AFFILIATED INSTITUTIONS

ANNA UNIVERSITY, CHENNAI

R - 2008

B.TECH. CHEMICAL AND ELECTROCHEMICAL ENGINEERING

II – VIII SEMESTERS CURRICULA AND SYLLABI

SEMESTER II

(Common to all B. E. / B. Tech. Degree Programmes except B. E. – Marine Engineering)

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	HS2161	Technical English – II*	3	1	0	4
2.	MA2161	Mathematics – II*	3	1	0	4
3.	PH2161	Engineering Physics – II*	3	0	0	3
4.	CY2161	Engineering Chemistry – II*	3	0	0	3
5. a	ME2151	Engineering Mechanics **(For non-circuit branches)**	3	1	0	4
5. b	EE2151	Circuit Theory **(For branches under Electrical Faculty)**	3	1	0	4
5. c	EC2151	Electric Circuits and Electron Devices **(For branches under I & C Faculty)**	3	1	0	4
6. a	GE2151	Basic Electrical & Electronics Engineering **(For non-circuit branches)**	4	0	0	4
6. b	GE2152	Basic Civil & Mechanical Engineering **(For circuit branches)**	4	0	0	4
PRACTICALS						
7.	GE2155	Computer Practice Laboratory-II*	0	1	2	2
8.	GS2165	Physics & Chemistry Laboratory - II*	0	0	3	2
9. a	ME2155	Computer Aided Drafting and Modeling Laboratory **(For non-circuits branches)**	0	1	2	2
9. b	EE2155	Electrical Circuits Laboratory **(For branches under Electrical Faculty)**	0	0	3	2
9. c	EC2155	Circuits and Devices Laboratory **(For branches under I & C Faculty)**	0	0	3	2
					TOTAL : 28 CREDITS	
10.	-	English Language Laboratory[+]	0	0	2	-

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
7. B.Tech. Plastics Technology

SEMESTER III

Subject Code	Subject	L	T	P	C
Theory					
MA3202	Transforms and Partial Differential Equations	3	1	0	4
CH3202	Physical Chemistry	3	0	0	3
CH3203	Organic Chemistry	3	0	0	3
CH3204	Materials Technology	3	0	0	3
CH3205	Chemical Process Calculations	3	0	0	3
CE3203	Fluid Mechanics	3	0	0	3
Practical					
CH3208	Physical Chemistry Laboratory	0	0	4	2
CH3209	Organic Chemistry Laboratory	0	0	4	2
CH3210	Basic Electrical Electronics Engineering Laboratory	0	0	4	2
	TOTAL	**18**	**1**	**12**	**25**

SEMESTER IV

Subject Code	Subject	L	T	P	C
Theory					
MA3021	Numerical Methods	3	1	0	4
CH3212	Chemical Engineering Thermodynamics	3	1	0	4
EL3213	Chemical Reaction Engineering	3	0	0	3
CH3214	Mechanical Operations	3	0	0	3
CH3215	Mass Transfer I	3	0	0	3
CH3216	Heat Transfer	3	0	0	3
Practical					
CE3219	Fluid Mechanics and Mechanical Operations Laboratory	0	0	4	2
CH3219	Chemical Reaction Engineering Laboratory	0	0	4	2
EL3220	Equipment Design and Drawing I	0	0	3	2
	TOTAL	**18**	**2**	**11**	**26**

SEMESTER V

Subject Code	Subject	L	T	P	C
Theory					
MA3209	Probability and Linear Programming	3	1	0	4
CH3302	Instrumental Methods of Analysis	3	0	0	3
EL3303	Electrodics and Electrocatalysis	3	1	0	4
EL3304	Chemical Process Technology	3	0	0	3
CH3305	Mass Transfer II	3	0	0	3
EL3306	Electrochemical Reaction Engineering	3	1	0	4
Practical					
EL3308	Heat and Mass Transfer Laboratory	0	0	4	2
EL3309	Equipment Design and Drawing II	0	0	3	2
	TOTAL	**18**	**3**	**7**	**25**

SEMESTER VI

Subject Code	Subject	L	T	P	C
Theory					
GE3310	Total Quality Management & Engineering Economics	3	0	0	3
EL3311	Process Instrumentation	3	0	0	3
EL3312	Energy Technology	3	0	0	3
EL3313	Industrial Metal Finishing	3	0	0	3
EL3314	Corrosion Science & Engineering	3	0	0	3
EL3315	Electrochemical Process Technology	3	0	0	3
Practical					
EL3317	Electrochemical Engineering Laboratory I	0	0	4	2
EL3318	Electrochemical Reaction Engineering Laboratory	0	0	4	2
GE3318	Communication Skills and Soft Skills Laboratory	0	0	2	1
	TOTAL	**18**	**0**	**10**	**23**

SEMESTER VII

Subject Code	Subject	L	T	P	C
Theory					
GE3401	Professional Ethics	3	0	0	3
EL3402	Nanomaterials Technology	3	0	0	3
EL3403	Process Dynamics and Control	3	1	0	4
EL3404	Electrochemical Energy Conversion & Storage	3	0	0	3
EL3405	Electrochemical Materials Science	3	0	0	3
EL3406	Electrometallurgy and Thermics	3	0	0	3
Practical					
EL3408	Electrochemical Engineering Laboratory II	0	0	4	2
EL3409	Electrochemical Engineering Laboratory III	0	0	4	2
EL3410	Process Dynamics and Control Laboratory	0	0	4	2
	TOTAL	**18**	**1**	**12**	**25**

SEMESTER VIII

Subject Code	Subject	L	T	P	C
Theory					
GE3411	Environmental Engineering and Pollution Control	3	0	0	3
E1	Elective I	3	0	0	3
E2	Elective II	3	0	0	3
Practical					
EL3414	Project and Viva Voce	0	0	12	6
	TOTAL	**9**	**0**	**12**	**15**

LIST OF ELECTIVES

Subject Code	Subject	L	T	P	C
Theory					
CH3001	Process Modelling & Simulation	3	0	0	3
EL3002	Risk Analysis & Hazops	3	0	0	3
EL3003	Safety In Chemical Industries	3	0	0	3
EL3004	Chemical Process Optimization	3	0	0	3
CH3005	Transport Phenomena	3	0	0	3
EL3006	Plant Utilities	3	0	0	3
EL3007	Advanced Electrochemical Reaction Engineering	3	0	0	3
EL3008	Chlor – Alkali Technology	3	0	0	3
EL3009	Cathodic Protection Engineering	3	0	0	3
EL3010	Metal Coating Technology	3	0	0	3
EL3011	Protective Paint Coatings	3	0	0	3
EL3012	Advanced Computer Programming	3	0	0	3
MA3013	Operations Research	3	0	0	3
EL3014	Electrochemical Engineering	3	0	0	3
EL3015	Advanced Electrochemical Energy conversion and storage systems	3	0	0	3
EL3016	Surface Engineering	3	0	0	3
EL3017	Organic Electrochemistry	3	0	0	3
EL3018	Metal Finishing	3	0	0	3

HS2161 **TECHNICAL ENGLISH II** **L T P C**
3 1 0 4

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 parallelpipeds.

UNIT III ANALYTIC FUNCTIONS 12

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

UNIT IV COMPLEX INTEGRATION 12

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

UNIT V LAPLACE TRANSFORM 12

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

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

TOTAL : 60 PERIODS

TEXT BOOKS

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

REFERENCES

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

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 Tc 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 – Claussius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer) – ferroelectricity and applications.

UNIT V MODERN ENGINEERING MATERIALS 9

Metallic glasses: preparation, properties and applications.

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

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

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

TOTAL : 45 PERIODS

TEXT BOOKS

1. Charles Kittel ‘ Introduction to Solid State Physics’, John Wiley & sons, 7th edition, Singapore (2007)
2. Charles P. Poole and Frank J.Owen, ’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 - Fe^{2+} vs dichromate and precipitation – Ag^{+} vs Cl^{-} titrations) and conduct metric titrations (acid-base – HCI vs, NaOH) titrations,

UNIT II CORROSION AND CORROSION CONTROL 9

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

UNIT III FUELS AND COMBUSTION 9

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

UNIT IV PHASE RULE AND ALLOYS 9

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

UNIT V ANALYTICAL TECHNIQUES 9

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

TOTAL: 45 PERIODS

TEXT BOOKS

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

REFERENCES

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

ME2151 ENGINEERING MECHANICS L T P C
3 1 0 4

OBJECTIVE

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

UNIT I BASICS & STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – 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. Hibbeller, R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., (2000).
3. Palanichamy, M.S., Nagam, S., "Engineering Mechanics – Statics & Dynamics", Tata McGraw-Hill, (2001).
4. Irving H. Shames, "Engineering Mechanics – Statics and Dynamics", IV Edition – Pearson Education Asia Pvt. Ltd., (2003).
5. Ashok Gupta, "Interactive Engineering Mechanics – Statics – A Virtual Tutor (CDROM)", Pearson Education Asia Pvt., Ltd., (2002).

EE2151 CIRCUIT THEORY L T P C

(Common to EEE, EIE and ICE Branches) **3 1 0 4**

UNIT I BASIC CIRCUITS ANALYSIS 12

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

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

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

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

UNIT III RESONANCE AND COUPLED CIRCUITS 12

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

UNIT 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, 6th 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**

UNIT I CIRCUIT ANALYSIS TECHNIQUES 12

Kirchoff’s current and voltage laws – series and parallel connection of independent sources – R, L and C – Network Theorems – Thevenin, Superposition, Norton, Maximum power transfer and duality – Star-delta conversion.

UNIT II TRANSIENT RESONANCE IN RLC CIRCUITS 12

Basic RL, RC and RLC circuits and their responses to pulse and sinusoidal inputs – frequency response – Parallel and series resonances – Q factor – single tuned and double tuned circuits.

UNIT III SEMICONDUCTOR DIODES 12

Review of intrinsic & extrinsic semiconductors – Theory of PN junction diode – Energy band structure – current equation – space charge and diffusion capacitances – effect of temperature and breakdown mechanism – Zener diode and its characteristics.

UNIT IV TRANSISTORS 12

Principle of operation of PNP and NPN transistors – study of CE, CB and CC configurations and comparison of their characteristics – Breakdown in transistors – operation and comparison of N-Channel and P-Channel JFET – drain current equation – MOSFET – Enhancement and depletion types – structure and operation – comparison of BJT with MOSFET – thermal effect on MOSFET.

UNIT V SPECIAL SEMICONDUCTOR DEVICES (Qualitative Treatment only) 12

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

TOTAL : 60 PERIODS

TEXT BOOKS

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

REFERENCES

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

GE2151 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C

(Common to branches under Civil, Mechanical and Technology faculty) **4 0 0 4**

UNIT I ELECTRICAL CIRCUITS & MEASURMENTS 12

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

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

UNIT II ELECTRICAL MECHANICS 12

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

UNIT III SEMICONDUCTOR DEVICES AND APPLICATIONS 12

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

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

UNIT IV DIGITAL ELECTRONICS 12

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

UNIT V FUNDAMENTALS OF COMMUNICATION ENGINEERING 12

Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations.

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

TOTAL : 60 PERIODS

TEXT BOOKS

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

REFERENCES

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

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

A – CIVIL ENGINEERING

UNIT I SURVEYING AND CIVIL ENGINEERING MATERIALS 15

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

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

UNIT II BUILDING COMPONENTS AND STRUCTURES 15

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

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

TOTAL: 30 PERIODS

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 I C 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

1. UNIX COMMANDS **15**

Study of Unix OS - Basic Shell Commands - Unix Editor

2. SHELL PROGRAMMING **15**

Simple Shell program - Conditional Statements - Testing and Loops

3. C PROGRAMMING ON UNIX **15**

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 $BaCl_2$ vs Na_2SO_4
4. Potentiometric Titration (Fe^{2+} / $KMnO_4$ or $K_2Cr_2O_7$)
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.

TOTAL: 45 PERIODS

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.

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 -

1. Listening: **5**

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

2. Speaking: **5**

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

Classroom Session **20**

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

Evaluation

(1) Lab Session – 40 marks

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

(2) Classroom Session – 60 marks

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

Note on Evaluation

1. Examples for role play situations:
   a. Marketing engineer convincing a customer to buy his product.
   b. Telephone conversation – Fixing an official appointment / Enquiry on availability of flight or train tickets / placing an order. etc.

2. Presentations could be just a Minute (JAM activity) or an Extempore on simple topics or visuals could be provided and students could be asked to talk about it.

REFERENCES

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

LAB REQUIREMENTS

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

MA3202 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
3 1 0 4

OBJECTIVES

The course objective is to develop the skills of the students in the areas of Transforms and Partial Differential Equations. This will be necessary for their effective studies in a large number of engineering subjects like heat conduction, communication systems,electro-optics and electromagnetic theory. The course will also serve as a prerequisite for post graduate and specialized studies and research.

UNIT I FOURIER SERIES 9

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier Series – Parseval's identity – Harmonic Analysis.

UNIT II FOURIER TRANSFORMS 9

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT III PARTIAL DIFFERENTIAL EQUATIONS 9

Formation of partial differential equations – Lagrange's linear equation – Solutions of standard types of first order partial differential equations – Linear partial differential equations of second and higher order with constant coefficients.

UNIT IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9

Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

UNIT V Z -TRANSFORMS AND DIFFERENCE EQUATIONS 9

Z-Transforms – Elementary properties – Inverse Z-Transforms – Convolution theorem – Formation of difference equations – Solution of difference equations using Z-Transform.

L : 45 T : 15 TOTAL : 60 PERIODS

TEXTBOOKS

1. Grewal B.S, "Higher Engineering Mathematics", 39th Edition, Khanna Publishers, 2007.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill Company Ltd., 2007.

REFERENCES

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

CH3202 PHYSICAL CHEMISTRY L T P C
3 0 0 3

UNIT I MOLECULAR QUANTUM MECHANICS 9

Term symbols for a diatomic molecule; symmetry of molecular orbitals, Molecular orbitals for homonuclear diatomic molecules, (Eg.H_2) MO energy level diagrams for heteronuclear diatomic molecules (Eg. CO)

UNIT II GROUP THEORY 9

Symmetry elements & symmetry operations, group postulates, types of groups, point groups, representations of molecular point groups, character tables for point groups, point groups & geometry of some common molecules (Eg. H_2, CO_2, CH_4, NH_3 and H_2) Applications of group theory, crystal systems, molecular symmetry and crystallographic symmetry, quasi crystals.

UNIT III PHOTOCHEMISTRY & ELECTRIC AND MAGNETIC PROPERTIES 9

Jablonski diagram, radiative and non-radiative transtitions, Beer-Lambert and Grotthus – Draper laws, Stark-Einstein law of photochemical equivalence, quantum efficiency, quantum yield, determination - Photochemical reactions, photochemical rate law, kinetics of H_2-CO_2reactions, anthracene; photosensitization, quenching, chemiluminescene, electronic spectra and photochemistry, geometry of excited states. lasers – principles and applications. Clausius – Mosotti equation, Debye equation, dependence of polarizability on frequency, molar refractivity, dipole moments and molecular structure, magnetic permeability & susceptibility, dia and para magnetism, Measurement of magnetic susceptibility.

UNIT IV STATISTICAL THERMODYNAMICS 9

Classical statistical mechanics and quantum statistical mechanics, combination and permutation, Probability, Error, Microstates and macro states, Maxwell's law of distribution of velocities, Maxwell's velocity distribution function and speed distribution function, Maxwell Boltzmann distribution, Quantum statistics, Bose Einstein and Fermi Dirac statistics, Applications, Partition functions, Types, Relationship between partition functions and thermodynamic quantities.

UNIT V IONICS 9

Ion solvent interaction - Introduction, Expression for ΔH and ΔS of ion-solvent interaction., Experimental verification of Born Model, Ion-dipole model of ion-solvent interaction and expression for heat of salvation. Ion transport in solution - Einstein-Smoluchowski equation, transport numbers, molar and equivalent conductance. Ion-Ion Interaction -true and potential electrolytes, activity coefficient and ion-ion interaction

TOTAL : 45 PERIODS

TEXT BOOKS

1. Puri & Sharma, "Principles of Physical Chemistry", Vishal Publishing Co., 2003
2. Bockris & Reddy, "Modern aspects of Electrochemistry", Springer, Vol-I, 2nd Edition,1998.

REFERENCES

1. Peter Atkins and Julio de Paula, "Physical Chemistry", Oxford University Press, 7th Edition, 2002.
2. Samuel Glasstone and David Lewis, "Elements of Physical Chemistry", Macmillan Publishers Ltd., 2nd Edition, 1966.
3. Walter J. Moore, "Physical Chemistry", Prentice Hall Inc, 1964
4. Terrell.L.Hill, Lousier, "Introduction to Statistical Thermodynamics", Dover Publications, 1986.

CH3203 **ORGANIC CHEMISTRY** **L T P C**
3 0 0 3

UNIT I ORGANIC REACTION MECHANISM 9

Electrophilic reactions-Friedel crafts reaction, Riemer Tiemenn reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation; free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide; allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene $CH_3 – CH = CH_2$

UNIT II CARBOHYDRATES 9

Introduction – mono and disaccharides – important reactions – polysaccarides – starch and cellulose – derivatives of cellulose – carboxy methyl cellulose and gun cotton – structural aspects of cellulose

UNIT III POLYNUCLEAR AROMATICS AND HETEROCYCLES 9

Classification of polynuclear aromatics. naphthalene preparation, properties and uses. Classification of heterocyclic compounds. Furan, thiophene, pyridine preparation, properties and uses

UNIT IV AMINO ACIDS AND PROPERTIES 9

Classification and properties of Amino acids – composition and classification of proteins – tests for proteins – amino acids in proteins – estimation of general properties and relations of proteins – hydrolysis of proteins – polypeptides.

