ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

R - 2013

B. TECH. CHEMICAL AND ELECTROCHEMICAL ENGINEERING

PROGRAMME OBJECTIVES:

1. To produce employable graduates with the knowledge and competency in Chemical and electrochemical engineering complemented by the appropriate skills and attributes.
2. To produce creative and innovative graduates with design and soft skills to carry out various problem solving tasks.
3. To enable the students to work as teams on multidisciplinary projects with effective communication skills, individual, supportive and leadership qualities with the right attitudes and ethics.
4. To produce graduates who possess interest in research and lifelong learning, as well as continuously striving for the forefront of technology.
5. To enable the students to set up models for an electrochemical system, based on continuity equations and transport equations for relevant variables, and with necessary boundary conditions.

PROGRAMME OUTCOMES:

The graduates of this programme would have

1. Ability to implement equations for production and transport of heat in electrochemical systems, and explain the temperature dependence of electrode potentials, electrode kinetics and mass transport properties.
2. Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3. Ability implement models for current distribution in porous electrodes.
4. Understanding of professional and ethical responsibility.
5. Recognition of the need and ability to engage in life-long learning.

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AFFILIATED INSTITUTIONS

R - 2013

B. TECH. CHEMICAL AND ELECTROCHEMICAL ENGINEERING

I – VIII SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER – I

CODE	COURSE TITLE	L	T	P	C
THEORY					
HS6151	Technical English – I	3	1	0	4
MA6151	Mathematics – I	3	1	0	4
PH6151	Engineering Physics – I	3	0	0	3
CY6151	Engineering Chemistry – I	3	0	0	3
GE6151	Computer Programming	3	0	0	3
GE6152	Engineering Graphics	2	0	3	4
PRACTICAL					
GE6161	Computer Practices Laboratory	0	0	3	2
GE6162	Engineering Practices Laboratory	0	0	3	2
GE6163	Physics and Chemistry Laboratory - I	0	0	2	1
	TOTAL	**17**	**2**	**11**	**26**

SEMESTER – II

CODE	COURSE TITLE	L	T	P	C
THEORY					
HS6251	Technical English – II	3	1	0	4
MA6251	Mathematics – II	3	1	0	4
PH6251	Engineering Physics – II	3	0	0	3
CY6251	Engineering Chemistry – II	3	0	0	3
GE6252	Basic Electrical and Electronics Engineering	4	0	0	4
GE6253	Engineering Mechanics	3	1	0	4
PRACTICAL					
GE6261	Computer Aided Drafting and Modeling Laboratory	0	1	2	2
GE6262	Physics and Chemistry Laboratory - II	0	0	2	1
GE6263	Computer Programming Laboratory	0	1	2	2
		19	**5**	**6**	**27**

SEMESTER – III

CODE	COURSE TITLE	L	T	P	C
THEORY					
MA6351	Transforms and Partial Differential Equations	3	1	0	4
EL6301	Molecular Physical Chemistry	3	0	0	3
EL6302	Organic Chemistry	3	0	0	3
CH6359	Inorganic Chemistry	3	0	0	3
EL6303	Chemical Process Calculations	3	0	0	3
EL6404	Fluid Mechanics	3	0	0	3
PRACTICALS					
CH6312	Physical Chemistry Laboratory	0	0	3	2
CH6367	Inorganic and Organic Chemistry Laboratory	0	0	3	2
EE6368	Electrical and Electronics Engineering Laboratory	0	0	3	2
	TOTAL	**18**	**1**	**9**	**25**

SEMESTER – IV

CODE	COURSE TITLE	L	T	P	C
THEORY					
MA6459	Numerical Methods	3	1	0	4
CH6455	Chemical Engineering Thermodynamics	3	1	0	4
EL6401	Chemical Reaction Engineering	3	0	0	3
CH6460	Materials Technology	3	0	0	3
EL6402	Heat Transfer and its Applications	3	0	0	3
EL6403	Principles of Electrochemistry	3	0	0	3
PRACTICALS					
EL6411	Fluid Mechanics Laboratory	0	0	3	2
CH6512	Mechanical Operations Laboratory	0	0	3	2
GE6674	Communication and Soft Skills - Laboratory Based	0	0	4	2
	TOTAL	**18**	**2**	**10**	**26**

SEMESTER – V

CODE	COURSE TITLE	L	T	P	C
THEORY					
EL6501	Corrosion Science & Engineering	3	0	0	3
EL6502	Chemical Process Technology	3	0	0	3
CH6557	Mass Transfer I	3	0	0	3
EL6505	Instrumental Methods of Analysis	3	0	0	3
EL6503	Electrodics and Electrocatalysis	3	0	0	3
EL6504	Electrochemical Reaction Engineering	3	1	0	4
PRACTICALS					
EL6511	Chemical Reaction Engineering Laboratory	0	0	3	2
PC6612	Heat and Mass Transfer Laboratory	0	0	3	2
EL6513	Electrochemical Reaction Engineering Laboratory	0	0	3	2
	TOTAL	**18**	**1**	**9**	**25**

SEMESTER – VI

CODE	COURSE TITLE	L	T	P	C
THEORY					
EL6601	Electrochemical Materials Science	3	0	0	3
CH6653	Mass Transfer II	3	0	0	3
EL6602	Industrial Metal Finishing	3	0	0	3
EL6603	Instrumentation	3	0	0	3
EL6604	Electrochemical Process Technology	3	0	0	3
EL6605	Process Dynamics and Control	3	1	0	4
PRACTICALS					
EL6611	Equipment Design	0	0	3	2
EL6612	Computer Applications in Chemical Engineering Laboratory	0	0	3	2
EL6613	Corrosion and Metal Finishing Laboratory	0	0	3	2
	TOTAL	**18**	**1**	**9**	**25**

SEMESTER – VII

CODE	COURSE TITLE	L	T	P	C
THEORY					
CH6751	Process Modeling and Simulation	3	0	0	3
EL6701	Process Synthesis and Design	3	0	0	3
GE6351	Environmental Science and Engineering	3	0	0	3
EL6703	Transport Phenomena	3	0	0	3
EL6702	Electrometallurgy and Thermics	3	0	0	3
	Elective I	3	0	0	3
PRACTICALS					
EL6711	Batteries and Electrochemical Materials Science Laboratory	0	0	3	2
EL6712	Electrochemicals and Electro Metallurgy Laboratory	0	0	3	2
EL6713	Process Dynamics and Control Laboratory	0	0	3	2
	TOTAL	**18**	**0**	**9**	**24**

SEMESTER – VIII

CODE	COURSE TITLE	L	T	P	C
THEORY					
EL6801	Electrochemical Energy Conversion and Storage	3	0	0	3
EL6802	Surface Science	3	0	0	3
	Elective –II	3	0	0	3
PRACTICALS					
EL6811	Project Work	0	0	12	6
	TOTAL	**9**	**0**	**12**	**15**

