogen as fuel.

**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.

<b>PC3008</b>	<b>NOVEL SEPARATION PROCESS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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 ZONE MELTING 9**

Zone melting – Introduction – Equilibrium Diagram – Apparatus and Applications – Large scale and continuous operations – Limitations.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. Schoen, H.M., "New Chemical Engineering Separation Techniques", Interscience Publishers, 1972.
2. Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., 1980.

**REFERENCES**

1. Geankoplis, C.J. "Transport Processes and Unit Operations", 3rd Edition, Prentice Hall of India Pvt. Ltd, 2000.
2. Sivasankar, B., "Bioseparations Principles and Techniques", Prentice Hall India Pvt. Ltd, 2006.



<b>PC3010</b>	<b>MULTICOMPONENT DISTILLATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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 IV VARIOUS METHODS OF MCD COLUMN DESIGN 9**

Theta method of convergence –  $K_b$  method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method – Stage and reflux requirements – Short cut methods and Simplified graphical procedures.

**UNIT V VARIOUS TYPES OF MCD COLUMNS 9**

Design of sieve, bubble cap, valve trays and structured packing columns for multi component distillation – computation of plate efficiencies.

**TOTAL: 60 PERIODS**

**TEXT BOOKS**

1. Holland, C.D., "Fundamentals of Multi Component Distillation", McGraw Hill Book Company, 1981
2. Van Winkle, "Distillation Operations", McGraw Hill Publications, 1987.

**REFERENCES**

1. King, C.J., "Separation Process Principles", Mc Graw Publications, 1986.

2. Treybal, R.E., "Mass Transfer Operations", 5th Edition, Mc Graw Hill publications. 1996.
3. Mc Cabe and Smith, J.C., Harriot, "Unit Operation of Chemical Engineering", 6th Edition, McGraw Hill, 2001.

**PC3011 COMBUSTION AND FURNACE DESIGN**

L	T	P	C
3	0	0	3

**UNIT I COMBUSTION STOICHIOMETRY 9**

Stoichiometry relations – Theoretical air required for complete combustion – Calculation of minimum amount of air required for a fuel of known composition – Calculation of dry flue gases if fuel composition is known – Calculation of the composition of fuel and excess air supplied, from exhaust gas analysis – Dew point of products – Flue gas analysis ( $O_2$ ,  $CO_2$ ,  $CO$ ,  $NO_x$ ,  $SO_x$ ).

**UNIT II COMBUSTION THERMODYNAMICS AND KINETICS 9**

Combustion reaction – Reaction kinetics – Rate of reaction – Mass and energy balance of chemical reactions – First and second law analysis of combustion system – Adiabatic flame temperature- Calculation of equilibrium composition and temperature.

**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.

- John Griswold, "Fuel Combustion and Furnaces", McGraw Hill, 1996.

## REFERENCES

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

**PC3012**

**POLYMER TECHNOLOGY**

L	T	P	C
3	0	0	3

**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

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

## REFERENCES

- Rodriguez, F., "Principals of Polymer Systems", 4th Edition, Taylor and Francis, 1996.
- Mark, H. F., "Encyclopedia of Polymer Science and Technology", 3rd Edition John Wiley Inter Science, 2007

3. Ebewele, R.O., "Polymer Science and Technology", CRC Press, 2000.