UNIT V DRUGS, PESTICIDES & DYES 9

Classification and properties of drugs. sulpha drugs, mode of action, synthesis of sulphanilamide, chloroquine and chloroamphenicol, pesticides - classes. Synthesis of DDT and methoxychlor.

Colour and constitution, chromogen and chromophore. Classification of dyes based on structure and mode of dyeing. Synthesis of dyes. Malachite green, methyl orange, congo red, phenolphthalein.

TOTAL : 45 PERIODS

TEXT BOOKS

1. B.S.Bhal and Arun Bhal, “A Text Book of Organic Chemistry”, S Chand & Company Ltd. New Delhi, 4th edition, 2005.
2. P.L. Soni and H.M Chawla, “A Text Book of Organic Chemistry”, Sultan Chand & Sons, NewDelhi, 28th edition, 1999.
3. Robert T.Morrison and Robert N Byod “Organic Chemistry”, Dorling Kindersley(India) Pvt. Ltd.,

REFERENCES

1. Jonathan Clayden, Nick Greeves, Staurt Warren and Peter Wothers, “Organic Chemistry”, Oxford University Press, 1st Edition, 2001.
2. Robert Thornton Morrison and Robert Neilson Boyd, “Organic chemistry”, Prentice Hall of India P.Ltd, New Delhi, 6th edition, 28th Indian reprint, 2001.
3. K.S. Tiwari, N.K. Vishnoi, S.N. Mehrotra, “A Text Book of Organic Chemistry”, Vikas Publishing House P.Ltd, 2nd Revised edition, 1998.
4. A.I.Vogel, Brain S. Furniss, Antony J. Hannaford, Peter W.G. Smith and Austin R. Tatchell, “Vogel’s Text Book of Practical Organic Chemistry”, Prentice Hall, New Delhi, 5th edition, 1996.

CH3204 MATERIALS TECHNOLOGY L T P C
3 0 0 3

UNIT I STRUCTURE OF MATERIALS 9

Introduction-classification of materials, selection of materials, properties of materials, x-ray crystallography, Bragg's law, x-ray diffraction for determining crystal structures, structure of NaCl and diamond, crystal defects, point, line, surface and volume defects, Alloy formation, solid solution types, solidification of castings, Macro and Micro structural examination, specimen preparation, Microscopes, macro etching and observation.

UNIT II METALLURGICAL PROPERTIES OF MATERIALS 9

Phase diagrams, isomorphous, eutectic, peritectic system. Diffusion and Fick 's laws. Mechanical properties, tension tests materials properties, hardness tests, Brinnel, Vickers, Rockwell's micro hardness test. Shore scleroscope, impact tests, fracture, fatigue, creep. Grifiths' theory, fracture toughness, embrittlement phenomena, fatigue and creep resistant materials, strengthening mechanisms, solid solution strengthening, work hardening, grain refinement, recrystallization.

UNIT III TYPES OF MATERIALS 9

Classification of steel, structure of steel, Fe-C phase diagram, heat treatment, TTT curves, ausforming, marforming, annealing types, normalizing, hardening, tempering, case hardening methods, effect of alloying elements, tool steels, stainless steel, cast iron, malleable and ductile types and their formation and properties, copper and its alloys brass, bronze, copper, nickel precipitation hardened types aluminium and its alloys, cast and wrought types precipitation, hardening treatment Al cladding and welding electric and magnetic materials, nano particles and nano structures, nickel and its alloys, titanium and its alloys, cermets.

UNIT IV PHYSICAL CHARACTERISTICS OF MATERIALS 9

Metals, semiconductors, insulators, electron theory, band theory, types of magnetism, domain structures, anisotrophy of materials, and application. Soft and hard magnets. semiconductors, electronic structure. Conductivity of materials, zone refining, crystal growth techniques.

UNIT V NON-METALLIC MATERIALS 9

Ceramic materials, oxides, silicates, refractories, acid, basic and neutral types, glasses, enamels ;abrasives, cement and concrete materials. Classification of polymers, reaction types, mechanisms, addition, condensation, copolymerization, shapes, cross linking branching, deformation, of polymers, mechanical, thermal, electrical and chemical, behaviour, rubber, silicones, fluoro carbons, composites, FRP, particulates, and laminates.

TOTAL : 45 PERIODS

TEXT BOOKS

1. N.K.Srinivasan, S.S.Ramakrishnan, “The Science of Engineering Materials”, Oxford & IBH Publishing co., Calcutta 1983.
2. V.Raghavan, Materials Science and Engineering : A first course, Prentice Hall of India , 5th Edition 2004.
3. O.P.Khanna, “A text book of material science and metallurgy”, Dhanpat Rai & sons, 1998.

REFERENCES

1. Van Vlack L.H , “Elements of Materials Science and Engineering” (Addision Wesley series in metallurgy and materials engineering), Prentice Hall, 6th Edition, 1989.
2. A.G.Guay, “Essentials of Material Science”, Mc.Graw Hill, New York, 1976.
3. WF.Hosford, Material Science, Cambridge Univ. Press, New York, 2006.

CH3205 CHEMICAL PROCESS CALCULATIONS L T P C
3 0 0 3

UNIT I BASIC CONCEPTS – MATERIAL BALANCE IN UNIT OPERATIONS 9

Methods of expressing composition of mixtures and solutions. Use of molal units, partial pressure and pure component volume in calculations. Material balance for processes not involving chemical reactions - unit operations like distillation, evaporation, drying etc.

UNIT II MATERIAL BALANCE IN REACTION SYSTEM- UNSTEADY STATE PRECESSES 9

Material balance for processes involving chemical reactions. Limiting and excess reactants. Degree of completion. Problems on recycle, bypass and purging. Material balance for simple unsteady state processes like mixing in a stirred tank.

UNIT III HUMIDITY AND SATURATION 9

Humidity and saturation. Relative and percentage saturation. Humidity calculations in evaporation and condensation processes. Usage of humidity chart. Solubility and crystallization. Material balance and yield calculations in dissolution and crystallization processes.

UNIT IV THERMO CHEMISTRY AND THERMO PHYSICS 9

Heat capacity of liquid mixtures, gaseous mixtures and solutions. Use of mean heat capacities in heat calculations. Evaluation of enthalpy changes for systems with and without phase transfers. Energy balance for systems with and without chemical reactions. Theoretical flame temperature.

UNIT V FUELS AND COMBUSTION 9

Problems on proximate analysis, ultimate analysis and calorific values of fuels. Calculations based on combustion of solid, liquid and gaseous fuels. Computations involving flue gas analysis and Orsat analysis. Determination of excess air and fuel composition.

TOTAL : 45 PERIODS

TEXT BOOKS

1. B.I. Bhatt and S.M. Vora, “Stoichiometry”, , Tata McGraw Hill, New Delhi, 4th Edition 2004.
2. K. Asokan “Chemical process calculations” , Universities Press, Hyderabad, 1st Edition, 2007.

REFERENCES

1. O.A. Hougen, K.M. Watson and R.A.Ragatz “Chemical Process Principles, Part I (Material & Energy Balances)”, CBS Publishers & distributors, New Delhi, Reprinted Indian Edition, 2004.
2. Himmelblau D.M, “Basic Principles and Calculation in Chemical Engineering”, 4th Edition, Prentice Hall Inc, 1982.
3. Venkataramani. V and Anantharaman.N, “Process calculations”, Prentice Hall of India Pvt. Ltd.,2003.

CE3201 FLUID MECHANICS L T P C
3 0 0 3

OBJECTIVES

To understand the basic properties of the fluid, fluid kinematics, fluid dynamics and to analyse and appreciate the complexities involved in solving the fluid flow problems.

UNIT I FLUID PROPERTIES AND FLUID STATICS 9

Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillarity and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers and pressure gauges.

UNIT II FLIUD KINEMATICS 9

Fluid Kinematics - Flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms)- Equation of streamline - stream function - velocity potential function - circulation - flow net.

UNIT III FLUID DYNAMICS 9

Fluid dynamics - equations of motion - Euler's equation along a streamline - Bernoulli's equation – applications - Venturi meter, Orifice meter, Pitot tube – flow through weirs and notches.

UNIT IV FLOW THROUGH PIPES 9

Viscous flow - Navier-Stoke's equation (Statement only) - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's) - Hydraulic and energy gradient - flow through pipes - Darcy -weisbach's equation - pipe roughness -friction factor- Moody's diagram.

UNIT V BOUNDARY LAYER 9

Boundary layer – definition- boundary layer on a flat plate – Thickness and classification – displacement , energy and momentum thickness – Boundary layer separation and control – drag in flat plate, cylinders and spheres – drag and lift coefficients.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Bansal, R.K., “Fluid Mechanics and Hydraulics Machines”, (5th edition), Laxmi publications (P) Ltd, New Delhi, 2008.
2. Ramamirtham, S., "Fluid Mechanics and Hydraulics and Fluid Machines", Dhanpat Rai and Sons, Delhi, 2001.
3. Kumar, K.L., “Engineering Fluid Mechanics”, Eurasia Publishing House (P) Ltd, New Delhi (7^{th} edition), 2004.

REFERENCES :

1. Streeter, V.L., and Wylie, E.B., “Fluid Mechanics”, McGraw-Hill, 2000.
2. Vasandani, V.P., “Hydraulic Machines - Theory and Design”, Khanna Publishers.2001.
3. White, F.M., “Fluid Mechanics”, Tata McGraw-Hill, 5th Edition, New Delhi, 2003.
4. Som, S.K., and Biswas, G., “Introduction to Fluid Mechanics and Fluid Machines”, Tata McGraw-Hill, 2nd Edition, 2004.

CH3208 **PHYSICAL CHEMISTRY LABORATORY** **L T P C**
0 0 4 2

1. Partition coefficient of iodine between two immiscible solvents,
2. Equilibrium constant of $KI + I_2 \rightleftharpoons KI_3$
3. Phase diagram of binary system
4. Solubility curve for a ternary system
5. Verification of Ostwald dilution law
6. Galvanostatic polarisation
7. Potentiostatic polarisation
8. Ion selective electrode
9. Impedence measurements
10. Adsorption isotherm
11. Heat of solution
12. Determination of acid value in the given oils

TOTAL : 60 PERIODS

CH3209 **ORGANIC CHEMISTRY LABORATORY** **L T P C**
0 0 4 2

I. QUALITATIVE ANALYSIS

1 Test for saturation / unsaturation
2 Tests for aliphatic / aromatic nature
3 Tests for elements (N, S, Halogens)
4 Tests for functional groups, acids, phenols, esters, aldehydes and ketones, carbohydrates, alcohols, amines, amides nitrogroup, hydrocarbon.

II. ORGANIC PREPARATION

Preparation of organic compounds involving the following reactions.

1. Hydrolysis – benzoic acid from benzamide
2. Acetylation – acetyl salicylic acid from salicylic acid
3. Bromination – tribromo aniline from aniline
4. Nitration – meta dinitrobenzene from nitrobenzene
5. Benzoylation – phenyl benzoate from phenol
6. Oxidation – benzoic acid from benzaldehyde
7. Esterification – carboxylic acid & alcohol

III. ESTIMATION OF POLYMERS

IV. HPLC-GPC - DEMONSTRATION

TOTAL : 60 PERIODS

CH3210 BASIC ELECTRICAL ELECTRONICS ENGINEERING LABORATORY L T P C
0 0 4 2

I : ELECTRICAL: (Any six)

1. RLC circuits.
2. D.C. shunt generator O.C.C.
3. D.C. shunt motor load characteristics
4. Speed control of D.C. shunt motor.
5. O.C. & S.C. test on single phase transformer
6. Alternator regulation (e.m.f. method)
7. Induction motor load tests.
8. Calibration of MI & MC instruments
9. Power measurement by two-watt meter method.
10. Calibration of energy meter.
11. Study of Star / Delta (Y/Δ) starters.

II : ELECTRONIC: (Any six)

1. Diode characteristics
2. Transistor characteristics
3. FET characteristics
4. UJT characteristics
5. SCR characteristics
6. Multivibrators using IC 555
7. Frequency response of RC coupled amplifier
8. RC phase shift oscillator
9. Wien bridge oscillator
10. Basic operational amplifier using IC 741
11. Adder, Multiplier, Integrator, Differentiator using IC741
12. Study of logic gates and counters.

TOTAL : 60 PERIODS

MA3021 NUMERICAL METHODS L T P C
3 1 0 4

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

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

UNIT II INTERPOLATION AND APPROXIMATION (8 + 3)

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

UNIT III NUMERICAL DIFFERENTATION AND INTEGRATION (9 + 3)

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

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

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

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

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

L: 45 T: 15 TOTAL : 60 PERIODS

TEXT BOOKS

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

REFERENCES

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

CH3212 CHEMICAL ENGINEERING THERMODYNAMICS L T P C
3 1 0 4

UNIT I FIRST LAW AND P-V-T RELATIONS OF FLUIDS 9

The first law and zeroth law, internal energy and enthalpy, state and point functions, reversible process, constant volume and constant pressure process, heat capacity, energy balance for closed and open systems. PVT behaviour of pure substances, virial equations and its applications, ideal gases, cubic equations of state, generalized correlations for gases.

UNIT II SECOND LAW AND PROPERTIES OF FLUIDS 9

Statements of second law by Classius and Kelvin, Planck, the heat engine, thermodynamic temperature scale, carnot cycle,ideal-gas- temperature scale, entropy, entropy changes of an ideal gas, the third law of themodynamics, entropy from microscopic point of view. Property relationship for homogeneous phase of constant composition, Maxwell equations, residual properties from the virial equations of the state, two phase systems, thermodynamic diagrams, generalized property correlations for gases.

UNIT III FLOW PROCESSES, POWER FROM HEAT AND REFRIGERATION 9

Flow process: flow through duct, pipe, nozzle, throttling, compression and expansion process, carnot engines, carnots principle, production of power by steam power plant, otto engine, diesel engine and gas-turbine engine. Refrigeration by carnot refrigerator ,vapour – compression refrigerator and absorption refrigerator, liquefaction process

UNIT IV VAPOUR/LIQUID EQUILIBRIA AND SOLUTION THERMODYNAMICS THEORY 9

Vapour – liquid equilibrium: The phase rule, Duhem theorem, retrograde condensation, azeotrope, dew point and bubble point calculations with Raoults law and modified Raoults law solution thermodynamics: The chemical potential and phase equilibria, partial properties, ideal gas mixtures, fugacity and fugacity coefficient, ideal solution, excess properties

UNIT V CHEMICAL REACTIONS 9

The reaction coordinate, equilibrium criteria to chemical reactions .Gibbs-energy change and equilibrium constant, temperature effect on equilibrium constant, equilibrium constant relations to gas-phase and liquid – phase reactions, equilibrium conversions for homogeneous gas phase reactions. Adiabatic reaction temperature

L : 45 T : 15 TOTAL : 60 PERIODS

TEXT BOOKS

1. J.M.Smith, and H.C Van Ness, “Introduction to Chemical Engineering Thermodynamics”, Mc.Graw Hill Book Company, 6th Edition, 2000.
2. Sundaram, “Chemical engineering Thermodynamics”, Ahuja Publishers, New Delhi, 7th Edition, 2005.

REFERENCES

1. Y.V.C Rao, “Chemical Engineering Thermodynamics”, Universities Press (India), 1997
2. K.V.Narayanan, “A text book of chemical Engineering thermodynamics”, Prentice Hall of India,2002.
3. Dodge B.F., “Chemical Engineering Thermodynamics”, McGraw- Hill, 1960.

EL3213 CHEMICAL REACTION ENGINEERING L T P C
3 0 0 3

UNIT I KINETICS OF HOMOGENEOUS REACTION AND INTERPRETATION OF BATCH REACTOR RATE 9

Classification of reactions. Types of rate expressions, Elementary and non elementary reactions. Temperature dependency of the rate constant based on Arrhenius theory.Differential and integral methods of analysis of rate data. Interpretation of rate data in constant and variable volume systems. Kinetics of irreversible, parallel and series reactions in constant volume batch reactor.

UNIT II DESIGN OF SINGLE IDEAL REACTORS 9

Introduction to reactor design – ideal batch reactor – space time and space velocity – steady state mixed flow reactor – steady state plug flow reactor – holding time and space time for flow reactors.

UNIT III DESIGN FOR SINGLE REACTION 9

Size comparison of single reactor – multiple reactor system – plug flow reactor in series/parallel – equal size mixed reactors in series – reactors of different types in series – recycle reactor**.**

UNIT IV TEMPERATURE AND PRESSURE EFFECTS AND BASIC CONCEPTS OF NON IDEAL FLOW 9

Temperature and pressure effects – heat of reaction and temperature - equilibrium constant – equilibrium conversion - equilibrium conversion with temperature – non ideal flow residence time distribution of fluid - E the age distribution of fluid – F curve – C curve relation among F, C and E curves, chemical reaction and dispersion – estimation of dispersion number from RTD studies.