TOTAL NO OF CREDITS : 193

LIST OF ELECTIVES

B. TECH. CHEMICAL AND ELECTROCHEMICAL ENGINEERING

ELECTIVE I

CODE	COURSE TITLE	L	T	P	C
CH6018	Process Plant Utilities	3	0	0	3
EL6001	Optimization of Chemical Processes	3	0	0	3
EL6002	Advanced Electrochemical Reaction Engineering	3	0	0	3
EL6003	Total Quality Management and Engineering Economics	3	0	0	3

ELECTIVE II

CODE	COURSE TITLE	L	T	P	C
EL6004	Chlor – Alkali Technology	3	0	0	3
EL6005	Cathodic Protection & Electrophoretic Coatings	3	0	0	3
EL6006	Functional Materials	3	0	0	3
EL6007	Organic Electrochemistry	3	0	0	3

HS6151 **TECHNICAL ENGLISH – I** **L T P C**
3 1 0 4

OBJECTIVES:

- To enable learners of Engineering and Technology develop their basic communication skills in English.
- To emphasize specially the development of speaking skills amongst learners of Engineering and Technology.
- To ensure that learners use the electronic media such as internet and supplement the learning materials used in the classroom.
- To inculcate the habit of reading and writing leading to effective and efficient communication.

UNIT I **9+3**

Listening - Introducing learners to GIE - Types of listening - Listening to audio (verbal & sounds); Speaking - Speaking about one's place, important festivals etc. – Introducing oneself, one's family / friend; Reading - Skimming a reading passage – Scanning for specific information - Note-making; Writing - Free writing on any given topic (My favourite place / Hobbies / School life, etc.) - Sentence completion - Autobiographical writing (writing about one's leisure time activities, hometown, etc.); Grammar - Prepositions - Reference words - Wh-questions - Tenses (Simple); Vocabulary - Word formation - Word expansion (root words / etymology); E-materials - Interactive exercises for Grammar & Vocabulary - Reading comprehension exercises - Listening to audio files and answering questions.

UNIT II **9+3**

Listening - Listening and responding to video lectures / talks; Speaking - Describing a simple process (filling a form, etc.) - Asking and answering questions - Telephone skills – Telephone etiquette; Reading – Critical reading - Finding key information in a given text - Sifting facts from opinions; Writing - Biographical writing (place, people) - Process descriptions (general/specific) - Definitions - Recommendations – Instructions; Grammar - Use of imperatives - Subject-verb agreement; Vocabulary - Compound words - Word Association (connotation); E-materials - Interactive exercises for Grammar and Vocabulary - Listening exercises with sample telephone conversations / lectures – Picture-based activities.

UNIT III **9+3**

Listening - Listening to specific task - focused audio tracks; Speaking - Role-play – Simulation - Group interaction - Speaking in formal situations (teachers, officials, foreigners); Reading - Reading and interpreting visual material; Writing - Jumbled sentences - Coherence and cohesion in writing - Channel conversion (flowchart into process) - Types of paragraph (cause and effect / compare and contrast / narrative / analytical) - Informal writing (letter/e-mail/blogs) - Paraphrasing; Grammar - Tenses (Past) - Use of sequence words - Adjectives; Vocabulary - Different forms and uses of words, Cause and effect words; E-materials - Interactive exercises for Grammar and Vocabulary - Excerpts from films related to the theme and follow up exercises - Pictures of flow charts and tables for interpretations.

UNIT IV **9+3**

Listening - Watching videos / documentaries and responding to questions based on them; Speaking - Responding to questions - Different forms of interviews - Speaking at different types of interviews; Reading - Making inference from the reading passage - Predicting the content of a reading passage; Writing - Interpreting visual materials (line graphs, pie charts etc.) - Essay writing – Different types of essays; Grammar - Adverbs – Tenses – future time reference; Vocabulary - Single word substitutes - Use of abbreviations and acronyms; E-materials - Interactive exercises for Grammar and Vocabulary - Sample interviews - film scenes - dialogue writing.

UNIT V **9+3**

Listening - Listening to different accents, Listening to Speeches/Presentations, Listening to broadcast and telecast from Radio and TV; Speaking - Giving impromptu talks, Making

presentations on given topics; Reading - Email communication - Reading the attachment files having a poem/joke/proverb - Sending their responses through email; Writing - Creative writing, Poster making; Grammar - Direct and indirect speech; Vocabulary - Lexical items (fixed / semi fixed expressions); E-materials - Interactive exercises for Grammar and Vocabulary - Sending emails with attachment – Audio / video excerpts of different accents - Interpreting posters.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

Learners should be able to

- Speak clearly, confidently, comprehensibly, and communicate with one or many listeners using appropriate communicative strategies.
- Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.
- Read different genres of texts adopting various reading strategies.
- Listen/view and comprehend different spoken discourses/excerpts in different accents

TEXT BOOKS:

1. Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai. 2011

REFERENCES:

1. Raman, Meenakshi & Sangeetha Sharma. Technical Communication: Principles and Practice. Oxford University Press, New Delhi. 2011.
2. Regional Institute of English. English for Engineers. Cambridge University Press, New Delhi. 2006.
3. Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi. 2005
4. Rutherford, Andrea. J Basic Communication Skills for Technology. Pearson, New Delhi. 2001.
5. Viswamohan, Aysha. English for Technical Communication. Tata McGraw-Hill, New Delhi. 2008.

EXTENSIVE Reading (Not for Examination)

1. Kalam, Abdul. Wings of Fire. Universities Press, Hyderabad. 1999.

WEBSITES:

1. http://www.usingenglish.com
2. http://www.uefap.com

TEACHING METHODS:

- Lectures
- Activities conducted individually, in pairs and in groups like self introduction, peer introduction, group poster making, grammar and vocabulary games, etc.
- Discussions
- Role play activities
- Short presentations
- Listening and viewing activities with follow up activities like discussion, filling up worksheets, writing exercises (using language lab wherever necessary/possible) etc.

EVALUATION PATTERN:

Internal assessment: 20%

3 tests of which two are pen and paper tests and the other is a combination of different modes of assessment like

- Project
- Assignment
- Reviews
- Creative writing
- Poster making, etc.

All the four skills are to be tested with equal weightage given to each.

- ✓ Speaking assessment: Individual speaking activities, Pair work activities like role play, Interview, Group discussions
- ✓ Reading assessment: Reading passages with comprehension questions graded from simple to complex, from direct to inferential
- ✓ Writing assessment: Writing paragraphs, essays etc. Writing should include grammar and vocabulary.
- ✓ Listening/Viewing assessment: Lectures, dialogues, film clippings with questions on verbal as well as audio/visual content.