UNIT V SOLID CATALYSED REACTION AND KINETICS OF FLUID PARTICLE REACTION 9

Solid catalysed reactions – the spectrum of kinetic regimes – pore diffusion resistance combined with surface kinetics – single cylindrical pore, first order reaction – porous catalyst particles – non catalytic system – fluid particle reactions – selection of model – unreacted core model for spherical particles of unchanging size – diffusion through gas film controls – diffusion through ash layer controls – chemical reaction controls.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Levenspiel. O, " Chemical Reaction Engineering", Wiley Eastern, New Delhi, 3rd Edition, 1999.
2. K.A.Gavhane, "Chemical Reaction Engineering", 4th Edition, 2007

REFERENCES

1. Charles G.Hier Jr, "An introduction to Chemical Engineering kinetics & Reactor design", John Wiley & sons, 1977
2. Smith,J.M., "Chemical Engineering Kinetics", McGraw Hill(ISE), 3rd Edition, 1981.

CH3214 MECHANICAL OPERATIONS L T P C
3 0 0 3

UNIT I PROPERTIES OF PARTICULATE SOLID – STORAGE AND CONVEYING SOLIDS 9

Characteristics of particulate solids– characterisation of particulate solids, introduction to storage and conveying of solids – pressure in bins, flow out of bins – bucket elevator – apron conveyors, belt conveyors, types of belt conveyors, selection considerations.

UNIT II SIZE REDUCTION – PRINCIPLES AND EQUIPMENTS 9

Size reduction properties and screening– screen analysis – energy and power requirement in communication – equipment for size reduction – crushers – grinders – mechanical separation – screening equipment – screen capacity.

UNIT III FILTRATION 9

Filtration – general consideration – filtration equipments – filter media and aids – principles of filtration – estimation of filtration – parameters for compressible and incompressible cakes and calculation – centrifugal filtration equipment and principle of operation.

UNIT IV SETTLING AND SEDIMENTATION 9

Gravity sedimentation processes – differential settling methods – clarifiers and thickeners – rate of sedimentation – equipment for sedimentation – thickeners design – centrifugal sedimentation – processes and principles.

UNIT V AGITATION AND MIXING 9

Introduction to agitation and mixing of liquids - agitated vessels – impellers and flow patterns – power consumption in agitated vessel – blending and mixing – types of mixers – dispersion operation.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Mc.Cabe, W.L.Smith, J.C and Harriott P, "Unit operations of Chemical Engineering", McGraw Hill (ISE), 7th Edition, 2005.
2. Badger, W.L., and Banchero, J.T : Introduction to Chemical Engineering, McGraw Hill (ISE), 1955.

REFERENCES

1. R.H Perry and D.W.Green, "Perry's Chemical Engineer's Handbook, New York, Mc Graw Hill, 7th Edition, 1997.
2. J.M.Coulson and J.F.Richardson, "Chemical Engineering" Vol.1& 2, Butterworth Heinmann, Oxford, 5th Edition, 1996

CH3215 MASS TRANSFER I L T P C
3 0 0 3

UNIT I DIFFUSION 9

Diffusion. Molecular and eddy diffusion in fluids. Diffusivity measurements and predictions Diffusion in solids. Multi component diffusion. Mass transfer coefficients and their correlation. Analogy between heat and mass transfer. J_D factor.

UNIT II THEORIES OF MASS TRANSFER 9

Theories of mass transfer, individual and over all mass transfer coefficients. Differential and stage wise contact operations. Equilibrium and operating lines. Concepts of ideal stages - Concepts of NTU and HTU and their relationships.

UNIT III GAS ABSORPTION 9

Absorption in packed towers. Pressure drop. Loading and flooding in absorption towers. Calculations of HTU, NTU and height of packing, Absorption in plate columns. Number of stages in plate columns. Absorption with chemical reaction.

UNIT IV ADSORPTION AND ION EXCHANGE 9

Adsorption. Theory of adsorption. Adsorption isotherms. Adsorbent selection. Industrial adsorbents. Adsorption equipment. Simple calculations. Ion exchange. Industrial equipments .Principles of ion exchange.

UNIT V LEACHING AND EXTRACTION 9

Leaching and extraction. Solid-liquid extraction. Liquid-liquid extraction. Batch and continuous extraction. Extraction equipments. Design of extractors. Calculation of number of stages in extraction and leaching.

TOTAL : 45 PERIODS

TEXT BOOKS

1. W.L. McCabe, J.C. Smith and Harriott, "Unit operations in Chemical Engineering", Mc Graw Hill, Singapore, 7th Edition, 2005.
2. Treybal R.E "Mass transfer operations", Mc Graw Hill, 3rd edition, 1985

REFERENCES

1. J.M. Coulson and J.F. Richardson, "Chemical Engineering", Vol.1, 6th Edition, Butterworth Heinmann, 1999.
2. G.K.Gavahnee "Unit Operation (mass transfer)" Niralla Parkasam, 20th Edition, 2006.

CH3216 HEAT TRANSFER L T P C

3 0 0 3

UNIT I HEAT TRANSFER BY CONDUCTION 9

Heat transfer by conduction in solids. Fourier's law. Steady state heat conduction through plane and composite wall. Radial heat conduction through hollow cylinder and hollow sphere. Concepts of thermal conductivity and thermal diffusivity. Conduction with heat source. Transient heat conduction.

UNIT II HEAT TRANSFER COEFFICIENT, NATURAL AND FORCED CONVECTION 9

Heat flow in fluids. Concept of heat exchange devices. Parallel and counter current heat exchangers. Log mean temperature difference. Overall and individual heat transfer coefficients. Heat transfer to fluids without phase change. Thermal boundary layer. Natural and forced convection. Application of dimensional analysis to convection. Heat transfer by forced convection in laminar flow, turbulent flow and in transition region.

UNIT III HEAT TRANSFER WITH PHASE CHANGE 9

Heat transfer to fluids with phase change. Heat transfer from condensing vapours. Drop wise and film type condensation, Nusselt equation for vertical and horizontal tubes. Heat transfer to boiling liquids and molten metals. Mechanism of boiling. Design of condensers and vaporizers.

UNIT IV HEAT EXCHANGE EQUIPMENT 9

Shell and tube heat exchangers. Single pass and multi pass shell and tube exchangers. LMTD correction for multipass exchangers. Heat exchanger effectiveness. Fouling factors. Heat transfer units. Plate type exchangers. Extended surface equipments. Heat transfer in packed and fluidized beds.

UNIT V RADIATION AND EVAPORATION 9

Concept of radiation. Black body and grey body concepts. Stefan-Boltzmann law. Kirchoff's law. radiation between surfaces. Radiation shield. Evaporation. Single effect and multiple effect evaporators. Mass and enthalpy balance. Calculation of heat transfer area. Factors affecting the performance of evaporators.

TOTAL : 45 PERIODS

TEXT BOOKS

1. W.L. McCabe, J.C. Smith and Harriott "Unit operations in Chemical Engineering", Mc Graw Hill, Singapore, 7th Edition, 2005.
2. Mc Adams W.H, "Heat Transmission", Mc Graw Hill, 1964.

REFERENCES

1 J.M. Coulson and J.F. Richardson, "Chemical Engineering", Vol.1, 6th Edition, Butterworth-Heinmann, 1999.
2. G.K.Gavahnee "Unit Operation (heat transfer)" Niralla Parkasam, 20th Edition, 2006.

CE3219 FLUID MECHANICS & MECHANICAL OPERATIONS LABORATORY L T P C
0 0 4 2

1. Venturimeter
2. V – Notch Weir
3. Efflux time
4. Pipe friction
5. Laminar flow
6. Non – Newtonian flow
7. Settling
8. Drop weight crusher
9. Ball mill
10. Jaw crusher
11. Centrifugal pump
12. Vaccum leaf filter

TOTAL : 60 PERIODS

CH3219 CHEMICAL REACTION ENGINERING LABORATORY L T P C
0 0 4 2

1. Batch reactor
2. Semi-batch reactor
3. Mixed flow reactor
4. Plug flow reactor
5. Heterogeneous catalytic reactor
6. Batch recirculation reactor
7. Electrochemical reactor
8. Residence time distribution studies in PFR & CSTR by step response
9. Residence time distribution Studies in PFR & CSTR by pulse response
10. Multiple reactors

TOTAL : 60 PERIODS

EL3220 EQUIPMENT DESIGN AND DRAWING I L T P C
0 0 3 2

1. STORAGE TANKS

Design of storage tanks – optimum proportions. Foundations and supports for equipments and tanks.

2. PRESSURE VESSELS

Design of vessels subjected to internal and external pressures. Design of formed ends and covers. Design of flanges and bolts. Design of agitators. Manhole and inspection openings. Design of tall vertical vessels.

2. SEPERATION EQUIPMENT

Design of cyclone separator, Centrifuge, Filtration Equipment, Thickeners and Crystalizers.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Perry, R.H. and Green, D.W. : "Perry's Chemical Engineers" Handbook, McGraw Hill(ISE), 7th Edition 1998.
2. Joshi M.V., Mahajani V.V : "Process Equipment Design", MacMillan, India Ltd, 3rd Edition, 1996.
3. Bhattacharya, B.C. "Introduction to Chemical Equipment Design", CBS Publishers and Distributors, New Delhi, 1985.
4. Coulson, J.M., Richardson, J.F. and Sinnott, R.K., Chemical Engineering, Vol.VI, 2nd Edition, 1998, Asian Books Pvt Ltd.,
5. Kern, D.Q.: Process Heat Transfer, McGraw Hill, 2006.

REFERENCES
1. Brownell, L.E, and Young, E.H.:"Process Equipment Design", Wiley Eastern, New Delhi, 1977.
2. Smith, B.D.: "Design of Equilibrium Stage Processes", McGraw Hill, New york, 1963.
3. Ludwig, E.E., "Applied Process Design for Chemical and Petrochemical Plants", Vols.I,II and III, Gulf Publishing Company, Texas, 2nd Edition, 1977, 1979, 1983.
4. Strigle, R.F."Random Packings and Packed Towers (Design and Application)", Gulf Publishing Company, Texas, 1987
5. Fraas, A.P. and Ozisik, M.N.:Heat Exchanger Design,John Wiley, New York, 2nd Edition, 1989.
6. Bednar, H.H, "Pressure Vessel Design" Handbook, CBS Publishers and Distributors, New Delhi, 2nd Edition, 1989.
7. Backhurst, J.R. and Harker, J.H. "Process Plant Design", Heinemann Books, London,1973.

MA3209 PROBABILITY AND LINEAR PROGRAMMING L T P C
3 1 0 4

UNIT I PROBABILITY AND RANDOM VARIABLES 9

Probability concepts – problem using Baye's theorem - random variables – discrete and continuous random variable – probability functions – distribution functions – moments – moment generating functions.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 9

Marginal and conditional probability distribution functions - mathematical expectations – variance – co-variance –correlation coefficients –rank correlation coefficients – regression lines.

UNIT III STANDARD DISTRIBUTIONS 9

Binomial – Poisson – geometric – negative binomial – exponential – gamma – Weibull distributions – transform of one dimensional random variable – problem using Chebychev inequality.

UNIT IV LINEAR PROGRAMMING 9

Introduction – formulation of the problem – graphical method – canonical form and standard forms of L.P.P – simplex method – artificial variable techniques - Big-M method – two phase simplex method.

UNIT V FURTHER TOPICS IN LINEAR PROGRAMMING 9

Duality principle – dual simplex method. Transportation model and algorithm, assignment model and Hungarian technique of solution, unbalanced assignment models, maximization case in transportation and assignment method.

L : 45 T : 15 TOTAL : 60 PERIODS

TEXT BOOKS

1. Kapur, J.N. and Saxena, H.C., "Mathematical statistics ", S.Chand & Company Ltd.,
2. Taha, H.A., " Operations Research, An Introduction ", Macmillan , New York, 1976.
3. Kanti Swarup, Guptha.P.K. and Man Mohan, " Operations Research ", Sultan Chand and Sons, New Delhi, 1982.

REFERENCES
1. Miller and Freund, J.E., "Probability and Statistics for Engineers ", Prentice Hall of India, New Delhi,1977.
2. Singaravelu, Siva Subramanian, “Probability and Random Processes”, Meenakshi Publications, 2008.
3. G.Balaji, “Probability and Statistics”, First Edition, G.Balaji Publishers, Chennai, 2010.

CH3302 INSTRUMENTAL METHODS OF ANALYSIS L T P C
3 0 0 3

UNIT I INTRODUCTION TO SPECTRAL METHODS 9

Qualitative and quantitative analysis – reliability of results – precision and accuracy – error analysis – signal to noise ratio, Absorbance – Beer’s law – sensitivity – resolution – instrumental – setup of a Spectrophotometer – double beam and single beam instruments.

UNIT II OPTICAL ABSORPTION SPECTROPHOTOMETRY 9

Ultraviolet and visible spectroscopy – sources – optical components and detectors – chemical applications. Infrared spectroscopy sources and detectors – FT techniques – regions of IR spectrum – chemical applications.

UNIT III CHROMATOGRAPHY 9

Theory of migration – retention time and volume – resolution – gas chromatography – stationary phase – capillary columns – stationary liquid phase – carrier gas – detectors – qualitative and quantitative analysis – liquid solid chromatography – liquid liquid chromatography – photometric and refractometric detectors.

UNIT IV THERMOMETRIC METHODS 9

Thermo gravimetric analysis – thermo balances – differential thermal analysis apparatus – scanning calorimetric DTA – thermo chemical analysis.

UNIT V X-RAY ATOMIC ABSORPTION SPECTROSCOPY AND OTHER SPECTROSCOPY TECHNIQUES 9

Absorption of X-rays – X-ray sources – monochromators – scintillation, gas ionization and solid state detectors – XRD principles and applications – X-ray fluorescence – principles and applications. AAS – atomization – flame, graphite furnace atomization – hollow cathode lamps – back ground correction – detection limits – interferences – applications. Basic principles of electroparamagnetic resonance and nuclear magnetic resonance spectroscopy.

TOTAL : 45 PERIODS

TEXT BOOKS
1. G.W.Ewing, “Instrumental Methods of Chemical Analysis”, Mc Graw Hill, 4th Edition,1975.
2. Hobart Hurd Willard, Lynne.L.Merritt and J.A. Dean, “Instrumental Methods of Analysis”, Wadsworth Publishers, 7th Edition, 1988.

REFERENCE
1. C.N. Banwell, “Fundamentals of molecular spectroscopy”, 4th Edition, Tata Mc Graw Hill Publishing co., 1996.

EL3303 ELECTRODICS AND ELECTROCATALYSIS L T P C
3 1 0 4

UNIT I ELECTRICAL DOUBLE LAYER 9

Thermodynamics of ideally polarizable and non-polarizable interfaces- Lipman equation-determination of interfacial tension, charge density, surface excess and double layer capacitance by electro capillary & bridge methods- Helmholtz, Gouy-Chapman and stern models of the double layer with discussion of potential and charge distribution inside the double layer-contact adsorption and its determination.

UNIT II ELECTRODE KINETICS 9

Concepts of equilibrium potential, Nernst equation, overpotential and its different types, equilibrium exchange current density-derivation of Butler-Volmer equation –high field and low field approximations – charge transfer resistance and polarizability of the interface – concepts of rate determining step, Stoichiometric number, reaction order – Determination of kinetics parameters [i_o, k_s, $\beta(\alpha)$] by Tafel and linear polarization methods.

UNIT III ELECTROCATALYSIS 9

Chemical catalysis and electro catalysis – comparison of electrocatalysts – electro catalysis in simple redox reactions involving adsorbed species – electronic and geometric factors in electrocatalysts -Discussion on the mechanisms of hydrogen evolution and oxygen reduction reactions.

UNIT IV ELECTROCHEMICAL TECHNIQUES I 9

Ion selective electrodes – Principles of potentiometry and amperometry- determination of dissolved oxygen. Linear sweep voltammetry and cyclic voltammetry derivation of Randles-Sevciks equation – effect of sweep rate-analysis of cyclic voltammograms.

UNIT V ELECTROCHEMICAL TECHNIQUES II 9

Potential step method (chronoamperometry) under diffusion control derivation of Cottrell equation for a planar and spherical electrode- significance of spherical diffusion – derivation of Ilkovic equation.- Chronopotentiometry and analysis of chronopotentiograms-derivation of sands equation for constant current input under linear diffusion- concepts of Faradaic impedance –derivation of kinetic parameters from impedance measurements – Nyquist and bode plots for simple redox reactions-principles of scanning probe techniques-STM-AFM and SECM.

L : 45 T : 15 TOTAL : 60 PERIODS

TEXT BOOKS

1. J.O.M Bockris & A.K.N. Reddy, “Modern Electrochemistry”, Plenum Press(Chapter 7 for unit I: Chapters 8 & 9 for unit II ; chapter 10 for unit III), Volume –II, 1996.
2. A.J.Bard & L.R. Faulkner, ”Electrochemical Methods Fundamentals and Applications”, John Wiley & Sons. 2nd Edition, 2001.

REFERENCES

1. Paul Delahay, “Double Layer Structure and Electrode Kinetics”, 1965.
2. James A. Plam Beck , “Electroanalytical Chemistry – Basic Principles and Applications”, John Wiley & sons, Wiley Publication, 1982
3. B.H.Vassos and G.W. Ewing, “Electroanalytical Chemistry”, John Wiley & sons, 1983.
4. T.S. Ma & S.S.M Hassan, “Organic Analysis using Ion Selective Electrodes”. Vol 1&2, Academic Press, London, 1982.

EL3304 CHEMICAL PROCESS TECHNOLOGY L T P C
3 0 0 3

UNIT I SULPHUR, SULPHURIC ACID AND GLASSES 9

Mining of sulphur and manufacture of sulphuric acid. Types of cements and its manufacturing process, manufacturing of Glass, special glasses.

UNIT II INDUSTRIAL GASES AND FERTILIZERS 9

Industrial gases; carbondioxide, nitrogen, Hydrogen, oxygen and acetylene. Fertilizer industries; ammonia, nitric acid, urea, ammonium nitrate, phosphorous and phosphoric acid, super phosphate and triple super phosphate.

UNIT III NATURAL PRODUCT INDUSTRIES 9

Production of pulp, paper. Manufacturing of sugar starch and starch derivatives – fermentation process for production of ethyl alcohol. Edible oils, soaps and detergents.

UNIT IV PETROLEUM REFINING AND PETROCHEMICALS 9

Petroleum refining to produce naptha, fuel hydrocarbons and lubricants – processes for the production of petrochemical precursers – ethylene, acetylene propylene, butadiene, benzene toluene and xylene.

UNIT V PLASTICS 9

Thermosetting and thermoplastic resins – polyethylene – polypropylenes, phenolic resins and epoxy resins. Polymers and their application in engineering practice. Process for the production of synthetic rubbers.

TOTAL : 45 PERIODS

TEXT BOOKS

1. M.Gopal Rao and M.Sittig, Drydens "Outlines of Chemical Technology", East West Affliated Press, 3rd Edition, reprint 2005.
2. Austin; Shreves, "Chemical Process Industries", Mc Graw Hill Book Co., 5th Edition, 1984.

REFERENCES

1. S.D.Shukla & G.N.Pandey, "Text book of Chemical Technology", Vol.I Vikas Publications Co., 1977.
2. S.C. Bhatia, "Chemical Process Industries", CBS Publishers & Distributors, New Delhi, 2002.
3. "Reigels Hand Book of Industrial Chemistry", Revised by Kent, CBS Publishers & Distributors, New Delhi, 10th Edition, 2003.

CH3305 **MASS TRANSFER II** **L T P C**
3 0 0 3

UNIT I DISTILLATION 9

Distillation. Importance of Vapor-liquid equilibria in distillation. Volatility and relative volatility. Batch, flash and steam distillations and calculations. Low pressure, azeotropic and extractive distillations.

UNIT II CONTINUOUS FRACTIONATION 9

Continuous fractionation of binary systems. Reflux. Minimum reflux , total reflux and optimum reflux. Number of plates and minimum number of plates. Design calculations based on McCabe – Theile method. Concept of the Ponchon – Savarit methods.

UNIT III CRYSTALLISATION AND DRYING 9

Crystallisation. Factors governing nuclei formation and crystal growth. Theory of crystallisation. Classification of crystalliser and their application. Calculations of industrial crystallisation. Drying, Industrial drying equipments. Theory and mechanism of drying. Drying characteristics of materials. Estimation of drying time.

UNIT IV HUMIDIFICATION 9

Humidification and air conditioning. Basic concepts. Psychrometric chart. Methods of humidification and dehumidification. Calculations. Cooling towers. Principle and operation. Types of cooling towers.

UNIT V NEW SEPARATION PROCESSES (THEORETICAL PRINCIPLES ONLY – NO PROBLEMS) 9

New Separation Processes. Chromatography. Membrane separation processes. Concept of osmosis, reverse osmosis, dialysis, electrodialysis and their applications.Thermal and sweep diffusion processes. Foam separation and Zone refining techniques.

TOTAL : 45 PERIODS

TEXT BOOKS

1. W.L. McCabe, J.C. Smith and Harritp, “Unit operations in Chemical Engineering”, Mc GrawHill, Singapore, 7th Edition, 2005.
2. R.E. Treybal, “Mass Transfer Operations”, Mc Graw Hill, 3rd Edition, 1985.

REFERENCE

1. J.M. Coulson and J.F. Richardson, “Chemical Engineering”, Butterworth-Heinmann, Oxford, Vol. 1 & 2 Fifth edition, 1996.

EL3306 ELECTROCHEMICAL REACTION ENGINEERING L T P C
3 1 0 4

UNIT I CURRENT-VOLTAGE RELATIONSHIPS & ESTIMATION OF MASS TRANSFER CO-EFFICIENT 9

A general view of electrolytic processes; current-voltage relationships in electrolytic reactors; the limiting current plateau; mass & energy balance, and efficiency in electrochemical reactors. The estimation of mass transport coefficients at commonly occurring electrodes. The estimation of mass transport coefficients under enhanced convection conditions.

UNIT II PLUG FLOW & CSTER SYSTEMS MODEL 9

A general view of plug flow model of electrolytic reactors: plug flow model of electrochemical reactors employing parallel plate reactor; Plug flow model under constant mass flux conditions; PFM analysis with electrolyte recycling PFM and real electrochemical reactors. General view of simple CSTER systems; CSTER in cascades; CSTER analysis of batch electrochemical reactors, CSTER analysis of semi-continuous electrochemical reactors; CSTER analysis of electrolyte recycling; Batch reactor combined with electrolyte recycling.

UNIT III THERMAL BEHAVIOR OF REACTORS 9

General aspects of thermal behavior in electrochemical reactor. Thermal behavior under CSTER conditions. The estimation of heat losses; the thermal behavior under PFR conditions; Thermal behavior of batch electrochemical reactors.

UNIT IV CONVECTIVE DIFFUSION EQUATION & CURRENT DISTRIBUTION 9

Convective diffusion equation and migration effects –derivation of convective diffusion equation theory – scope and limitation – migration effects – Electroneutrality conditions – supporting electrolyte effect – fundamental of Nernst layer model – Estimation of true limiting current

UNIT V DISPERSION MODELS & OPTIMIZATION OF ELECTROCHEMICAL REACTOR 9

General aspects of dispersion models-tracer input signal/output signal - axial dispersion in electrochemical reactors - axial dispersion and reactor performance - axial dispersion analysis via tank-in-series model - general notions on optimization of electrochemical reactor – elementary process optimization – IBL formula – optimization of electro refining process – Jaskula formula – optimization of a general electrolytic process – The Beck formula.

L : 45 T : 15 TOTAL : 60 PERIODS

TEXT BOOK

1. T.Z.Fahidy, “Principles of Electrochemical Reactor Analysis”, Elsevier, 1985.

REFERENCE

1. K.Scott, “Electrochemical Reaction Engineering”, Academic Press, 1991

EL3308 HEAT AND MASS TRANSFER LABORATRORY L T P C
0 0 4 2

1. Transient state heat conduction
2. Surface evaporation
3. Jacketted kettle
4. Temperature profile of a rod
5. Natural convection
6. Thermal conductivity of composite wall
7. Emissivity measurement
8. Measurement of diffusion coefficient
9. Simple distillation
10. Leaching
11. Adsorption

TOTAL : 60 PERIODS

EL3309 EQUIPMENT DESIGN AND DRAWING II L T P C
0 0 3 2

Heat transfer equipments - design of heat exchangers, condensers, evaporators and reboilers. Mass transfer equipments- design of distillation columns, extraction and absorption equipment, rotary dryers and cooling towers.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Perry, R.H. and Green, D.W., "Perry's Chemical Engineers" Handbook, McGraw Hill(ISE), 7th Edition, 1998.
2. Joshi, M.V., Mahajani V.V, " Process Equipment Design", MacMilan, India, 3rd Edition, 1996
3. Bhattacharya, B.C., "Introduction to Chemical Equipment Design", CBS Publishers and Distributors, New Delhi, 1989.
4. Coulson, J.M., Richardson, J.F and Sinnott, R.K. "Chemical Engineering", Vol VI, 2nd Edition, 1998, Asian Book Private Ltd.
5. Kern, D.Q. "Process Heat Transfer", McGraw Hill , 2006.
6. Brownell, L.E and Young, E.H., "Process Equipment Design", Wiley Eastern, New Delhi ,1977

REFERENCES
1. Smith, B.D. “Design of Equilibrium Stage Processes”, McGraw Hill, New york, 1963.
2. Ludwig, E.E. “Applied Process Design for Chemical and Petrochemical Plants”, Gulf Publishing Company, Texas, Vols.I,II and III 2nd Edition, 1977, 1979, 1983)
3. Strigle, R.F.”Random Packings and Packed Towers” (Design and Application), Gulf Publishing Company, Texas, (1987)
4. Fraas, A.P. and Ozisik, M.N., ”Heat Exchanger Design”, John Wiley, New York, 2nd Edition, 1989.
5. Bednar, H.H., “Pressure Vessel Design” Handbook, , CBS Publishers and Distributors, New Delhi, 2nd EdItion, 1989.
6. Backhurst, J.R. and Harker, J.H. “Process Plant Design”, Heinemann Books, London, 1973.
7. Dawande : S.D. “Process Design of Equipments”, Central Techno Publications, Nagpur,1999.

GE3310 TOTAL QUALITY MANAGEMENT & ENGINEERING ECONOMICS L T P C
3 0 0 3

UNIT I QUALITY AND CUSTOMER CONCEPTS 9

Introduction - definitions of quality, dimensions of quality, historical review of total quality management, customer satisfaction - customer perception of quality, customer complaints, service. Quality, customer retention, continuous process improvement - Juran trilogy, PDSA cycle, 5S, Kaizen. Performance measures:- basic concepts, strategy. The seven tools of quality, concept of six sigma, seven management tools.

UNIT II QUALITY MANAGEMENT TOOLS AND QUALITY SYSTEMS 9

TQM tools - benchmarking - reasons to benchmark, benchmarking process, quality function deployment - house of quality, QFD process, benefits, Taguchi quality loss function, total productive maintenance - concept, improvement needs, FMEA - stages of FMEA. Quality systems - Need for ISO 9000 and QS 9000 : elements, implementation, documentation, quality auditing, concept, requirements and benefits.

UNIT III VALUE OF MONEY, AMORTIZATION, CAPITAL REQUIREMENTS, COSTS, EARNINGS, PROFITS 9

Value of money – equivalence - value of money, equations for economic studies, equivalence amortization - capital recovery, depreciation, interest in depreciation calculations, depreciation accounting, capital requirements for process plants - cost indices, the Williams six-tenths factor, capital requirements for complete plants, balance sheet, sources of capital, earnings, profits and returns - variable costs, fixed costs, profits and earnings, economic production charts.

UNIT IV ECONOMICS OF SELECTING ALTERNATES, RATE OF RETURN & PAYOUT TIME, ECONOMIC BALANCE 9

Economics of selecting alternates - annual cost method, present worth method, equivalent alternates, rate-of return method, payout-time method, replacement of existing facilities, irreducible factors in economic analyses, economic balance - economic balance in evaporation, economic vessel design, economic balance in fluid flow, economic balance with two variables, economic balance in combined operations – economic balance with one variable and two variable.

UNIT V ECONOMIC BALANCE - CYCLIC OPERATIONS – YIELD AND RECOVERY 9

Economic balance in cyclic operation, batch operations (fixed cycle time), batch operations (variable cycle time), continuous and semi continuous operations, economic balance in yield and recovery - economic analysis for variable feed and product grades, economic analysis of a complete process - operating plants, proposed plants, evaluation.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Dale H. Besterfiled, et al., "Total Quality Management", Pearson Education Asia, 2003 ,(Indian reprint 2002).
2. Schwyer H E; "Process Engineering Economics", McGraw-Hill Book Company, Inc, New York,1955.

REFERENCES

1. James R.Evans & William M. Lidsay, The Management and Control of Quality, (5th Edition), South-Western (Thomson Learning), 2007 (ISBN 0-324-06680-5)
2. Feigenbaum. A.V. "Total Quality Control, McGraw Hill, 1991, 3rd Edition revised.
3. Oakland.J.S. " Total Quality Management Butterworth – Hcinemann Ltd., Oxford.1994, 2nd Edition.
4. S. Peters and K.D. Timmerhaus, "Plant Design, Costing and Economics", McGraw Hill, Inc. 4th Edition ,1991.

EL3311 PROCESS INSTRUMENTATION L T P C
3 0 0 3

UNIT I MEASUREMENTS AND MEASUREMENT SYSTEMS 9

Significance of measurement – methods of measurement – direct and indirect method – instrument and measurement system – classification of instruments – absolute and secondary – static characteristics of instrument – error in measurement – gross error – systematic error – random error – calibration and standards – principles of operation, handling and maintenance of instruments.

UNIT II OPERATIONAL AMPLIFIER 9

Block diagram of operational amplifier – ideal operational amplifier – characteristics- Non-inverting mode – inverting mode – definition – CMPR –gain bandwidth product – OP-AMPS circuits used in instrumentation – ideas – voltage follower- inverter – adder – subtractor - multiplier – divider - integretor – differentiator – comparator – logarithmic converter – current to voltage converter – voltage to current converter – wave form generator – differential amplifier – instrumentation amplifier.

UNIT III INSTRUMENT CONTROL UNIT AND OUTPUT UNIT 9

Analog instrument – digital instrument. ADC and DAC concept. Introduction – 8085A architecture - pin configuration, 8085 single board micro computer system . Output unit – displays – recorders, printers.

UNIT IV PROCESS INSTRUMENTATION 9

Process control principles and system elements - temperature measurement-monitoring and control, pressure measurement using bellows and LVDT - pH measurement – conductivity measurement.

UNIT V ELECTROCHEMICAL INSTRUMENTATION 9

Basic configuration and applications of constant voltage and anodic stripping voltammetry, potentiostat, galvanostat and zero resistance ammeter - computer/microprocessor based instruments, battery life cycle testing – computerized (SCADA) supervisory control systems for anodic / cathodic protection of steel structure.

TOTAL : 45 PERIODS

TEXT BOOKS

1. A.K.Sawhney, " A course in Electrical and Electronics measurement and instrumentation", Dhanpat Rai Publication, 1994. (Unit I & II)
2. Ramesh S Goankar, "Microprocessor Architecture, Programming & Applications with 8085 / 8080A, Wiley Easter Ltd., (Unit III)
3. Curties D.Johnson, "Process Control Instrumentation Technology" Prentice Hall, 5th Edition,1997. (Unit IV)
4. Hobart Hurd Willard, Lynne.L.Merritt and J.A. Dean, "Instrumental Methods of Analysis", Wadsworth Publishers, 7th Edition, 1988. (Unit IV)
5. A.J.Bard & L.R. Faulkner, "Electrochemical Methods Fundamentals and Applications", John Wiley & Sons. 2nd Edition, 2001. (Unit V)

REFERENCES

1. Howard A Strobel, Electrochemical Instrumentation, a system approach, Addition werley publishing company 1973.
2. Douglos M Considine, Process Instruments and Control Handbook - McGraw Hill 1988.
3. D.Roy Choudhury, Shail Jain, "Linear Integrated Circuits", John Wiley & Sons, 1996.
4. Badri Ram, "Fundamentals of Microprocessors and Micro computers", Dhanpat Rai & sons, New Delhi, 1990, (Chapter 1,3,4).\
5. Albert Paul Malvino, " Electronic Principles",McGraw Hill Education, New Delhi, ISE Edition, 1998 (Chapter15 to 18).

EL3312 ENERGY TECHNOLOGY L T P C
3 0 0 3

UNIT I SOLID FUELS 9

Principal solid fuel, coal – properties, testing, preparation, handling and storage, carbonisation, Briquetting.

UNIT II LIQUID FUELS 9

Liquid fuels from crude oil, synthetic and other liquid fuels, storage and handling of liquid fuels.

UNIT III GASEOUS FUELS 9

Natural gas, manufacture of gaseous fuels, gas purification, combustion, furnaces, waste heat recovery.

UNIT IV NUCLEAR ENERGY SOURCES 9

Nuclear energy – nuclear reactions. Fuel materials, moderators and structural material. Nuclear reactors. Reprocessing of spent nuclear fuel, safety measure.

UNIT V RENEWABLE ENERGY SOURCES 9

Solar energy – basic principle, storage, collectors, application such as water heating, photo voltaic cells - production of hydrogen, pumping. Energy from biomasses – biomass conversion and biogas generation, biogas plant, process parameter. Wind energy – basic principle, wind energy conversion, components, design, environmental aspects, safety. Tidal and ocean thermal sources – basic principle, components, operation methods, advantages, limitations

TOTAL : 45 PERIODS

TEXT BOOKS

1. Gupta, O.P, "Elements of fuels, furnaces and Refractories", Khanna Publishers, New Delhi, 1990
2. S.Rao, Energy Technology, Khanna Publishers, New Delhi (non conventional, conventional and renewable), 2005.

REFERENCES

1. Considine D.M, "Energy Technology", Hand book, Mc Graw Hill, New York, 1977.
2. Griswold.J : "Fuels, Combustion and furnaces", Mc Graw Hill, New York, 1946.
3. Himus, G.W., "The Elements of fuel technology", Leonard Hill, London, 2nd Edition, 1958.
4. P.C. Jain and Monika Jain, "Engineering Chemistry", Dhanpat Rai and Sons, New Delhi 1986

EL3313 INDUSTRIAL METAL FINISHING L T P C
3 0 0 3

UNIT I ELECTROPLATING OF METALS 9

Fundamental principles – Faradays laws, mechanism of deposition, surface preparation for electroplating, electroplating of copper, nickel, chromium, zinc, tin and precious metals (gold and silver)

UNIT II EVALUATION & TESTING 9

Measurements of pH, specific gravity, surface tension, conductivity, throwing power and current efficiency of electroplating electrolytes. Testing of Electro deposits for thickness, adhesion, stress, corrosion, porosity, hardness, ductility and solderability. The use of Hull-cell in plating.

UNIT III ELECTROPLATING OF ALLOYS AND OTHER PLATING METHODS 9

Principles of alloy deposition, barrel finishing and plating, electroforming of copper and nickel, electroless deposition of copper and nickel, brush plating, continuous plating, PCB plating.