End Semester Examination: 80%

MA6151 MATHEMATICS – I L T P C
3 1 0 4

OBJECTIVES:

- To develop the use of matrix algebra techniques this is needed by engineers for practical applications.
- To make the student knowledgeable in the area of infinite series and their convergence so that he/ she will be familiar with limitations of using infinite series approximations for solutions arising in mathematical modeling.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To introduce the concepts of improper integrals, Gamma, Beta and Error functions which are needed in engineering applications.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues and eigenvectors – Statement and applications of Cayley-Hamilton Theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II SEQUENCES AND SERIES 9+3

Sequences: Definition and examples – Series: Types and Convergence – Series of positive terms – Tests of convergence: Comparison test, Integral test and D'Alembert's ratio test – Alternating series – Leibnitz's test – Series of positive and negative terms – Absolute and conditional convergence.

UNIT III APPLICATIONS OF DIFFERENTIAL CALCULUS 9+3

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes - Evolute as envelope of normals.

UNIT IV DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES 9+3

Limits and Continuity – Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian and properties – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT V MULTIPLE INTEGRALS 9+3

Double integrals in cartesian and polar coordinates – Change of order of integration – Area enclosed by plane curves – Change of variables in double integrals – Area of a curved surface - Triple integrals – Volume of Solids.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- This course equips students to have basic knowledge and understanding in one fields of materials, integral and differential calculus.

TEXT BOOKS:

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
2. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, 2011.

REFERENCES:

1. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., 2011.
2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012.
3. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
4. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2008.
5. Sivarama Krishna Das P. and Rukmangadachari E., "Engineering Mathematics", Volume I, Second Edition, PEARSON Publishing, 2011.

PH6151 ENGINEERING PHYSICS – I L T P C
3 0 0 3

OBJECTIVES:

- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I CRYSTAL PHYSICS

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Diamond and graphite structures (qualitative treatment) - Crystal growth techniques –solution, melt (Bridgman and Czochralski) and vapour growth techniques (qualitative)

UNIT II PROPERTIES OF MATTER AND THERMAL PHYSICS 9

Elasticity- Hooke's law - Relationship between three modulii of elasticity (qualitative) – stress - strain diagram – Poisson's ratio –Factors affecting elasticity –Bending moment – Depression of a cantilever –Young's modulus by uniform bending- I-shaped girders

Modes of heat transfer- thermal conductivity- Newton's law of cooling - Linear heat flow – Lee's disc method – Radial heat flow – Rubber tube method – conduction through compound media (series and parallel)

UNIT III QUANTUM PHYSICS 9

Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory – Compton effect. Theory and experimental verification – Properties of Matter waves – G.P Thomson experiment -Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box - Electron microscope - Scanning electron microscope - Transmission electron microscope.

UNIT IV ACOUSTICS AND ULTRASONICS 9

Classification of Sound- decibel- Weber–Fechner law – Sabine's formula- derivation using growth and decay method – Absorption Coefficient and its determination –factors affecting acoustics of buildings and their remedies.

Production of ultrasonics by magnetostriction and piezoelectric methods - acoustic grating - Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C –scan displays, Medical applications - Sonogram

UNIT V PHOTONICS AND FIBRE OPTICS 9

Spontaneous and stimulated emission- Population inversion -Einstein's A and B coefficients - derivation. Types of lasers – Nd:YAG, CO_2, Semiconductor lasers (homojunction & heterojunction)- Industrial and Medical Applications.

Principle and propagation of light in optical fibres – Numerical aperture and Acceptance angle - Types of optical fibres (material, refractive index, mode) – attenuation, dispersion, bending - Fibre Optical Communication system (Block diagram) - Active and passive fibre sensors- Endoscope.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will have knowledge on the basics of physics related to properties of matter, optics, acoustics etc., and they will apply these fundamental principles to solve practical problems related to materials used for engineering applications.

TEXT BOOKS:

1. Arumugam M. Engineering Physics. Anuradha publishers, 2010
2. Gaur R.K. and Gupta S.L. Engineering Physics. Dhanpat Rai publishers, 2009
3. Mani Naidu S. Engineering Physics, Second Edition, PEARSON Publishing, 2011.

REFERENCES:

1. Searls and Zemansky. University Physics, 2009
2. Mani P. Engineering Physics I. Dhanam Publications, 2011
3. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009
4. Palanisamy P.K. Engineering Physics. SCITECH Publications, 2011
5. Rajagopal K. Engineering Physics. PHI, New Delhi, 2011
6. Senthilkumar G. Engineering Physics I. VRB Publishers, 2011.

CY6151 ENGINEERING CHEMISTRY - I L T P C
3 0 0 3

OBJECTIVES:

- To make the students conversant with basics of polymer chemistry.
- To make the student acquire sound knowledge of second law of thermodynamics and second law based derivations of importance in engineering applications in all disciplines.
- To acquaint the student with concepts of important photophysical and photochemical processes and spectroscopy.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- To acquaint the students with the basics of nano materials, their properties and applications.

UNIT I POLYMER CHEMISTRY 9

Introduction: Classification of polymers – Natural and synthetic; Thermoplastic and Thermosetting. Functionality – Degree of polymerization. Types and mechanism of polymerization: Addition (Free Radical, cationic and anionic); condensation and copolymerization. Properties of polymers: Tg, Tacticity, Molecular weight – weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension. Preparation, properties and uses of Nylon 6,6, and Epoxy resin.

UNIT II CHEMICAL THERMODYNAMICS 9

Terminology of thermodynamics - Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Clausius inequality. Free energy and work function: Helmholtz and Gibbs free energy functions (problems); Criteria of spontaneity; Gibbs-Helmholtz equation (problems); Clausius-Clapeyron equation; Maxwell relations – Van't Hoff isotherm and isochore(problems).

UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9

Photochemistry: Laws of photochemistry - Grotthuss–Draper law, Stark–Einstein law and Lambert-Beer Law. Quantum efficiency – determination- Photo processes - Internal Conversion, Inter-system crossing, Fluorescence, Phosphorescence, Chemiluminescence and Photo-sensitization. Spectroscopy: Electromagnetic spectrum - Absorption of radiation – Electronic, Vibrational and rotational transitions. UV-visible and IR spectroscopy – principles, instrumentation (Block diagram only).

UNIT IV PHASE RULE AND ALLOYS 9

Phase rule: Introduction, definition of terms with examples, One Component System- water system - Reduced phase rule - Two Component Systems- classification – lead-silver system, zinc-magnesium system. Alloys: Introduction- Definition- Properties of alloys- Significance of alloying, Functions and effect of alloying elements- Ferrous alloys- Nichrome and Stainless steel – heat treatment of steel; Non-ferrous alloys – brass and bronze.