UNIT IV ENGINEERING ASPECTS 9

Equipment selection, rectifier, pre-treatment equipment-mechanical - chemical, automation, flooring, materials for tanks and linings, ventilation, bus bar, filtration and purification, agitation, heating and cooling arrangement for electrolytes.

UNIT V ANODIZING 9

Anodizing of aluminium, principles, pre-treatment, jigging. Sulphuric acid process, operating conditions for decorative and protective anodizing, effect of impurities, analysis for free acid and aluminium content, chromic acid process, operating conditions, effect of impurities, coloring of anodized aluminium with organic dyes. Sealing in hot water and dichromate solution. Testing of anodic film thickness by Eddy current method and stripping method, coating weight – coating ratio.

TOTAL : 45 PERIODS

TEXT BOOKS

1. F.A.Lowenheim, "Modern Electroplating", John Wiley and Sons INC. USA, 3rd Edition, 1974.
2. N.V.Parthasarathy, "Practical Electroplating Handbook", Prentice Hall Inc., 1989
3. E.Raub and K.Muller, "Fundamentals of metal deposition, Elsevier Publication company", 1967.

REFERENCES

1. L.J.Durney, "Electroplating Engineering Handbook", Van Nostrand Reinhold, New york, 1984.
2. V.F. Henley, "Anodic Oxidation of Metals", Pergamon ,1st edition, 1982.

EL3314 CORROSION SCIENCE & ENGINEERING L T P C
3 0 0 3

UNIT I BASIC ASPECTS 9

Introduction, classification, economics, emf series, Galvanic series. Corrosion theories : derivation of potential – current relationships of activation controlled and diffusion controlled corrosion processes. Potential – pH diagrams Fe-H_2O system, application and limitations. Passivation-definition, anodic passivation theory of Passivation.

UNIT II FORMS OF CORROSION 9

Definition, factors and control methods of various forms of corrosion : uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement.

UNIT III ATMOSPHERIC CORROSION AND PROTECTIVE COATINGS 9

Atmospheric corrosion – classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods ; organic coating – surface preparation, natural, synthetic resin, paint formulation and applications. Paint testing and evaluation.

UNIT IV IMMERSION CORROSION AND ELECTROCHEMICAL PROTECTION 9

Corrosion in immersed condition : effect of dissolve gases, salts, pH, temperature and flow rates of corrosion; marine corrosion. Underground corrosion – corrosion process in the soil, factors influencing soil corrosion, Biological corrosion definition, mechanism of biological

corrosion control of bio corrosion. Electrochemical methods of protection theory of cathodic protection, design of cathodic protection, sacrificial anodes, impressed current anodes, anodic protection. Corrosion inhibitors for acidic, neutral and alkaline media, cooling water system - boiler water system. Corrosion resistant alloys.

UNIT V CORROSION MONITORING 9

Laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by Gravimetric, Tafel polarization, linear polarization, cyclic polarization, impedence spectroscopy, harmonics and NDT techniques- ultrasonics, radiography eddy current.

TOTAL : 45 PERIODS

TEXT BOOKS

1. S.N.Banerjee, "An Introduction to Corrosion Science and Corrosion Inhibition", Oxonian Press P.Ltd., New Delhi, 1985.
2. Zaki Ahmad, "Principles of Corrosion Engineering & Corrosion Control", Butterworth Heinemann, 2006
3. M.G.Fontana & N.D. Greene, "Corrosion Engineering", McGraw Hill, New York , 1978.

REFERENCES

1. LL.Shrier "Corrosion", Vol. I & II, Butterworth Heinemann, 1994.
2. H.H.Uhlig and R.W.Revie, "Corrosion and Corrosion Control", A Wiley – Inter Science Publication John Wiley & Sons, New York, 3rd Edition, 1985.

EL3315 ELECTROCHEMICAL PROCESS TECHNOLOGY L T P C
3 0 0 3

UNIT I ELECTRODES AND SEPARATORS 9

Electrodes and separators for the electrolytic production of inorganic chemicals – preparation, characteristics and applications of graphite, magnetite, lead dioxide coated anodes, noble metal coated anodes, noble metal oxide coated anodes, spinal anodes, Perovskite anodes, steel cathodes, coated cathodes, diaphragms and ion exchange membranes.

UNIT II ELECTROLYTIC PRODUCTION OF IN-ORGANIC CHEMICALS 9

Electrolytic production of sodium hypochlorite, sodium and potassium chlorates, bromates and iodates. Sodium, potassium and ammonium perchlorates, perchloric acid. Potassium, and ammonium persulphates, hydrogen peroxide, potassium permanganate, cuprous oxide and maganese dioxide – Basic principles, reaction mechanisms, effect of operating variables, cell design and operating characteristics of industrial cells.

UNIT III BASICS OF ELECTRO ORGANIC CHEMISTRY AND ELECTRODIALYSIS 9

Production of hydrogen by water electrolysis. Electrodialysis and its application to desalination of water electrolysis and waste recovery. Basic principles of Electro organic chemistry, constant current electrolysis, controlled potential electrolysis, material yield, current efficiency, selectivity and energy consumption for electro organic synthesis. Paired synthesis with example.

UNIT IV ELECTROCHEMICAL REDUCTION AND OXIDATION OF FUNCTIONAL GROUPS 9

Cathodic reduction of carbonyl compounds, nitro compounds, unsaturated compounds, nitriles and oximes. Electrohydrodimerization and cathodic coupling reactions, cathodic reactions using mediators. Anodic halogenation, oxidation through redox carriers – metal ion, non-metal ion and organic mediators. Anodic coupling reactions. Kolbe synthesis, mechanism and applications. Anodic oxidation of aromatic hydrocarbons and phenol. Anodic substitution reactions: alkoxylation, acetoxylation, cyanation and acetamidation.

UNIT V INTRODUCTION TO ELECTRO POLYMERIZATION AND INDUSTRIAL ELECTRO ORGANIC PROCESSES 9

Electro polymerization. Anodic and cathodic polymerization with example (anionic polymerization, cationic polymerization and radical polymerization). Electrochemical preparation of conducting polymers such as polyacetylene, polypyrrole, polythiophene, polyaniline and their applications (excluding mechanism of polymerization). Industrial Electro organic processes such as adiponitrile from acrylonitrile, dimethyl sebacate from monomethyl adipate, Tetra alkyl lead from alkyl chloride, perfluorooctanoic acid from octanoylchloride, Aromatic aldehydes from toluenes. Electrochemical fluorination of organic compounds - Electrochemical perfluorination, Electrochemical selective/partial fluorination with examples.

TOTAL : 45 PERIODS

TEXT BOOKS

1. D.Pletcher and F.C.Walsh, “Industrial Electrochemistry”, Chapman and Hall, London, 1990.
2. A.T.Kuhn, “Industrial Electrochemical Process”, Elsevier Publishers, 1971.
3. M.M.Baizer, “Organic Electrochemistry”, Dekker Inc, Newyork, 1983.

REFERENCES

1. D.Kyriacou, “Modern electro-organic chemistry”, Springer-Verlag, Berlin, Heidelberg, Germany, 1994.
2. A.J.Bard and M.Stratmann, Encyclopedia of Electrochemistry,Vol.8,“Organic Electrochemistry”, Wiley-VCH, Weinheim, 2004.
3. Marcel Dekker , M.R. Rifi and F. H. Covitz, “Introduction to Organic Electrochemistry”, Inc. NewYork 1994.

EL3317 ELECTROCHEMICAL ENGINEERING LABORATORY I L T P C
0 0 4 2

CORROSION

1. Determination of efficiency of the given inhibitor by gravimetric method
2. Efficiency of cathodic protection by impressed current method
3. Determination of anodic efficiency in sacrificial anode system
4. Standard Test Methods for specific gravity of pigments (3 pigments)
5. Determination of corrosion rate measurements by gravimetric method.
6. Determination of corrosion rate by galvanostatic polarization method [Tafel and linear
   Polarization methods]

ELECTROCHEMICALS

Electrochemical preparation of the following compounds :

1. Potassium chlorate from potassium chloride
2. Sodium perchlorate from sodium chlorate
3. Sodium hypochlorite from sodium chloride
4. Calcium gluconate from glucose
5. Succinic acid from maleic acid
6. Manganic sulphate from manganous sulphate

TOTAL : 60 PERIODS

EL3318 ELECTROCHEMICAL REACTION ENGINEERING LABORATORY L T P C
0 0 4 2

1. Electrochemical batch reactor-constant current operation.
2. Factorial design for investigating the current efficiency of copper deposition.
3. Monopolar and bipolar cells.
4. Electrochemical semi batch reactor
5. Electrochemical batch reactor - constant voltage operation.
6. Continuous flow stirred tank electrochemical reactor (CSTER)
7. Axial flow electrochemical reactor (PFER)
8. Packed bed reactor-flow through configuration
9. Local mass transfer on the wall of stirred tank reactor

TOTAL : 60 PERIODS

GE3318 COMMUNICATION SKILLS AND SOFT SKILLS LAB L T P C
0 0 2 1

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

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

I. PC based session

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

1. **Resume / Report Preparation / Letter Writing:** (3)
   Letter writing – Job application with Resume - Project report - Email etiquette.
2. **Presentation skills:** (3)
   Elements of effective presentation – Structure of presentation - Presentation tools – Body language.
3. **Soft Skills:** (3)
   Time management – Stress management – Assertiveness – Negotiation strategies, Psychometrics - Analytical and logical reasoning.
4. **Group Discussion:** (3)
   Group discussion as part of selection process, Structure of group discussion – Strategies in group discussion – Mock group discussions.
5. **Interview Skills:** (3)
   Kinds of interviews – Interview techniques – Corporate culture – Mock interviews.

TOTAL 30 PERIODS

II. Class Room Session

1. **Resume / Report Preparation / Letter writing**: Students prepare their own resume and report. (9)
2. **Presentation Skills:** Students make presentations on given topics. (12)
3. **Group Discussion**: Students participate in group discussions. (12)
4. **Interview Skills**: Students participate in Mock Interviews (12)

Note: Classroom sessions are practice sessions.

REFERENCES:

1. Prakash P, Verbal and Non-Verbal Reasoning, Macmillan India Ltd., 2nd Edition, New Delhi, 2004.
2. John Seely, The Oxford Guide to Writing and Speaking, Oxford University Press, New Delhi 2004.
3. Paul V Anderson, Technical Communication, Thomson Wadsworth , 6th Edition, New Delhi, 2007.
4. Edgar Thorpe and Showick Thorpe, Objective English, Pearson Education, 2nd Edition, New Delhi 2007.
5. David Evans, Decision maker, CUP, 1997

Lab Requirement:

1. Teacher console and systems for students.
2. English Language Lab Software
3. Tape recorders

GE3401 PROFESSIONAL ETHICS L T P C
3 0 0 3

UNIT I ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – variety of moral issues – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – consensus and controversy – professions and professionalism – professional ideals and virtues – theories about right action – self-interest – customs and religion – uses of ethical theories.

UNIT II ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation – Engineers as responsible experimenters – codes of ethics – a balanced outlook on law – the challenger case study.

UNIT III ENGINEER'S RESPONSIBILITY FOR SAFETY 9

Safety and risk – assessment of safety and risk – risk benefit analysis – reducing risk – the three mile island and Chernobyl case studies.

UNIT IV RESPONSIBILITIES AND RIGHTS 9

Collegiality and loyalty – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – intellectual property rights– discrimination.

UNIT V GLOBAL ISSUES 9

Multinational corporations – environmental ethics – computer ethics – weapons development – Engineers as managers – Consulting Engineers – Engineers as expert witnesses and advisors – moral leadership – sample code of conduct.

TOTAL : 45 PERIODS

TEXT BOOK

1. Mike.W.Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill Professional, New York, 4th Edition , 2004.

REFERENCES

1. Charles Byrns Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 2008.
2. Laura Schlesinger, "How Could You Do That: The Abdication of Character, Courage, and Conscience", Harper Collins, New York, 1996.
3. Stephen Carter, "Integrity", Basic Books, New York, 1996.
4. Tom Rusk, "The Power of Ethical Persuasion: From Conflict to Partnership at Work and in Private Life", Viking, New York, 1993

EL3402 NANOMATERIALS TECHNOLOGY L T P C
3 0 0 3

UNIT I PROPERTIES OF MATTER 12

Size effects, structure of solids, energy bands, localized particles. Synthesis and properties of: metal, metal oxide, semiconductor and magnetic nanoparticles. Carbon nanostructures – brief notes on synthesis, properties and application.

UNIT II METHODS OF CHARACTERIZATION 6

Nanoparticle characterization: X-ray Diffraction (XRD), Small Angle X-ray scattering (SAXS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Energy Dispersive Spectrum (EDS), Scanning Probe Microscopy (SPM), and other spectroscopy techniques (UV-Vis, IR and Raman)

UNIT III TYPES OF NANOSTRUCTURES 9

Nanostructures in zeolites cages, quantum wells, wires and dots. Preparation of quantum nanostructures, size and dimensionality effects, single electron tunneling

UNIT IV MAGNETIC PROPERTIES 9

Nanostructured ferromagnetism – basics of ferromagnetism, effect of nanostructuring of bulk magnetic materials, dynamics of nanomagnets, nanopore containment of magnetic particles, nanocarbon ferromagnets, giant and colossal magneto-resistance, ferrofluids

UNIT V NANOPARTICLE SYNTHESIS 9

Self assembly – techniques, semiconductor islands – monolayers. Catalysis - nature of catalysis – surface area of nanoparticles – porous materials – pillared clays – colloids.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Catherine Brechignac, Philipe Houdy, Marcel Lahmani "Nanomaterials and Nanochemistry", Springer.
2. "Nanostructures & Nanomaterials" Synthesis, Properties & Applications by Guozhong Cao, ISBN 1-86094-44809, World Scientific Publishing Company, Jan 2004.

REFERENCES

1. Taylor & Francis, "Nanomaterials Handbook", Edited by Yuri Gogotsi, CRC Press, 2006
2. "Handbook of Nanotechnology", Bhushan Bharat Springer Edition.
3. C.N.R.Rao, "The chemistry of Nanomaterials", Vol. 1 & 2, Wiley – VCH.

EL3403 PROCESS DYNAMICS AND CONTROL L T P C

3 1 0 4

UNIT I LINEAR OPEN-LOOP SYSTEM 9

An introductory example – response of first order systems – physical examples of first order systems – response of first order systems in series – higher order systems, second order and transportation lag.

UNIT II LINEAR CLOSED LOOP SYSTEM 9

The control system – development of a block diagram process – measuring element – controller- controllers and final control elements –Ideal transfer functions-control valve, controller - proportional, proportional integral, proportional derivative and proportional integral derivative control, block diagram of a chemical reactor control system, closed loop transfer functions for change in load and set point – overall transfer function for multi loop control system**.**

UNIT III STABILITY 9

Transient response of simple control systems – proportional control for set point and load change – PI control for load and set point change – proportional control of system with measurement lag - stability – concept – definition-stability criterion characteristic equation – Routh test for stability – theorems of the Routh test.

UNIT IV FREQUENCY RESPONSE 9

Introduction to frequency response – substitution rule – bode diagrams first order system – first order system in series – control system design by frequency response – bode stability criterion – gain and phase margin – Ziegler-Nichols controller setting.

UNIT V CONTROLLER TUNING 9

Controller tuning and process identification – controller tuning - selection of controller modes – criteria for good control – tuning rules – Ziegler-Nichols rules - precautions in Z-N method – Cohen and Coon rule.

L : 45 L : 15 TOTAL : 60 PERIODS

TEXT BOOK

1. Donald R. Coughanowr, “Process Systems, Analysis and Control”, McGraw Hill International Edition – II , Edition 1991.

REFERENCES

1. Sundaram.S, “Process Dynamics and Control”, Ahuja Publishers, New Delhi, 2002.
2. Dale E.Seborg, Thomas F.Edgar, Duncan A.Mellichamp, “Process Dynamics and Control”, Wiley India, 2004.

EL3404 ELECTROCHEMICAL ENERGY CONVERSION & STORAGE L T P C
3 0 0 3

UNIT I FUNDAMENTALS 9

EMF, reversible cells and irreversible cells, reversible electrodes, relationship between electrical energy and energy content of a cell, free energy changes and emf in cells, relationship between the energy changes accompanying a cell reaction and concentration of the reactants, effect of cell temperature on batteries, derivation of number of electrons involved in a cell reactions, thermodynamic calculation of the capacity of a battery, calculations of energy density of cells, heating effects in batteries, spontaneous reaction in electrochemical cells, pressure development in sealed batteries.

UNIT II FACTORS AFFECTING BATTERY PERFORMANCE 9

Factors affecting battery capacity, voltage level current drain of discharge, types of discharge continuous, intermittent, constant current, constant load, constant power, service life, voltage regulation, changing methods, battery age & storage condition, effect of battery design.

UNIT III STORAGE BATTERIES 9

Principle design construction, advantage and disadvantages. Primary batteries - Zn-MnO_2 system, carbon-zinc and carbon-zinc chlorides performance characteristics and zinc-silver oxide. secondary batteries – lead acid, nickel cadmium, nickel metal hydride, silver oxide zinc system, lithium ion, lithium polymer.

UNIT IV TESTING & EVALUATION 9

Evaluation of active masses, porosity - mercury porosity meter, liquid absorption method, surface area measurement - BET method (nitrogen absorption.), internal resistance of cells - D.C. methods, polarization elimination method. I.E. polarization and flash current method A.C. methods, A.C. impedance method, testing of storage batteries -capacity test -test for retention of charge, vibration test, life test, efficiency test, leakage test for sealed cells, testing of separators, HRD at normal and low temperature.