UNIT V NANOCHEMISTRY 9

Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Nanoparticles: nano cluster, nano rod, nanotube(CNT) and nanowire. Synthesis: precipitation, thermolysis, hydrothermal, solvothermal, electrode position, chemical vapour deposition, laser ablation; Properties and applications

TOTAL :45 PERIODS

OUTCOMES:

- The knowledge gained on polymer chemistry, thermodynamics. spectroscopy, phase rule and nano materials will provide a strong platform to understand the concepts on these subjects for further learning.

TEXT BOOKS:

1. Jain P.C. and Monica Jain, “Engineering Chemistry”, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2010
2. Kannan P., Ravikrishnan A., “Engineering Chemistry”, Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009

REFERENCES:

1. Dara S.S, Umare S.S, “Engineering Chemistry”, S. Chand & Company Ltd., New Delhi 2010
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2008.
3. Gowariker V.R. , Viswanathan N.V. and JayadevSreedhar, “Polymer Science”, New Age International P (Ltd.,), Chennai, 2006.
4. Ozin G. A. and Arsenault A. C., “Nanochemistry: A Chemical Approach to Nanomaterials”, RSC Publishing, 2005.

GE6151 COMPUTER PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

The students should be made to:

- Learn the organization of a digital computer.
- Be exposed to the number systems.
- Learn to think logically and write pseudo code or draw flow charts for problems.
- Be exposed to the syntax of C.
- Be familiar with programming in C.
- Learn to use arrays, strings, functions, pointers, structures and unions in C.

UNIT I INTRODUCTION 8

Generation and Classification of Computers- Basic Organization of a Computer –Number System – Binary – Decimal – Conversion – Problems. Need for logical analysis and thinking – Algorithm – Pseudo code – Flow Chart.

UNIT II C PROGRAMMING BASICS 10

Problem formulation – Problem Solving - Introduction to ‘ C’ programming –fundamentals – structure of a ‘C’ program – compilation and linking processes – Constants, Variables – Data Types – Expressions using operators in ‘C’ – Managing Input and Output operations – Decision Making and Branching – Looping statements – solving simple scientific and statistical problems.

UNIT III ARRAYS AND STRINGS 9

Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays. String- String operations – String Arrays. Simple programs- sorting- searching – matrix operations.

UNIT IV FUNCTIONS AND POINTERS 9

Function – definition of function – Declaration of function – Pass by value – Pass by reference – Recursion – Pointers - Definition – Initialization – Pointers arithmetic – Pointers and arrays- Example Problems.

UNIT V STRUCTURES AND UNIONS 9

Introduction – need for structure data type – structure definition – Structure declaration – Structure within a structure - Union - Programs using structures and Unions – Storage classes, Pre-processor directives.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Design C Programs for problems.
- Write and execute C programs for simple applications.

TEXTBOOKS:

1. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", First Edition, Oxford University Press, 2009
3. Yashavant P. Kanetkar. " Let Us C", BPB Publications, 2011.

REFERENCES:

1. Byron S Gottfried, "Programming with C", Schaum's Outlines, Second Edition, Tata McGraw-Hill, 2006.
2. Dromey R.G., "How to Solve it by Computer", Pearson Education, Fourth Reprint, 2007.
3. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006.
4. Dr. M. Rajaram and P. Uma Maheswari, "Computer Programming with C", Pearson, 2014.

GE6152 ENGINEERING GRAPHICS L T P C
2 0 3 4

OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREE HAND SKETCHING 5+9

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves, Scales: Construction of Diagonal and Vernier scales.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 5+9

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and

traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 5+9

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+9

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+9

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method .

COMPUTER AIDED DRAFTING (Demonstration Only) 3

Introduction to drafting packages and demonstration of their use.

TOTAL : 75 PERIODS

OUTCOMES:

On Completion of the course the student will be able to:

- Perform free hand sketching of basic geometrical constructions and multiple views of objects.
- Do orthographic projection of lines and plane surfaces.
- Draw projections and solids and development of surfaces.
- Prepare isometric and perspective sections of simple solids.
- Demonstrate computer aided drafting.

TEXT BOOK:

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.

REFERENCES:

1. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
3. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2009.
4. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.
5. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009.
6. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.

4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

GE6161 COMPUTER PRACTICES LABORATORY L T P C
0 0 3 2

OBJECTIVES:

The student should be made to:

- Be familiar with the use of Office software.
- Be exposed to presentation and visualization tools.
- Be exposed to problem solving techniques and flow charts.
- Be familiar with programming in C.
- Learn to use Arrays, strings, functions, structures and unions.

LIST OF EXPERIMENTS:

1. Search, generate, manipulate data using MS office/ Open Office
2. Presentation and Visualization – graphs, charts, 2D, 3D
3. Problem formulation, Problem Solving and Flowcharts
4. C Programming using Simple statements and expressions
5. Scientific problem solving using decision making and looping.
6. Simple programming for one dimensional and two dimensional arrays.
7. Solving problems using String functions
8. Programs with user defined functions – Includes Parameter Passing
9. Program using Recursive Function and conversion from given program to flow chart.
10. Program using structures and unions.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Apply good programming design methods for program development.
- Design and implement C programs for simple applications.
- Develop recursive programs.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Standalone desktops with C compiler 30 Nos.
(or)
Server with C compiler supporting 30 terminals or more.

GE6162 ENGINEERING PRACTICES LABORATORY L T P C
0 0 3 2

OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 9

Buildings:

(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise:
Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.
(b) Hands-on-exercise:

Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 13

Welding:

(a) Preparation of arc welding of butt joints, lap joints and tee joints.
(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning
(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:
(b) Model making – Trays, funnels, etc.
(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
(b) Foundry operations like mould preparation for gear and step cone pulley.
(c) Fitting – Exercises – Preparation of square fitting and vee – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE 10

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE 13

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EOR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to fabricate carpentry components and pipe connections including plumbing works.
- Ability to use welding equipments to join the structures.
- Ability to fabricate electrical and electronics circuits.

REFERENCES:

1. Jeyachandran K., Natarajan S. & Balasubramanian S., "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
2. Jeyapoovan T., Saravanapandian M. & Pranitha S., "Engineering Practices Lab Manual", Vikas Puplishing House Pvt.Ltd, 2006.
3. Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.
4. Rajendra Prasad A. & Sarma P.M.M.S., "Workshop Practice", Sree Sai Publication, 2002.
5. Kannaiah P. & Narayana K.L., "Manual on Workshop Practice", Scitech Publications, 1999.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets.
2. Carpentry vice (fitted to work bench)	15 Nos.
3. Standard woodworking tools	15 Sets.
4. Models of industrial trusses, door joints, furniture joints	5 each
5. Power Tools: (a) Rotary Hammer	2 Nos
(b) Demolition Hammer	2 Nos
(c) Circular Saw	2 Nos
(d) Planer	2 Nos
(e) Hand Drilling Machine	2 Nos
(f) Jigsaw	2 Nos

MECHANICAL

1. Arc welding transformer with cables and holders	5 Nos.
2. Welding booth with exhaust facility	5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5. Centre lathe	2 Nos.
6. Hearth furnace, anvil and smithy tools	2 Sets.
7. Moulding table, foundry tools	2 Sets.
8. Power Tool: Angle Grinder	2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner	One each.

ELECTRICAL

1. Assorted electrical components for house wiring	15 Sets
2. Electrical measuring instruments	10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4. Megger (250V/500V)	1 No.
5. Power Tools: (a) Range Finder	2 Nos
(b) Digital Live-wire detector	2 Nos

ELECTRONICS

1. Soldering guns	10 Nos.
2. Assorted electronic components for making circuits	50 Nos.
3. Small PCBs	10 Nos.
4. Multimeters	10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply	

GE6163 PHYSICS AND CHEMISTRY LABORATORY – I L T P C
0 0 2 1

PHYSICS LABORATORY – I

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS

(Any FIVE Experiments)

1. (a) Determination of Wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
2. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
3. Determination of wavelength of mercury spectrum – spectrometer grating
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of Young's modulus by Non uniform bending method
6. Determination of specific resistance of a given coil of wire – Carey Foster's Bridge

OUTCOMES:

- The hands on exercises undergone by the students will help them to apply physics principles of optics and thermal physics to evaluate engineering properties of materials.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Diode laser, lycopodium powder, glass plate, optical fiber.
2. Ultrasonic interferometer
3. Spectrometer, mercury lamp, grating
4. Lee's Disc experimental set up
5. Traveling microscope, meter scale, knife edge, weights
6. Carey foster's bridge set up
   (vernier Caliper, Screw gauge, reading lens are required for most of the experiments)

CHEMISTRY LABORATORY- I

OBJECTIVES:

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by vacometry.

LIST OF EXPERIMENTS

(Any FIVE Experiments)

1 Determination of DO content of water sample by Winkler's method.
2 Determination of chloride content of water sample by argentometric method.
3 Determination of strength of given hydrochloric acid using pH meter.
4 Determination of strength of acids in a mixture using conductivity meter.
5 Estimation of iron content of the water sample using spectrophotometer. (1,10- phenanthroline / thiocyanate method).
6 Determination of molecular weight of polyvinylalcohol using Ostwald viscometer.
7 Conductometric titration of strong acid vs strong base.

TOTAL: 30 PERIODS

OUTCOMES:

- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

REFERENCES:

1. Daniel R. Palleros, "Experimental organic chemistry" John Wiley & Sons, Inc., New York 2001.
2. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel's Textbook of practical organic chemistry", LBS Singapore 1994.
3. Jeffery G.H., Bassett J., Mendham J.and Denny vogel's R.C, "Text book of quantitative analysis chemical analysis", ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
4. Kolthoff I.M., Sandell E.B. et al. "Quantitative chemical analysis", Mcmillan, Madras 1980.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Iodine flask	-	30 Nos
2.	pH meter	-	5 Nos
3.	Conductivity meter	-	5 Nos
4.	Spectrophotometer	-	5 Nos
5.	Ostwald Viscometer	-	10 Nos

Common Apparatus : Pipette, Burette, conical flask, percelain tile, dropper (each 30 Nos.)

HS6251 TECHNICAL ENGLISH II L T P C
3 1 0 4

OBJECTIVES:

- To make learners acquire listening and speaking skills in both formal and informal contexts.
- To help them develop their reading skills by familiarizing them with different types of reading strategies.
- To equip them with writing skills needed for academic as well as workplace contexts.
- To make them acquire language skills at their own pace by using e-materials and language lab components.

UNIT I **9+3**

Listening - Listening to informal conversations and participating; Speaking - Opening a conversation (greetings, comments on topics like weather) - Turn taking - Closing a conversation (excuses, general wish, positive comment, thanks); Reading - Developing analytical skills, Deductive and inductive reasoning - Extensive reading; Writing - Effective use of SMS for sending short notes and messages - Using 'emoticons' as symbols in email messages; Grammar - Regular and irregular verbs - Active and passive voice; Vocabulary - Homonyms (e.g. 'can') - Homophones (e.g. 'some', 'sum'); E-materials - Interactive exercise on Grammar and vocabulary – blogging; Language Lab - Listening to different types of conversation and answering questions.

UNIT II **9+3**

Listening - Listening to situation based dialogues; Speaking - Conversation practice in real life situations, asking for directions (using polite expressions), giving directions (using imperative sentences), Purchasing goods from a shop, Discussing various aspects of a film (they have already seen) or a book (they have already read); Reading - Reading a short story or an article from newspaper, Critical reading, Comprehension skills; Writing - Writing a review / summary of a story / article, Personal letter (Inviting your friend to a function, congratulating someone for his / her success, thanking one's friends / relatives); Grammar - modal verbs, Purpose expressions; Vocabulary - Phrasal verbs and their meanings, Using phrasal verbs in sentences; E-materials - Interactive exercises on Grammar and vocabulary, Extensive reading activity (reading stories / novels), Posting reviews in blogs - Language Lab - Dialogues (Fill up exercises), Recording students' dialogues.

UNIT III **9+3**

Listening - Listening to the conversation - Understanding the structure of conversations; Speaking - Conversation skills with a sense of stress, intonation, pronunciation and meaning - Seeking information – expressing feelings (affection, anger, regret, etc.); Reading - Speed reading – reading passages with time limit - Skimming; Writing - Minutes of meeting – format and practice in the preparation of minutes - Writing summary after reading articles from journals - Format for journal articles – elements of technical articles (abstract, introduction, methodology, results, discussion, conclusion, appendices, references) - Writing strategies; Grammar - Conditional clauses - Cause and effect expressions; Vocabulary - Words used as nouns and verbs without any change in the spelling (e.g. 'rock', 'train', 'ring'); E-materials - Interactive exercise on Grammar and vocabulary - Speed Reading practice exercises; Language Lab - Intonation practice using EFLU and RIE materials – Attending a meeting and writing minutes.

UNIT IV **9+3**

Listening - Listening to a telephone conversation, Viewing model interviews (face-to-face, telephonic and video conferencing); Speaking - Role play practice in telephone skills - listening and responding, -asking questions, -note taking – passing on messages, Role play and mock interview for grasping interview skills; Reading - Reading the job advertisements and the profile of the company concerned – scanning; Writing - Applying for a job – cover letter - résumé preparation – vision, mission and goals of the candidate; Grammar - Numerical expressions - Connectives (discourse markers); Vocabulary - Idioms and their meanings – using idioms in sentences; E-materials - Interactive exercises on Grammar and Vocabulary - Different forms of résumés- Filling up a résumé / cover letter; Language Lab - Telephonic interview – recording the responses - e-résumé writing.