UNIT V FUEL CELLS & SUPER CAPACITOR 9

Introduction to super capacitors, types of super capacitors, introduction to fuel cells, types of fuel cells and technology development, current versus potential issues.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Mr. Barak, "Electrochemical Power sources", I.E.E. series Peter Peregrinus Ltd. Steverage,U.K 1980 reprint 1997**.**
2. B. E. Conway, "Electrochemical Supercapacitors : Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum publishers, New York, 1999.
3. Linden D and Thomas B.Reddy, "Hand Book on Batteries and Fuel Cell", McGraw Hill Book Co., New York, 3rd Edition, 2002.
4. T.R. Crompton, "Batteries Reference Book", Newners, 3rd Edition, 2002.

REFERENCES

1. J.P. Gabano, "Lithium Batteries", Academic Press, London, 1983
2. G.W. Vinal, Storage Batteries, John Wiley, New York 1955.
3. N. Corey Cahoon and George W. Heise, "Primary Battery (Vol. I & II)", John Wiley, New York, 1971 & 1976 London.

EL3405 ELECTROCHEMICAL MATERIALS SCIENCE L T P C
3 0 0 3

UNIT I FUNDAMENTALS OF SEMICONDUCTORS 9

Semiconductors, n-type and p-type semiconductors, conductivity of semiconductors (no derivation of equations only formulae), applications of semiconductors, photoconductivity, photoconducting materials, electronic transitions in photoconductors, trapping and recombination, general mechanism of photoconductivity, life-time of majority carriers, preparation of CdS photoconductors by the sintering technique, ohmic contacts, fabrication of photo conductive cells and their applications.

UNIT II METHODS OF PREPARATION 9

Thin films of semiconductors, methods of preparation, vacuum evaporation, sputtering, molecular beam epitaxy, hot wall epitaxy, chemical bath deposition, spray pyrolysis, electrodeposition, liquid phase epitaxy, chemical vapour deposition, structural, electrical and optical characterization, mechanical properties of thin films, effect of grain boundaries.

UNIT III SUPERCONDUCTIVITY 9

Superconductivity (only elementary treatment of theories of superconductivity, no derivations), properties of superconducting materials, synthesis of high temperature superconducting materials and their applications.

UNIT IV BASICS OF PHOTOVOLTAICS 9

Basics of photovoltaics (no derivation for (i) minority carrier lifetime (ii) continuity equations and (iii) p-n junction equation or dark characteristics of a diode(iv) photovoltaic effect equation (v) total photocurrent generation in pn solar cell), homo and heterojunctions, preparation of single crystal and polycrystalline silicon solar cells, Metal-Insulator-Metal and semiconductors – Insulator – semiconductors solar cells, photovoltaic measurements, I-V characteristics, spectral response and capacitance measurements.

UNIT V SOLAR CELLS & PHOTO ELECTROCHEMICAL (PEC) CELLS 9

Preparation of CdS/Cu_2S solar cells, amorphous Si solar cells, GaAs solar cells and their characteristics. Semiconductor- electrolyte interface. Photo-electrochemical cells for conversion of light energy to electrical energy. PEC cells based on CdSe, Si and GaAs and their output characteristics. Estimation of flat band potential from Mott-Schottky plots.

TOTAL : 45 PERIODS

TEXT BOOKS

1. M.Arumugan, "Materials Science (Physics of Materials)", Anuradha Agencies, Sept 2002, Third Revised Edition. (Chapter 8 – Superconductors, Chapter 9 – Semiconductors, Unit I & III).
2. B.S Saxena, R.C.Gupta and P.N. Saxena, "Fundamentals of Solid State Physics" , Pragati Prakashan Educational Publishers , Meerut, 1993 (Chapters 17-Photoconductivity, Unit I).
3. K.L. Chopra and S.R.Das, "Thin Film solar cells", Plenum New York, 1983. (Chapter 5 - Thinfilm deposition techniques, Chapter 10 – Photoelectrochemical cells, Unit II & V)
4. R.K.Kotnala and N.P.Singh , "Essentials of solar cells", Allied Publishers P.Ltd., New Delhi, 1986 (Chapter 5 – Continuity Equation for p-n junction and solar Ltd., (Chapter 6 – Solar cell fabrication technology, Chapter 7 – Characterization techniques, Characterization of solar cell, Chapter 8 – More about material, Unit IV & V).

REFERENCES

1. C.Hu and R.M.White, "Solar Cells", McGraw Hill Book Company, New Delhi, 1983
2. A.F.Fahrenbruch and R.H. Bube, "Fundamentals of Solar Cells", Academic Press, London,1983.
3. "Photoelectrochemical Solar Cell", Edited By KSV Santhanam and M.Sharon, Elsevier Science Publishers, New York 1988.
4. A.C.Rose – Innes and E.H.Rhoderick , "Introduction to Superconductivity", Elsevier Science, 1994.

EL3406 ELECTROMETALLURGY AND THERMICS L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Survey of Indian scene of ores and metallurgical industries with special reference to electrometallurgical industries. Preparation of cell feed for copper, zinc, aluminium, magnesium and titanium electrolytic cells. Principles of solvent extraction/ ion exchange for the recovery of metallic values. Pollution and control measures adopted/recommended in electrometallurgical Industries like Al, Mg & Cr.

UNIT II ELECTROCHEMICAL PRINCIPLES 9

Cell voltage and its components- types of anodes and cathodes-necessity of diaphragms. Physicochemical properties of molten & aqueous electrolytes like conductivity, decomposition potential, density etc. Current and energy efficiency- features of aqueous and molten salt electrolysis distinction between electro winning and refining. Anode effect.

UNIT III AQUEOUS SYSTEM 9

Electro winning of zinc, copper and nickel. Operating conditions for electro winning of copper and Nickel. Electro refining of silver, lead and copper- periodic current reversal technique. Electrolytic metal powders-principles, preparation and characterization. Secondary recovery of metals-Importance and approaches with examples of zinc and copper**.**

UNIT IV MOLTEN SALT ELECTROLYSIS 9

Hall-Heroult cell for electrowinning of Aluminium–composition and structure of cryolite electrolyte, Brief discussion on (anodes and) cathode pot construction, and reactions. Start up and operation of Cell- anode effect. Koope's three layer process. Dow, I.G. and other types cells for production of Magnesium. Interference of impurities like moisture and sludge formation. Electrowinning of sodium, calcium, misch metal and titanium. Operating data for production of lithium and zirconium.- refining of titanium.

UNIT V THERMICS 9

Modes of electrical heating. Design criteria of arc furnaces. Description of furnaces used and the process for production of calcium carbide. Calcium silicide, Calcium cyanamide, fused alumina, ferroalloys, phosphorous, graphite and Silicon carbide.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Satya Narain and R. Sharan, "An introduction to Electrometallurgy", Standard Publishers Distributors 1969.
2. H.S. Ray, Sridar and K.P. Abraham, "Extraction of Non-ferrous metals", Affiliated East West press P.Ltd., New Delhi, 1985.
3. Newton J., "Extractive Metallurgy", Wiley New York (1959)

REFERENCES

1. Grjotheim K and Welch B.J., "Aluminium Smelter Technology", Aluminium Verlag, 1982.
2. Strelets Kh.L., "Electrolytic Production of Magnesium", Israel Program of Scientific Translation 1977.
3. S. Venkatachalam, "Hydrometallurgy", Narosa Publishing House, New Delhi , 1998.
4. C.L. Mantell, "Chemical Engineering Series – Industrial Electrochemistry", Mc Graw Hill Co., Inc.London, 1958.
5. Ullman's Encylopedial of Industrial Chemistry, VCH Verlag, Gessellschaff, 1990.

EL3408 ELECTROCHEMICAL ENGINEERING LABORATORY II L T P C
0 0 4 2

BATTERIES:

1. Porosity determination of unformed and formed positive and negative plates by theoretical and experimental methods.
2. Measurement of electrical resistance of battery separators by d.c voltage drop method.
3. Characteristics of lead acid cell/battery during constant current discharge
4. Characteristics of lead acid cell/battery during constant current charge
5. Measurement of internal resistance of a lead acid cell/battery by d.c voltage drop method and graphical methods.

ELECTROCHEMICAL MATERIAL SCIENCE:

1. Chemical deposition of lead sulphide films and determining the thickness of the films deposited.
2. Current voltage characteristics of the given photo-conductive cell in darkness as well as in light and estimation of photosensitivity.
3. Intensity-photocurrent characteristics of the given photoconductive cell for different bias voltage conditions.
4. Power characteristics of the given silicon at specified intensities.
5. Estimation of the diode parameters of a silicon solar cell.
6. Preparation of CdSe films by the electrochemical route and find the growth rate of thickness for different time intervals.
7. Power Characteristics of Photoelectrochemical cell
8. Mott-Schottky plot from capacitance measurements and estimation of the flat-band potential and carrier concentration (Demonstration)

TOTAL : 60 PERIODS

EL3409 ELECTROCHEMICAL ENGINEERING LABORATORY III L T P C
0 0 4 2

INDUSTRIAL METAL FINISHING:

1. Anodizing of Aluminium
2. Electroforming of Metal Foil
3. Hull Cell Studies in Electroplating Bath
4. Throwing Power Studies in Electroplating Bath
5. Nickel Plating
6. Analysis of nickel plating solution

ELECTRO HYDRO METALLURGY:

1. Electro winning of zinc.
2. Electrolytic preparation of copper powder.
3. Determination of limiting current for electrodeposition of copper.
4. Determination of decomposition potential for electrodeposition of copper
5. Stripping and extraction efficiency of D2EHPA for zinc ion.
6. Recovery of metals by ion exchange resins.

TOTAL : 60 PERIODS

EL3410 PROCESS DYNAMICS AND CONTROL LABORATORY L T P C
0 0 4 2

1. Resistance Temperature Detector transmitter
2. Pressure transmitter
3. Level transmitter
4. I/P converter and pneumatic control valve
5. Flow transmitter
6. Direct digital control for pressure control
7. Direct digital control for level control
8. Direct digital control using process temperature analyzer
9. Effect of load disturbance over the bath and controller output action
10. Direct digital control using flow process analyzer

TOTAL : 60 PERIODS

GE3411 ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL L T P C
3 0 0 3

UNIT I GENERAL CONCEPTS OF ENVIRONMENT 9

Introduction, pollution categorization, forms of pollution, air, water and solid; effects of air pollution on human health, materials, eco-system, and plants, ozone depletion, climatic changes, air pollution and its control, solid wastes and their disposal**.**

UNIT II CHARACTERIZATION AND CLASSIFICATION OF WASTES 9

Industrial process water: hardness of water and its effects, volume reduction, strength reduction, classification of wastes, characterization of industrial wastewater, sampling techniques and preservation of effluent.

UNIT III WASTEWATER TREATMENT TECHNIQUE 9

Treatment methods, treatment technique for industrial process water, degree of treatment required, physical, chemical and physico-chemical methods of treatment of industrial effluent neutralization, equalization and proportioning, coagulation, sedimentation, flotation, filtration, ion exchange, absorption, adsorption, oxidation and disinfections. Treatment methods for industrial waste waters, preliminary treatment such as bar screen, grit chamber and sedimentation tank methods, primary secondary and tertiary treatment methods, conventional methods of effluent treatment, biological treatment methods, aerobic and anaerobic oxidation stabilization pond, oxidation pond oxidation ditch and lagoons.

UNIT IV CASE STUDIES 9

General and specific pollution control with respect to a few chemical industries such as tanneries, textile, fertilizer, pickle wastes, petroleum and petrochemical, Soap and detergent and electroplating industries.

UNIT V POLLUTION MANAGEMENT AND CONTROL 9

Effluent management, recycling of industrial wastewater, pollution control boards state and central boards, tolerance limits and specifications, environmental Impact assessment and methodology.

TOTAL : 45 PERIODS

TEXT BOOKS

1. P.C. Jain and Monika Jain, “Engineering Chemistry”, Dhanpat Rai and Sons, New Delhi 1986 (Chapter 1 and 18)
2. M.N. Rao and A.K. Dutta, “Wastewater Treatment”, Oxford and IBH Publishing Co., Delhi 1987.
3. C.S Rao, “Environmental Pollution and Control”, Wiley Eastern Engineering Limited, New Age International, New Delhi 2002.
4. Santosh kumar Garg., “Sewage disposal and Air pollution Engineering: Environmental Engineering”, Vol.II, Khanna publishers, New Delhi 1994.

REFERENCES

1. George Thobanoglous, Franklin L.Burton, “Waste Water Engineering” – Treatment, Disposal, Reuse (Metcalf & Eddy Inc., California),Tata McGraw-Hill Publishing company Limited, New Delhi, 1995.
2. Clair Sawyer, Perry McCarty, Gene Parklin, “Chemistry for Environmental Engineering”, 4th edition 1994.
3. Nelson Leonard Nemerow, “Industrial Water Pollution”: Origins, Characteristics, Treatment Addision –Wesley Education Publishers Inc.1990.
4. Joseph A. Salvato, Nelson Leonard Nemerow frank Agardy, “Environmental Engineering”, John Wiley &Sons Inc(E), 2003

5. Mahajan S.P., “Pollution control in process Industries”, Tata McGraw Hill, New Delhi1998.
6. R.K. Trivedi, “Handbook of Environmental laws, Acts, Guidelines, Compliances and Standards”, Vol. 1, Enviro Media, India, 1996.
7. A.K.De., “Environmental Chemistry”, New Age Intl. pub Co,New Delhi, 1990

EL3414 PROJECT WORK AND VIVA VOCE L T P C
0 0 12 6

PROJECT REPORT

Each student is required to submit a project report on the research and the design and development of Industrial plant selecting the best process with optimum equipment sizes and operating conditions. The Project report will be treated as test of ability of the student to tackle a practical problem in the same way as might be expected of him if he were required to report as a Electrochemical Engineer on a new manufacturing proposal.

VIVA – VOCE

The objects of the viva-voce examination are to test the performance of a student for his attainment for the profession of an Electrochemical Engineer.

TOTAL : 180

CH3001 PROCESS MODELLING AND SIMULATION L T P C
3 0 0 3

UNIT I PRINCIPLES OF MODELING 9
Uses of mathematical models – principles of formulation. Fundamental laws: continuity equations, energy equation, equations of motion, transport equations, equations of state, equilibrium and chemical kinetics, simple examples.

UNIT II HYDRAULIC TANK 9
Simple Hydraulic tank, variable flow hydraulic tank, enclosed tank, adiabatic compression in gas space, mixing vessel, mixing with reaction, reversible reaction, steam jacketed vessel, continuous – flow boiling system.

UNIT III GAS FLOW AND LIQUID FLOW SYSTEMS 9
Gas flow systems – example : three-volume gas flow system, hydraulic transients – between two reservoirs, pumping system, reaction kinetics: general modelling scheme, liquid phase CSTR – radical kinetics – elementary reduction of radical mechanism – rate limiting steps, heterogeneous kinetics – example : autoclave.

UNIT IV EXTRACTION, DISTILLATION AND HEAT EXCHANGER 9

Staged operations : countercurrent extraction, distillation columns – binary distillation. Distributed systems : countercurrent heat exchanger, pipeline gas flow, pipeline flasher process, tubular reactor.

UNIT V ANALOG SIMULATION 9

Analog simulation : Introduction, basic components, operational blocks, simple examples, three CSTR's in series, gravity flow tank, digital simulation : numerical methods – implicit function convergence, numerical integration – Euler, Runge Kutta fourth-order methods. Simple examples : three CSTR's in series, nonisothermal CSTR, binary distillation column, batch reactor.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Luyben W.L : "Process Modeling, Simulation and control for chemical Engineers", McGraw Hill, 1990.
2. Franks, R.G.E : "Modeling and simulation in chemical Engineering", Wiley-Interscience, NewYork, 1971.
3. Ramirez W.F :"Computational methods for process simulation", Butterworths, New York, 1989.

REFERENCE

1. Himmelblau D.M and Bischoff K.B , "Process Analysis and Simulation", Wiley, 1968.

EL3002 RISK ANALYSIS AND HAZOPS L T P C
3 0 0 3

UNIT I INTRODUCTION TO CONSEQUENCE ANALYSIS 9

Risk analysis introduction – quantitative risk assessment – rapid risk analysis – comprehensive risk analysis – emission and dispersion – leak rate calculation – single and two phase flow – dispersion model for dense gas – flash fire – plume dispersion – jet dispersion – toxic dispersion model – evaluation of risk.

UNIT II FIRE AND EXPLOSION MODELS 9

Radiation – tank on fire – flame length – radiation intensity calculation and its effect on plant, people & property radiation VCVCE – explosion due to – over pressure – effects of explosion, risk contour –effects, explosion – BLEVE – jet fire – fire ball.

UNIT III RISK MANAGEMENT AND ISO 14000 9

Overall risk analysis – generation of metrological data – ignition data – population data – consequences analysis and total risk analysis – overall risk contours for different failure sceneries – disaster management plan – emergency planning – on site & off site emergency planning, risk management ISO 14000, EMS models, case studies – marketing terminal, gas processing complex, refinery.

UNIT IV PAST ACCIDENT ANALYSIS 9

Hazard identification – safety audits – checklists – what if analysis – vulnerability models event tree and fault tree analysis. HAZAN, past accident analysis fix borough – Mexico – Bhopal – Madras – Vizag accident analysis.

UNIT V PRINCIPLES OF HAZOP 9

HAZOP – guide word – parameter – deviation – causes – consequences – recommendation - coarse HAZOP study – case studies – pumping system – reactor system – mass transfer system.