UNIT V **9+3**

Listening - Viewing a model group discussion and reviewing the performance of each participant - Identifying the characteristics of a good listener; Speaking - Group discussion

skills – initiating the discussion – exchanging suggestions and proposals – expressing dissent/agreement – assertiveness in expressing opinions – mind mapping technique; Reading - Note making skills – making notes from books, or any form of written materials - Intensive reading; Writing – Checklist - Types of reports – Feasibility / Project report – report format – recommendations / suggestions – interpretation of data (using charts for effective presentation); Grammar - Use of clauses; Vocabulary – Collocation; E-materials - Interactive grammar and vocabulary exercises - Sample GD - Pictures for discussion, Interactive grammar and vocabulary exercises; Language Lab - Different models of group discussion.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

Learners should be able to

- Speak convincingly, express their opinions clearly, initiate a discussion, negotiate, argue using appropriate communicative strategies.
- Write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.
- Read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation.
- Listen/view and comprehend different spoken excerpts critically and infer unspoken and implied meanings.

TEXT BOOKS:

1. Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai. 2011

REFERENCES:

1. Anderson, Paul V. Technical Communication: A Reader-Centered Approach. Cengage. New Delhi. 2008
2. Muralikrishna, & Sunita Mishra. Communication Skills for Engineers. Pearson, New Delhi. 2011
3. Riordan, Daniel. G. Technical Communication. Cengage Learning, New Delhi. 2005
4. Sharma, Sangeetha & Binod Mishra. Communication Skills for Engineers and Scientists. PHI Learning, New Delhi. 2009
5. Smith-Worthington, Darlene & Sue Jefferson. Technical Writing for Success. Cengage, Mason USA. 2007

EXTENSIVE Reading (Not for Examination)

1. Khera, Shiv. You can Win. Macmillan, Delhi. 1998.

Websites

1. http://www.englishclub.com
2. http://owl.english.purdue.edu

TEACHING METHODS:

- Lectures
- Activities conducted individually, in pairs and in groups like individual writing and presentations, group discussions, interviews, reporting, etc
- Long presentations using visual aids
- Listening and viewing activities with follow up activities like discussions, filling up worksheets, writing exercises (using language lab wherever necessary/possible) etc
- Projects like group reports, mock interviews etc using a combination of two or more of the language skills

EVALUATION PATTERN:

Internal assessment: 20%

3 tests of which two are pen and paper tests and the other is a combination of different modes of assessment like

- Project
- Assignment
- Report
- Creative writing, etc.

All the four skills are to be tested with equal weightage given to each.

- ✓ Speaking assessment: Individual presentations, Group discussions
- ✓ Reading assessment: Reading passages with comprehension questions graded following Bloom's taxonomy
- ✓ Writing assessment: Writing essays, CVs, reports etc. Writing should include grammar and vocabulary.
- ✓ Listening/Viewing assessment: Lectures, dialogues, film clippings with questions on verbal as well as audio/visual content graded following Bloom's taxonomy.

End Semester Examination: 80%

MA6251 MATHEMATICS – II L T P C
3 1 0 4

OBJECTIVES:

- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To acquaint the student with the concepts of vector calculus needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow the of electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I VECTOR CALCULUS 9+3

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 parallelopipeds.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 9+3

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 III LAPLACE TRANSFORM 9+3

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

UNIT IV ANALYTIC FUNCTIONS 9+3

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: $w = z+k$, kz, $1/z$, z^2, e^z and bilinear transformation.

UNIT V COMPLEX INTEGRATION 9+3

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Cauchy's residue theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- The subject helps the students to develop the fundamentals and basic concepts in vector calculus, ODE, Laplace transform and complex functions. Students will be able to solve problems related to engineering applications by using these techniques.

TEXT BOOKS:

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd.,2011.
2. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, 2011.

REFERENCES:

1. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., 2011
2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012.
3. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
4. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2008.
5. Sivarama Krishna Das P. and Rukmangadachari E., "Engineering Mathematics" Volume II, Second Edition, PEARSON Publishing, 2011.

PH6251 ENGINEERING PHYSICS – II L T P C
3 0 0 3

OBJECTIVES:

- To enrich the understanding of various types of materials and their applications in engineering and technology.

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 – compound

semiconductors -direct and indirect band gap- derivation of carrier concentration in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration – – Hall effect –Determination of Hall coefficient – Applications.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials – Ferrites and its applications

Superconductivity: properties – Type I and Type II superconductors – BCS theory of superconductivity(Qualitative) - High T_c superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.

UNIT IV DIELECTRIC MATERIALS 9

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

UNIT V ADVANCED ENGINEERING MATERIALS 9

Metallic glasses: preparation, properties and applications. Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, Nanomaterials– Preparation -pulsed laser deposition – chemical vapour deposition – Applications – NLO materials –Birefringence-optical Kerr effect – Classification of Biomaterials and its applications

TOTAL: 45 PERIODS

OUTCOMES:

- The students will have the knowledge on physics of materials and that knowledge will be used by them in different engineering and technology applications.

TEXT BOOKS:

1. Arumugam M., Materials Science. Anuradha publishers, 2010
2. Pillai S.O., Solid State Physics. New Age International(P) Ltd., publishers, 2009

REFERENCES:

1. Palanisamy P.K. Materials Science. SCITECH Publishers, 2011
2. Senthilkumar G. Engineering Physics II. VRB Publishers, 2011
3. Mani P. Engineering Physics II. Dhanam Publications, 2011
4. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009

CY6251 ENGINEERING CHEMISTRY - II L T P C
3 0 0 3

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- Principles of electrochemical reactions, redox reactions in corrosion of materials and methods for corrosion prevention and protection of materials.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.

UNIT I WATER TECHNOLOGY 9

Introduction to boiler feed water-requirements-formation of deposits in steam boilers and heat exchangers- disadvantages (wastage of fuels, decrease in efficiency, boiler explosion) prevention of scale formation -softening of hard water -external treatment zeolite and demineralization - internal treatment- boiler compounds (phosphate, calgon, carbonate, colloidal) - caustic embrittlement -boiler corrosion-priming and foaming- desalination of brackish water –reverse osmosis.

UNIT II ELECTROCHEMISTRY AND CORROSION 9

Electrochemical cell - redox reaction, electrode potential- origin of electrode potential- oxidation potential- reduction potential, measurement and applications - electrochemical series and its significance - Nernst equation (derivation and problems). Corrosion- causes- factors- types-chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method. Paints- constituents and function. Electroplating of Copper and electroless plating of nickel.

UNIT III ENERGY SOURCES 9

Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion- differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power generator- classification of nuclear reactor- light water reactor- breeder reactor- solar energy conversion- solar cells- wind energy. Batteries and fuel cells:Types of batteries- alkaline battery- lead storage battery- nickel-cadmium battery- lithium battery- fuel cell H_2 -O_2 fuel cell- applications.

UNIT IV ENGINEERING MATERIALS 9

Abrasives: definition, classification or types, grinding wheel, abrasive paper and cloth. Refractories: definition, characteristics, classification, properties – refractoriness and RUL, dimensional stability, thermal spalling, thermal expansion, porosity; Manufacture of alumina, magnesite and silicon carbide, Portland cement- manufacture and properties - setting and hardening of cement, special cement- waterproof and white cement–properties and uses. Glass - manufacture, types, properties and uses.

UNIT V FUELS AND COMBUSTION 9

Fuel: Introduction- classification of fuels- calorific value- higher and lower calorific values- coal- analysis of coal (proximate and ultimate)- carbonization- manufacture of metallurgical coke (Otto Hoffmann method) - petroleum- manufacture of synthetic petrol (Bergius process)- knocking- octane number - diesel oil- cetane number - natural gas- compressed natural gas(CNG)- liquefied petroleum gases(LPG)- producer gas- water gas. Power alcohol and bio diesel. Combustion of fuels: introduction- theoretical calculation of calorific value- calculation of stoichiometry of fuel and air ratio- ignition temperature- explosive range - flue gas analysis (ORSAT Method).

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

1. Vairam S, Kalyani P and SubaRamesh.,“Engineering Chemistry”., Wiley India PvtLtd.,New Delhi., 2011
2. DaraS.S,UmareS.S.“Engineering Chemistry”, S. Chand & Company Ltd., New Delhi , 2010

REFERENCES:

1 Kannan P. and Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009

2. AshimaSrivastava and Janhavi N N., "Concepts of Engineering Chemistry", ACME Learning Private Limited., New Delhi., 2010.

3. RenuBapna and Renu Gupta., "Engineering Chemistry", Macmillan India Publisher Ltd., 2010.

4 Pahari A and Chauhan B., "Engineering Chemistry"., Firewall Media., New Delhi., 2010

GE6252 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C
4 0 0 4

OBJECTIVES:

- To explain the basic theorems used in Electrical circuits and the different components and function of electrical machines.
- To explain the fundamentals of semiconductor and applications.
- To explain the principles of digital electronics
- To impart knowledge of communication.

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

OUTCOMES:

- Ability to identify the electrical components explain the characteristics of electrical machines.
- Ability to identify electronics components and use of them to design circuits.

TEXT BOOKS:

1. Mittle N., “Basic Electrical Engineering”, Tata McGraw Hill Edition, New Delhi, 1990.
2. Sedha R.S., “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.

GE6253	ENGINEERING MECHANICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

UNIT I BASICS AND STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – Lami’s theorem, Parallelogram and triangular Law of forces –– Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports –Action and reaction forces –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 – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS 12

Centroids and centre of mass– Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem –Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids 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 laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 12

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL : 60 PERIODS

OUTCOMES:

- Ability to explain the differential principles applies to solve engineering problems dealing with force, displacement, velocity and acceleration.
- Ability to analyse the forces in any structures.
- Ability to solve rigid body subjected to dynamic forces.

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi, 2004.
2. Vela Murali, "Engineering Mechanics", Oxford University Press, 2010

REFERENCES:

1. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
2. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education 2006.
3. Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons,1993.
4. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.
5. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
6. Kumar, K.L., "Engineering Mechanics", 3rd Revised Edition, Tata McGraw-Hill Publishing company, New Delhi 2008.

GE6261 COMPUTER AIDED DRAFTING AND MODELING LABORATORY L T P C
0 1 2 2

OBJECTIVES:

- To develop skill to use software to create 2D and 3D models.

List of Exercises using software capable of Drafting and Modeling

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

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

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to use the software packers for drafting and modeling
- Ability to create 2D and 3D models of Engineering Components

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Sl.No	Description of Equipment	Quantity
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.

GE6262 PHYSICS AND CHEMISTRY LABORATORY – II

L	T	P	C
0	0	2	1

PHYSICS LABORATORY – II

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS
(Any FIVE Experiments)

1. Determination of Young's modulus by uniform bending method
2. Determination of band gap of a semiconductor
3. Determination of Coefficient of viscosity of a liquid –Poiseuille's method
4. Determination of Dispersive power of a prism - Spectrometer
5. Determination of thickness of a thin wire – Air wedge method
6. Determination of Rigidity modulus – Torsion pendulum

OUTCOMES:

- The students will have the ability to test materials by using their knowledge of applied physics principles in optics and properties of matter.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Traveling microscope, meter scale, Knife edge, weights
2. Band gap experimental set up
3. Burette, Capillary tube, rubber tube, stop clock, beaker and weighing balance
4. spectrometer, prism, sodium vapour lamp.
5. Air-wedge experimental set up.
6. Torsion pendulum set up.

(vernier Caliper, Screw gauge, reading lens are required for most of the experiments)

CHEMISTRY LABORATORY - II

OBJECTIVES:

- To make the student acquire practical skills in the wet chemical and instrumental methods for quantitative estimation of hardness, alkalinity, metal ion content, corrosion in metals and cement analysis.

LIST OF EXPERIMENTS
(Any FIVE Experiments)

1 Determination of alkalinity in water sample
2 Determination of total, temporary & permanent hardness of water by EDTA method
3 Estimation of copper content of the given solution by EDTA method
4 Estimation of iron content of the given solution using potentiometer
5 Estimation of sodium present in water using flame photometer
6 Corrosion experiment – weight loss method
7 Conductometric precipitation titration using $BaCl_2$ and Na_2SO_4
8 Determination of CaO in Cement.

TOTAL: 30 PERIODS

OUTCOMES:

- The students will be conversant with hands-on knowledge in the quantitative chemical analysis of water quality related parameters, corrosion measurement and cement analysis.

REFERENCES:

1. Daniel R. Palleros, "Experimental organic chemistry" John Wiley & Sons, Inc.,New York, 2001.
2. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel's Textbook of practical organic chemistry, LBS Singapore ,1994.
3. Jeffery G.H, Bassett J., Mendham J. and Denny R.C., "Vogel's Text book of quantitative analysis chemical analysis", ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
4. Kolthoff I.M. and Sandell E.B. et al. Quantitative chemical analysis, McMillan, Madras 1980

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Potentiometer - 5 Nos
2. Flame photo meter - 5 Nos
3. Weighing Balance - 5 Nos
4. Conductivity meter - 5 Nos

Common Apparatus : Pipette, Burette, conical flask, percelain tile, dropper (30 Nos each)

GE6263 COMPUTER PROGRAMMING LABORATORY

L	T	P	C
0	1	2	2

OBJECTIVES:
The Students should be made to

- Be exposed to Unix shell commands
- Be familiar with an editor on Unix
- Learn to program in Shell script
- Learn to write C programme for Unix platform

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

OUTCOMES:

At the end of the course the students should be able to:

- Use Shell commands
- Design of Implement Unix shell scripts
- Write and execute C programs on Unix

HARDWARE / SOFTWARE REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Hardware

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

Software

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

MA6351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS **L T P C**
3 1 0 4

OBJECTIVES:

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS **9 + 3**

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

UNIT II FOURIER SERIES **9 + 3**

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 III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **9 + 3**

Classification of PDE – Method of separation of variables - Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).