TOTAL : 45 PERIODS

TEXT BOOKS

1. K.V. Raghavan and A.A. Khan: "Methodologies in Hazard identification and assessment manual", by CLRI December 1990.
2. V.C. Marshal: "Major Chemical Hazards", Ellis Harwood Ltd., Chichester, U.K. 1987

REFERENCES

1. Frank P. Leis: "Loss prevention in process industries", Vol I: Butter worth –London 1980.
2. A Guide to Hazard Operability Studies – Chemical Industry Safety and Health Council 1977.

EL3003 SAFETY IN CHEMICAL INDUSTRIES L T P C
3 0 0 3

UNIT I INDUSTRIAL SAFETY 9

Industrial safety principles, site selection and plant layout, legal aspects. Design for ventilation, emergency response systems for hazardous goods.

UNIT II HAZARDS OF CHEMICAL INDUSTRY 9

Chemical hazards classification, hazards due to fire, explosion and radiation, reduction of process hazards by plant condition monitoring.

UNIT III HEALTH HAZARDS IN CHEMICAL INDUSTRIES 9

Dangerous occupational diseases, poisoning, dust effect, the biomedical and engineering response to health hazards.

UNIT IV SAFETY IN CONTROL AND INSTRUMENTATION SYSTEMS 9

Engineering control of plants instrumentation. colour codes for pipelines, safety aspects of reactive chemicals.

UNIT V SAFETY IN CHEMICAL PROCESS INDUSTRIES 9

Safety in operations and processes, Runaway reactions unstable products.

TOTAL : 45 PERIODS

TEXT BOOKS

1. T.Yoshida, "Safety of Reactive Chemicals" Vol.1, Elsevier, 1987.
2. William Handely, "Industrial Safety Handbook",., Mc Graw Hill, 2nd Edition 1968.
3. R.V. Betrabet and T.P.S. Rajan, "Safety in Chemical Industry" in Chentech. I,Chem. Engg. Education Development Centre, IIT, Chennai.

REFERENCES

1. H.H. Fawcett & W.S. Wood, "Safety and Accident Prevention in Chemical Operation", 2nd edition, John Wiley & Sons, 1982.
2. "Loss Prevention and safety promotion in Chemical process industries", Vol. III, Published by Institution of Chemical Engineering , U.K. 1983.

EL3004 CHEMICAL PROCESS OPTIMIZATION L T P C
3 0 0 3

UNIT I OPTIMIZATION 11

Introduction ; formulation of objective functions ; fitting models to data; classification of functions ; necessary and sufficient conditions for optimum; unimodal, multimodal functions, analytical methods Lagrange multiplier methods.

UNIT II NUMERICAL METHODS 12

Unimodal functions : Newton's quasi, Newton secant methods, region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; random, grid. Hooke's Nelder and Mead methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant methods.

UNIT III LINEAR AND NON-LINEAR PROGRAMMING 11

Review on basic concepts of LP formulations; simplex methods ; integer, quadratic, geometric and dynamic programming.

UNIT IV APPLICATIONS 11

Heat Transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale systems.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Edgar T.F, Himmelblau D.M, "Optimisation of Chemical Processes", McGraw-Hill Book Co., New York, 1985.
2. Reklaitis G.V, Ravindran A, Ragsdell K.M, "Engineering Optimisation", John Wiley, New York, 1980.

REFERENCES

1. Biles W.E, Swain J.J, "Optimisation and industrial experimentation", Inter Science, New York, 1980.
2. Seinfeld J.H, Lapidus L, "Process Modeling, Estimation and Identification", Prentice Hall, Englewood cliffs, New Jersey, 1974.

CH3005 TRANSPORT PHENOMENA L T P C
3 0 0 3

UNIT I MOMENTUM TRANSPORT 9

Derivation of the basic momentum transport equation – derivation using elementary volume concept and conservation theorems. Equation of continuity and motion – Navier – Stokes and Euler equations of motion in rectangular, cylindrical and spherical co-ordinate systems. Dimensional analysis of equations of change. Analysis of momentum transport using shell balance technique and basic transport equations – types of boundary conditions.

UNIT II MOMENTUM TRANSFER 9

Flow of fluids in thin films, parallel plates, circular tubes and annulus, adjacent flow of two immiscible fluids, couette flow, rotating surface flow and radial flow. Flow near a wall suddenly set in motion.

UNIT III ENERGY TRANSPORT 9

Basic energy transport equations – derivations using elementary volume concept and conservation theorems in different co-ordinate systems. Dimensional analysis of equations of change. Analysis of energy transport using shell balance technique and basic transport equations – types of boundary conditions.

UNIT IV HEAT TRANSFER 9

Conductions with energy sources in fixed bed catalytic reactors and in cooling fins. Forced convection in circular tubes – natural convection from a heated plate. Unsteady state conduction of finite slab.

UNIT V MASS TRANSPORT 9

Continuity equation for a binary mixture and its derivation. Dimensional analysis of equations of change. Analysis of mass transport using shell balance technique and types of boundary conditions. Steady and unsteady state one dimensional diffusion, diffusion in porous catalyst with and without chemical reaction and diffusion in falling liquid film.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Bird R.B, Stewart W.E md Lightfoot E.W, "Tranport Phenomena", John Wiley,(ISE), 2nd Edition, 2002.
2. Brodkey R.S and Hershey H.C, "Transport Phenomena", McGraw Hill(ISE), 1998.

REFERENCES

1. Welty J.R, Wicks C.E and Wilson R.E, "Fundamentals of Momentus, Heat and Mass Transfer", John Wiley, (ISE), 3rd Edition, 1984.
2. Slattery J.S, "Advanced Transport Phenomena", Cambridge University Press, London 1992.
3. Bennet C.O and Meyers J.E, "Momentrum, Heat and Mass Transfer", Tata-McGraw Hill, New Delhi, 3rd Edition, 1983.
4. Geankoplis C.J, "Transport Processes – Momentum, Heat and Mass", Allyn and bacon, Inc, Boston , USA, 1983.

EL3006 PLANT UTILITIES L T P C
3 0 0 3

UNIT I WATER 9

Water resources, treatment and cooling. Storage and distribution of water. Re-use and conservation of water.

UNIT II COMPRESSED AIR & VACUUM 9

Compressors and vacuum pumps – performance characteristics of compressors and vacuum pumps. Boosters. Air receivers. Piping systems. Lubrication. Oil and moisture removal.

UNIT III REFRIGERATION 9

Refrigeration systems and their characteristics. Production of cryogenic temperatures.

UNIT IV AIR CONDITIONING & VENTILATION 9

Characteristics of Air-water systems. Humidification and Dehumidification equipment. Exhaust Ventilation.

UNIT V STEAM 9

Steam generation in chemical process plants. Properties of steam. Boilers and power generation equipment. Steam engines and turbines. Steam handling and distribution. Steam economy. Electric power distribution in process plants.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Bhasin, S.D.: "Project Engineering of Process Plants", Chemical Engineering Education Development Centre, I.I.T., Madras,1979.
2. Davidson, P.J. & West, T.F: "Services for the Chemical Industry", Pergamon Press oxford,1968.
3. "Process Utilities", Chemical Engineering Development Centre, I.I.T., Madras,1986

REFERENCES

1. Perry, R.H & Green, D.W , "Perry's Chemical Engineers' Handbook ", McGraw Hill (ISE), 6th Edition, 1984
2. Cremer, H.W & Watkins, S.B , "Chemical Engineering Practice", Vol.10,Butterworths, London,1960
3. Culp, G.L & Culp, R.L: "New Concepts in water purification", Van Nostrand – Reinhold, New York, 1974
4. Rase, H.F & Barrow, M.H, "Project Engineering of Process Plants", John Wiley,New York, 1957
5. Milter, L.M: "Students Text Book of Heating", Ventilating & Air Conditioning,Technitrade Journals, London, 1976
6. Jennings, B.H: "Environmental Engineering" (Analysis & Practice), International Text Book Co., New York , 1970.
7. Mcquiston, F.C & Parker, J: "Heating, Ventilating & Air conditioning – Analysis and Design", John Wiley, New York , 3rd Edition, 1988.

EL3007 ADVANCED ELECTROCHEMICAL REACTION ENGINEERING L T P C
3 0 0 3

UNIT I FUNDAMENTALS OF ELECTROCHEMICAL REACTION KINETICS 9

Fundamentals of reaction kinetics, rate of electrochemical reaction, thermodynamics-heat of reaction and reaction equilibria, electrochemical thermodynamics, practical cell voltage requirements and polarization. Reactor classification, configuration and production capacity, Basic electrode kinetics, Ideal isothermal reactors: single electrochemical reactions, potentiostatic operations of first order reaction and galvanostatic operation of first order reactions. CSTR with general order reactions, Effect of mass transport and side reaction.

UNIT II PLUG FLOW REACTORS WITH AND WITHOUT MASS TRANSPORT 9

Plug flow and recycle reactors, Kinetics of electrochemical reactions: multistep electrochemical reactions, multistep electrode processes with mass transport, series and parallel reactions, interaction of chemical reaction, electrochemical reactions involving adsorption, electro analytical methods.

UNIT III MULTIPLE ELECTROCHEMICAL REACTIONS 9

Multiple electrochemical reactions with inter-phase mass transport-reaction classification, consecutive reactions, parallel reaction and complex reaction. Potentiostatic and galvanostatic operation of series and parallel electrochemical reactions, reversible reaction. RTD analysis, dispersed plug flow, tank in series model, multi parameter models, reactor dynamics of isothermal CSTR and PFR.

UNIT IV SIMULTANEOUS MASS TRANSFER AND ELECTROCHEMICAL REACTION 9

Simultaneous mass transfer and chemical reaction; mathematical model of interphase mass transport-film model, penetration model, regimes of operation, fast and intermediate chemical reaction. Multiple chemical reaction, multiple electrochemicals and chemical reaction. Batch recycle and continuous recycle operation, multiple fluid phases at the electrode surface and in the electrolyte phase. Reactor for multiple phase reactions.

UNIT V MIGRATION AND CURRENT DISTRIBUTION 9

Migration effects on mass transport, influence of migration in the reactor design, current and potential distribution, primary current distribution, current and potential distribution arising from polarization, three dimensional electrodes, diaphragm cell reactor models, energy balance, heat transfer and technical optimizations.

TOTAL : 45 PERIODS

TEXT BOOK

1. Scott. K, “Electrochemical Reaction Engineering”, Plenum Press, New York, 1991.

REFERENCE

1. Thomas Fahidy, “Principles of Electrochemical Reactor Analysis,” Elsvier science publishers,1981.

EL3008 CHLOR-ALKALI TECHNOLOGY L T P C
3 0 0 3

UNIT I ELECTRODES AND SEPERATORS 9

Anodes, cathodes and separators for chlor – alkali production: graphite, metal anodes, steel cathodes, coated cathodes, gas diffusion cathodes, asbestos diaphragms, improved diaphragms, cation exchange membranes – different types-preparation-characteristics.

UNIT II CONVENTIONAL PROCESSES 9

Diaphragm cell process, different cell designs, deposition of diaphragm, mercury cell process. Different cell designs, reasons for hydrogen evolution in the primary cells, denuder vertical and horizontal types, Design aspects.

UNIT III MODERN PROCESS 9

Membrane cell process, different designs of membrane cell, mono polar and bipolar cells. Conversion of mercury and diaphragm cells to membrane cells. Factors affecting the performance of the membrane cells .

UNIT IV UNIT OPERATIONS 9

Unit operations in chlor-alkali industry, Salt washing, saturation. Brine dechlorination. Primary brine purification. secondary brine purification, caustic concentration. Separation of salt from diaphragm cell liquor, handling of hydrogen, chlorine and caustic, chlorine liquefaction.

UNIT V GENERAL TOPICS 9

Energy conservation in chlor-alkali industry, chlorine utilization. Materials of construction. Electrode protection devices. Environmental pollution and its control. Analytical techniques. Process control and instrumentation. Safety aspects.

TOTAL : 45 PERIODS

TEXT BOOKS

1. "Ullmann's Encyclopedia of Industrial Chemistry" , Vol.6, Weinheim, Wiley Interscience, New York , pp: 399- 481 (1986).
2. Krik – Othmer, " Encyclopedia of Chemical Technology", 4th Edition, Vol : I., Pp 938 1025, (1991).

REFERENCES

1. N.M.Prout And J.S.Moorhouse, "Modern Chlor – Alkali Technology", Elsevier Applied Science, London, Vol. IV, 1990
2. T.Wellington, "Modern Chlor – Alkali Technology" Elsevier Science, Essex , Vol. 5, 1992.

EL3009 CATHODIC PROTECTION ENGINEERING L T P C
3 0 0 3

UNIT I BASIS OF CATHODIC PROTECTION 9

Basis of cathodic protection - working of cathodic protection system - factors leading to corrosion of underground metallic structures - electrical basis of cathodic protection - electrochemical theory of cathodic protection - definition of cathodic protection using Evans diagram and Pourbiax diagram, derivation of protective potential for steel - anodic polarization

UNIT II SACRIFICIAL ANODE SYSTEM 9

Cathodic protection system - components of galvanic systems - galvanic anodes - life, current output - magnesium, aluminium and zinc : electrochemical properties - composition, fields of application :backfills for sacrificial anodes - calculation of current output of sacrificial anodes - calculation of number of anodes - advantages and disadvantages of sacrificial anode system.

UNIT III IMPRESSED CURRENT SYSTEM 9

Impressed current system - power source, cables, rectifier - components of rectifier, types of ground bed - required properties of impressed current anode - major impressed current anodes – high silicon, cast iron, scrap steel, graphite anodes, platinised titanium, platinised Niobium, platinised tantalum, metal oxide anode - lead alloy anode - properties - composition, consumption, fields of application. Backfills for impressed current anodes.

UNIT IV FIELD SURVEY 9

Design parameters in cathodic protection - current requirements - measurements in cathodic protection - field data : soil resistivity measurement - pipe to soil potential data - factors affecting pipe to soil potential - potential survey, pH determination - redox potential measurement, coating resistance, current drainage survey. Measurement of current flow.

UNIT V DESIGNING OF CP SYSTEM 9

Stray current corrosion - sources of stay current - cathodic protection interferences – examples of interferences - design charts - ground bed design with illustrative examples - designing of sacrificial anode system - designing of impressed current system - designing of cathodic protection to ship hull - calculations in cathodic protection design.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Zaki Ahmad, "Principles of Corrosion Engineering and Corrosion Control", Butterworth-Heinemann /IChemE Series, Ist edition, 2006.
2. Marshall E.Parker, Edwar G.Peatitle, "Pipeline Corrosion and Cathodic Protection" Gulf Publishing Company, 3rd edition, 1984.

REFERENCES

1. John H. Morgan, "Cathodic Protection", NACE international, 2nd edition, 1987.
2. Peabody A.N and Blanchetti R.L. , "Control of Pipeline Corrosion", NACE Int., 2nddition, Texas: Houstaon, USA, 2001.

EL3010 METAL COATING TECHNOLOGY L T P C
3 0 0 3

UNIT I ELECTROPLATING 9

Basic physical chemistry , surface chemistry, pretreatment principles – technology and control of electro deposition systems such as alloy plating, electrolysis, composites and non aqueous.

UNIT II HOT DIPCOATING 9

Hot dip coatings – principles, surface preparation, methods, applications, diffusion coatings – principles – cementation – cladding – case hardening – structures.

UNIT III CHEMICAL VAPOR DEPOSITION 9

Chemical vapour deposition – classification-techniques, metal organic type, plasma assisted, layer assisted, applications.

UNIT IV SPUTTERING TECHNIQUES 9

Sputtering techniques, methods, applications, plasma treatments, nitriding – carbonising – boriding, titanizing methods, applications.

UNIT V LASER COATINGS 9

Laser alloying – sources, variables, methods, applications, electron beam coating – evaporation materials, methods, applications.

TOTAL : 45 PERIODS

TEXT BOOKS

1. T.S.Sudarsan, “Surface Modification Technologies”, Editor: Marcel Dekker INC, 1989
2. D.R.Gabe, “Principles of Metal Surfaces Treatment and Protection”, Pergmon Press 1972.

REFERENCES

1. F.A.Lowenheim, “Modern Electroplating”, John Wiley and Sons INC. USA, 3rd Edition, 1974.
2. R.F.Bunshah, “Handbook of deposition technologies for films and coatings, science, technology And applications”, New York Noyes publications, 1994.

EL3011 PROTECTIVE PAINT COATINGS L T P C
3 0 0 3

UNIT I BINDERS, PIGMENTS AND OTHER RAW MATERIALS FOR PAINTS 9

Variable types of binders used in paint making – natural resins – shellac, rosin, oils and rubber-chemistry and properties; preparation and properties of synthetic resins – alkyds, phenolics, vinyls, amino resins, acrylics, epoxies, urethanes and silicones - Pigments and Extenders – Inorganic, organic and metallic pigments and extenders-corrosion inhibiting pigments-properties and functions.

UNIT II SOLVENTS 9

Solvents, additives, plasticizers and driers used in paints – solvency power, toxicity, Kauri-butanol and aniline point values for solvents-various additives and purpose of each considerations in formulation of a paint – concept of Pigment Volume Concentration and volume solids – rheological characteristics of paint – water based paints – composition and properties – factors affecting water dispersibility-Manufacture of paints – ball and pebble mills, attritors, sand and bead mills, three roller mills.

UNIT III TESTING AND EVALUATION OF PAINTS 9

Liquid paints – Instruments involved in each test – fineness of grind, volume solids, specific gravity, viscosity, consistency, wet film thickness, drying time - testing of physical properties – dry film thickness, holiday detection, adhesion, hardness, flexibility, impact resistance, abrasion resistance - testing of corrosion resistance – electrochemical tests, humidity, salt spray, weather resistance, immersion test and field exposure test. Paint film defects – identification and remedial measures.

UNIT IV SURFACE PREPARATION AND APPLICATION OF PAINTS 9

Methods of surface preparation – chemical and mechanical cleaning. Standards covering them and instruments involved. Conversion coatings-phosphating, chromating of ferrous and non-ferrous metals; application of paints – methods – brushing, dipping, roller coating, air spray, airless spray, electrostatic spray.

UNIT V PAINTS FOR FUNCTIONAL APPLICATION 9

Paints for rural atmospheres, industrially polluted atmospheres, marine atmospheres offshore applications, chemical paints, automobiles and air crafts. Coating for pipelines – coatings for concrete, wood and plastics. ceramic coatings , powder coating- principle, basics and application.

TOTAL : 45 PERIODS

TEXTBOOKS

1. R.Lambourne “Paint and Surface Coatings-Theory and Practice” , Woodhead Publishing Ltd,1999.
2. Surface Coating Assoication of Australia, “Surface Coatings , Raw materials and their usage” Chapman & Hall. 3rd Edition, 1993.

REFERENCES

1. Gosta Wranglen, “An Introduction to Corrosion and Protection of Metals”, ECS Princeton,1972.
2. Parker Dean H, ‘Principles of surface coating technology” , ECS Princeton, 1965
3. Willibald Machu, “Handbook of Electropainting Technology”, Electrochemical Publication Limited.1978.

EL3012 ADVANCED COMPUTER PROGRAMMING L T P C
3 0 0 3

UNIT I GETTING STARTED WITH VISUAL BASIC 9

Front end – back end concepts introduction to VB – VB programming environment – objects – properties, methods, events – VB programming fundamentals – modules, data types, variables – public & local variable – control structure – if, then, select… case, do… while loop, for … next loop.

UNIT II CONTROLS AND EVENTS IN VB 9

Creating and using controls – control categories – control properties – control arrays – events associated with controls.

UNIT III DATABASE ACCESSING IN VB 9

Introduction to database –database design – creating and using a data base – DB grid control – creating record set – opening a recordset – modifying a record, creating and using index.

UNIT IV INTRODUCTION TO VC++ 9

VC++ components, Microsoft developer studio, VC++ graphics editor, VC++ and microsoft foundation class library, project creation in VC++, application architecture, design a program.

UNIT V APPLICATION DEVELOPMENT IN VC++ 9

VC++ controls, customizing controls, C static class – styles, introduction to Appwizard, classwizard and the resource editors, database accessing using VC++

TOTAL : 45 PERIODS

TEXT BOOKS

1. Charles Petxold, “Windows Programming” Microsoft Press, 1996.
2. Garry Cornell, “Visual Basic 6.0” from the Ground Up”, TMH, 1999.
3. Steven Holzner, “Visual C++ Programming” Wiley Dream Tech India P.Ltd., 2003

REFERENCES

1. Milk Mekelvy, Jeff Spotts and Brian Siler, “Using Visual Basic 5.0”, Prentice, Hall – India 1998.
2. Bates & Tompleins, “Practical VC++”, Prentice Hall of India, 2002.
3. Muller & John, “Visual C++ from the Ground Up”, 2nd Edition, Tata Mc Graw Hill, 1999.

MA3013 OPERATIONS RESEARCH L T P C
3 0 0 3

UNIT I LINEAR PROGRAMMING 9

Linear programming - introduction, basic feasible solutions graphical method-simplex method-Big-M-method. duality in L.P. integer programming - Gomory's method. Transportation models - methods of solution - assignment algorithm. Game theory - two person zero sum game - pure and mixed strategies, saddle point, maximin and minimax principles - solution of 2 x 2 games without saddle point. Graphical method for 2 x n, m x 2 games dominance property - algebraic method of solution.

UNIT II INVENTORY THEORY 9

Inventory management - inventory, inventory classification, inventory control, its objectives and how to achieve them, inventory factors and their analysis - economic order quantity, single product, dynamic purchase inventory models, inventory models, with infinite shortage cost and uniform demand rate, purchase inventory models with infinite short - age and different demand rates, quantity discounts, Analysis of inventory systems, - ABC analysis.

UNIT III REPLACEMENT THEORY 9

Replacement decisions - introductions - reasons for replacement - factors to be considered for replacement equipments - methods used in selection of alternatives - replacement of items that deteriorate with time - replacement policy with change in money value - without change in money value - replacement of items that fail completely - group replacement policy - limitations of replacement.

UNIT IV QUEING THEORY 9

Queing theory - introduction - waiting line models - characteristics and limitations of queing models – distribution for arrival and service - single channel with finite and infinite population models multi channel models with infinite population.

UNIT V NETWORK ANALSYSIS 9

Network Analysis- introduction - network techniques. Basic concepts and terms related to network planning methods construction of network diagram, P.E.R.T. and C.P.M. techniques and their limitations - CPM techniques - estimating activity time - preparation of analysis table-crashing network application of network techniques of simple engineering problems.

TOTAL : 45 PERIODS

TEXT BOOK

1. Kanti Swaroop, P.K.Gupta and Manmohan, “Operations Research”, Sultan Chand & Sons, New Delhi, 5th Edition, 1990.

REFERENCES

1. Taha.H.A., “Operations Research, An Introduction”, Macmillan, New York, 1976.
2. Paul A Jensen and Jonathan F.Bard “Operations Research Models and Methods, John Wiley & Sons 2003.

EL3014 ELECTROCHEMICAL ENGINEERING L T P C
3 0 0 3

UNIT I BASIC ELECTROCHEMICAL CONCEPTS 9

Introduction and thermodynamic in terms of electrochemical potential-phase equilibrium, chemical and electrochemical potentials, cells with solution of uniform concentration, transport processes in junction regions, cells with a single electrolyte of varying concentration. The electric potential-the electrostatic potential, intermolecular forces, outer and inner potential, potentials of reference electrode, the electric potential in thermodynamics. Activity coefficients-ionic distributions in dilute solutions, electrical contribution to the free energy, measurement of activity coefficients.

UNIT II REFERENCE ELECTRODE AND ELECTRICAL DOUBLE LAYER 9

Reference electrode-criteria of reference electrodes, hydrogen electrode, the calomel electrode and other mercury and mercurous salt electrodes, silver-silver halide electrodes. Potentials of cells with junction- the Nernst equation, types of liquid junctions, cells with liquid junction, potentials across membranes. Structure of the electric double layer-qualitative description of double layers, the Gibbs adsorption isotherm, the Lippmann equation, the diffused part of the double layer. Electrode kinetics, electrokinetic phenomena, Electro capillary phenomena.

UNIT III INFINITELY DILUTE SOLUTIONS AND THERMAL BALANCE 9

Infinitely dilute solutions-transport laws, conductivity, diffusional potential and transference numbers, conservation of charge, binary electrolyte, supporting electrolyte, multicomponent diffusion by elemination of the electric field. Mobilities and diffusion coefficients. Neutrality and Laplace's equation. Concentrated solutions- liquid junction potentials. Thermal effects-thermal diffusion, heat generation, conervation and transfer. Thermogalvanic cells.

UNIT IV TRANSPORT PROPERTIES 9

Transport properties- single and multicomponent solutions. Fluid mechanics-stress in a Newtonian fluid, magnitude of electrical forces. Transport in dilutes solutions, simplification for convective transport, the Graetz problem, two-dimensional diffusion layer in laminar forced convection, axisymmetric diffusion layers in forced convection.

UNIT V POTENTIAL THEORY 9

Application of potential theory- primary and secondary current distribution. Numerical solution. Effect of migration on limiting currents-Correction factors for limiting currents. Concentration variation of supporting electrolyte, limiting currents for free convection. Concentration overpotential-binary electrolyte, supporting electrolyte. Currents below the limiting current.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Newman, J. "Electrochemical Systems", Englewood Cliffs, Prentice Hall,NJ, 1991.
2. Prentice, G. "Electrochemical Engineering Principles", Englewood Cliffs, Prentice Hall, NJ, 1986

REFERENCE

1. Rousar. I, Micka,.K., & Kimla, A., "Electrochemical Engineering I & II", Elsevier,New York, 1986

EL3015 ADVANCED ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE SYSTEMS **L T P C**
3 0 0 3

UNIT I MAINTENANCE FREE LEAD ACID BATTERIES 9

Concept of maintenance free batteries, thermodynamic parameters, current flow, kinetic parameters, heat effects, lead corrosion, water decomposition, self discharge, secondary reactions, internal oxygen cycle, separator, container, value design, manufacturing process, bipolar lab, recycling.

UNIT II NICKEL-BASED BATTERIES 9

Nickel/cadmium, nickel/iron, nickel/zinc, nickel/metal hydride, nickel/hydrogen – thermodynamics, kinetic effects, self discharge, heat effects. Electrode preparation, electrolyte, separator, battery design, parameters influence gas evlolution, Electrochemical behaviour, heat and temperature problems, recycling.

UNIT III LITHIUM BATTERIES 9

Lithium ion, lithium polymer battery, principle, positive and negative materials, electrolyte, separator, reaction mechanism, performance characteristics, manufacturing process, safety, charging techniques**.**

UNIT IV SUPER CAPACITORS 9

Similarities and differences between super capacitors and batteries for storing electrical energy, double layer at capacitor electrode interface, electrochemical capacitors based on pseudo capacitance, Technology development.

UNIT V FUEL CELLS 9

Fuel cell thermodynamics, fuel cell reaction kinetics, fuel cell charge transport, fuel cell mass transport, fuel cell modeling, fuel cell characterization, fuel cell types.

TOTAL : 45 PERIODS

REFERENCES

1. D. Berndt, “Maintenance Free Batteries”, John Wiley & Sons Inc., New York Chichester – Toronto Brishbane – Singapore, 3rd edition, 2003.
2. Tersuya Osaka, Madhav Dutta, “Energy Storage Systems for electronics” Gordon and Breach Science Publishers, Australia, 2000.
3. Ryan O’Hayre, Suk-Won Cha, Whitney Colella, Fritz B.Prinz, “Fuel cell Fundamentals”, John Wiley & Sons, 2nd edition, 2005.

TEXT BOOKS

1. B.D Mc.Nicol and D.A.J Rand, “Power Sources for Electric vehicle”, 1984 Elsevier, Amsterdam-354.
2. M.Barak, “Electrochemical Power sources” Peter Peregrinus Ltd., 216, Newyork,T.R.Crompton, Battery Reference Book, Butterworths, London, 1990.

EL3016 SURFACE ENGINEERING L T P C
3 0 0 3

UNIT I SURFACE CLEANING 9

Classification and selection of cleaning processes – alkaline cleaning – solvent cold cleaning and vapour degreasing – emulsion cleaning - molten salt bath cleaning - ultrasonic cleaning - acid cleaning –mechanical cleaning systems – pickling and descaling.

UNIT II SURFACE MODIFICATION PROCESSES 9

Thermal spray coatings – chemical vapour disposition coating processes – nonsemiconductor Materials – semiconductor materials – plasma-enhanced chemical vapour deposition – physical vapour deposition coating processes – vacuum deposition – reactive evaporation and gas evaporation – sputter deposition – ion plating - ion-beam-assisted deposition – arc deposition – ion implantation – diffusion coatings.

UNIT III SURFACE ENGINEERING OF FERROUS & NON FERROUS METALS 9

Cast irons – carbon and alloy steels – stainless steel – specialty steels – heat-resistant alloys –aluminium and aluminium alloys – copper and copper alloys – magnesium alloys – titanium and titanium alloys – nickel and nickel alloys.

UNIT IV TESTING AND CHARACTERIZATION OF COATINGS AND THIN FILMS 9

Film thickness measurements using optical techniques – corrosion testing – evaluation of mechanical properties of thin films – stress determination of coatings –testing of stability and thermal properties of thermal barrier coatings – surface and interface analysis of coatings and thin films

UNIT V ENVIRONMENTAL PROTECTION ISSUES 9

Environmental regulation of surface engineering – cadmium elimination – vapour degreasing alternatives – compliant organic coatings – compliant wipe solvent cleaners.

TOTAL : 45 PERIODS

TEXT BOOK

1. “ASM Handbook, Vol.5, Surface Engineering”, ASM International, 1994.

EL3017 ORGANIC ELECTROCHEMISTRY L T P C
3 0 0 3

UNIT I CATHODIC REACTIONS OF ORGANIC COMPOUNDS 9

Principles and methods, synthetic and mechanistic aspects of cathodic reactions of organic compounds classified by electrophores, hydrocarbons, halogenated organic compounds, nitro and related compounds, carbonyl compounds, azomethine compounds.

UNIT II ANODIC REACTIONS OF ORGANIC COMPOUNDS 9

Synthetic and mechanistic aspects of anodic reactions of organic compounds classified by electrophores, anodic oxidation of hydrocarbon, carboxylic acids, nitrogen-containing compounds, oxygen-containing compounds, sulphur-containing compounds, electrochemistry of certain comprehensive classes of compounds, electrolysis of heterocyclic compounds, natural products and pharmaceuticals, biomass, organoelemental and coordination compounds.

UNIT III CLASSIFICATIONS OF ELECTRODE REACTIONS 9

Electrode reactions classified by reaction type, reductive coupling, oxidative coupling, cleavages and deprotection, anodic substitution, anodic fluorination.

UNIT IV STEREOCHEMISTRY OF ELECTROCHEMICAL PROCESSES 9

Stereochemistry of organic electrode processes, amalgam and related reductions, electrogenerated reagents, electrogenerated acids and bases.

UNIT V INDUSTRIAL APPLICATIONS OF ELECTRO ORGANIC CHEMISTRY 9

Present and future applications, industrial electroorganic chemistry, electrochemical polymerization, chemically modified electrodes and conducting polymers, photoelectrochemistry, paired electrosynthesis.

TOTAL : 45 PERIODS

TEXT BOOK

1. Henning Laud, Manuel M. Baizer, "Organic Electrochemistry", Marcel Dekker, INC, New York, 1991.

REFERENCES

1. D.E.Danly "Emerging opportunities for electro organic process", Marcel Dekker, New York,1984.
2. S.Torii "Electro organic synthesis", Kodansha / VCH, Weinheim 1985.

EL3018 METAL FINISHING L T P C

3 0 0 3

UNIT I SURFACE PREPARATION AND BASICS OF ELECTRO DEPOSITION 9

Faradays Laws – current efficiency – anodic and cathodic, electrode potential – Nernst equation, reference electrode – polarisation of electrodes over voltage reactions. Metal discharge from simple and complex salts. pre-treatment – mechanical – polishing – buffing, buffing wheels – design – operation – belt polishing – blast finishing with glass beads – barrel polishing. Chemical – surface preparation: vapor degreasing – ultrasonic cleaning – pickling – rinsing – preparation of basis metals for plating.

UNIT II EVALUATION OF ELECTRO DEPOSITS 9

Plating bath constituents – types of formulations – acid – alkaline etc role of constituents – operating conditions CD, temperature and addition agents etc. anodes – anode dissolutions – trouble shooting – stripping analysis. Testing of Electro deposits for thickness, adhesion, stress, corrosion, porosity, hardness, ductility and solderability. The use of Hull-cell in plating. Measurements of pH, specific gravity, surface tension, conductivity, throwing power and current efficiency of electroplating electrolytes.

UNIT III ELECTROPLATING OF ALLOYS AND OTHER PLATING METHODS 9

Alloy plating principles – deposition of Brass, Palladium – Nickel and lead tin alloys electroforming – principles – pretreatments, operating conditions – application with respect to copper and nickel electroless plating – principles application operating condition for copper, tin, nickel, and gold. Heavy deposition of chromium. Barrel plating principle and application, Continuous plating with respect to Zn and Sn. Brush plating. Hot dipping, Spraying, Cladding and Vapour deposition.

UNIT IV ANODIZING 9

Anodizing: Anodizing of Aluminium, Principles, pretreatment, jigging. Sulphuric acid process, operating conditions for decorative and protective anodizing, effect of impurities, analysis for free acid and aluminium content, chromic acid process, operating conditions, effect of impurities, colouring of anodized aluminium with organic dyes. Sealing in hot water and dichromate solution. Testing of anodic film thickness by Eddy current method and stripping method, coating weight – coating ratio.

UNIT V ENGINEERING ASPECTS OF ELECTRO DEPOSITION 9

Engineering aspects: Equipment selection – rectifiers – pretreatment equipments – mechanical and chemical, automation, flooring materials for tanks and linings. Ventilation, air pollution – rack design – bus bars. Filtration purification agitation. Heater design – cooling of electrolytes. Effluent treatment and pollution control, costing.

TOTAL : 45 PERIODS

TEXT BOOKS

1. F.A. Lowenheim, "Modern Electroplating", John Wiley and Sons Inc. USA, 3rd Ed., 1963.
2. Durney L.J, "Electroplating Engineering Hand Book", Springer, 4th edition, 1984.
3. E.Ranb and K.Miller, "Fundamentals of metal deposition" Elsevier Publishing company, NewYork, 1967.

REFERENCES

1. "Metal Finishing Guidebook and Directory", USA, Metal & Plastic Publications, 1970
2. Foulke and Crane, "Electro Plater's Process Control" Hand Book, Reinhold Publishers, 1963.
3. V.F. Henley, "Anodic Oxidation of Metals", Pergamon ,1st edition, 1982.