UNIT IV FOURIER TRANSFORMS 9 + 3

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9 + 3

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Convolution theorem - Formation of difference equations – Solution of difference equations using
Z - transform.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- The understanding of the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.

TEXT BOOKS:

1. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
2. Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
3. Narayanan.S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students" Vol. II & III, S.Viswanathan Publishers Pvt Ltd. 1998.

REFERENCES:

1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd , 2007.
2. Ramana.B.V., "Higher Engineering Mathematics", Tata Mc-GrawHill Publishing Company Limited, NewDelhi, 2008.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
4. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
5. Ray Wylie. C and Barrett.L.C, "Advanced Engineering Mathematics" Tata Mc Graw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
6. Datta.K.B., "Mathematical Methods of Science and Engineering", Cengage Learning India Pvt Ltd, Delhi, 2013.

EL6301 MOLECULAR PHYSICAL CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart knowledge in the field of electrochemistry, solubility behaviour, chemical reaction kinetics, photochemical reactions and colloidal chemistry towards different applications.

UNIT I QUALITATIVE INTRODUCTION TO QUANTUM THEORY 9

Review of qualitative quantum theory. Schrodinger equation. Born interpretation of wave function. Postulates of quantum theory. Uncertainty principle. Solution to particle in a one dimensional box. Degeneracy and particle in two and three dimensional box. Quantizing vibrational motion. Particle in a ring and rotational motion.

UNIT II ATOMIC STRUCTURE AND SPECTRA 9

Introduction to time dependent and time independent perturbation theories. Structure and spectra of hydrogen atom. Structure of many electron atoms. Spectra of complex atoms.

UNIT III MOLECULAR STRUCTURE AND QUALITATIVE INTRODUCTION TO MOLECULAR SPECTROSCOPY 9

Born – Oppenheimer approximation. Valence bond theory. Molecular orbital theory of diatomic and poly atomic systems. Qualitative introduction to molecular spectroscopy. Origin of selection rules. Spectral line width and intensities with respect to vibrational, rotational and electronic spectra. Qualitative introduction to NMR.

UNIT IV INTRODUCTION TO STATISTICAL THERMODYNAMICS 9

Distribution of molecular states. Internal energy, enthalpy, free energy and entropy. Statistical ensembles**.** Canonical partition functions.

UNIT V APPLICATIONS OF STATISTICAL THERMODYNAMICS 9

Relationship between macro thermodynamic expressions and partition functions. Applications with respect to heat capacities, equations of state, molecular interaction in liquids. Residual entropies. Equilibrium constants.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the student would be able to define and to explain how thermodynamic laws are applied and incorporated to further our understanding of chemical equilibria, phase equilibria, electrochemical equilibria and biochemical reactions equilibria.

TEXT BOOKS:

1. P.W. Atkins and J.D.Paula**.** "Physical Chemistry" IX Edition, Oxford University Press (India), New Delhi, 2011.
2. A. Mcquarie, "Physical Chemistry: A molecular Approach". Viva books Private Limited, New Delhi, 2003.

REFERENCES:

1. Stephen Berry.R, Stuart Alan Rice and Ross. J, " Physical Chemistry", II edition, Wiley, New York, 2000.
2. Ira. N.Levine, " Physical Chemistry" V Edition, Mc Graw – Hill, New York, 2007.

EL6302 ORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVE:

To enable the students to learn the type of components in which organic reactions take place and also to know the preparation of the essential organic compounds.

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 PYRROLE 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.

UNIT V DRUGS, PESTICIDES & DYES 9

Classification and properties of drugs. Penicilian 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

OUTCOMES:

At the end of the course students will have knowledge on various reaction mechanism, preparation of organic compounds and their properties.

TEXT BOOKS:

1. B.S.Bhal and Arun Bhal, "A Text Book of Organic Chemistry", 17th edition, S Chand & Co. New Delhi, 2005.
2. Robert T.Morrison and Robert N Byod "Organic Chemistry", 6th edition, Prince Hall of India, New Delhi, 2001.

REFERENCES:

1. Jonathan Clayden, Nick Greeves, Staurt Warren and Peter Wothers, "Organic Chemistry", Oxford University Press, 1st edition, New Delhi, 2001.
2. K.S. Tiwari, N.K. Vishnoi, S.N. Mehrotra, "A Text Book of Organic Chemistry", Vikas Publishing House , 2nd Revised edition, New Delhi, 1998.

CH6359 INORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVE:

To introduce certain key aspects of inorganic chemistry, including solid state structures, the chemistry of phosphorus and hydrogen and transition metal chemistry.

UNIT I STRUCTURE AND BONDING IN INORGANIC CHEMISTRY 9

Structure of the atom. Energy levels. Wave equation. Symmetry of orbitals. Periodicity of the elements. Ionic bonding. Covalent bonding. Covalent character in predominant ionic bonding. Multiple bonding.

UNIT II CHEMISTRY IN AQUEOUS AND NON AQUEOUS SOLUTIONS 9

Acid – base chemistry. Acid - base concepts. Measures of acid - base strength. Hard and soft acids and bases. Non - aqueous solvents. Protic solvents and aprotic solvents. Solutions of metals in ammonia. Molten salts. Solutions of metals. Electro chemistry in non aqueous solvents.

UNIT III COORDINATION CHEMISTRY 9

Coordination number. Effective atomic number rule. Coordination compounds and their structure. Valence bond theory. Crystal field theory. Molecular orbital theory. Spectra of coordination compounds. Isomerisms. Structural equilibriums. Chelate effect. Reactions of coordination compounds.

UNIT IV CHEMISTRY OF TRANSITION METALS 9

Periodic trends among the three transition metal series. Comparison of properties of the oxidation states and electron configuration. General chemistry of heavier transition metals. Inorganic chains, rings and cages.

UNIT V ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY 9

Oranometallic chemistry. Synthesis and catalysis of metal carbonyls, metal nitrosyls, metallocenes, aromatic cyclopolyenes, olefin and acetylene complexes. Inorganic chemistry in biological systems. Metalloporphyrins, enzymes, essential and trace elements in biological systems

TOTAL : 45 PERIODS

OUTCOMES:

At the end of this course, the students will able to use these concepts in problem solving, describe and place in context the chemistry of main group elements and transition metals

TEXT BOOKS:

1. James E. Huheey, E.A. Keiter and R. L.Keiter " Inorganic Chemistry : Principles of structure and reactivity" IV Edition, Harper & Row, New York, 2004.
2. P.W. Atkins and Shriver. "Inorganic Chemistry" V Edition, Oxford University Press (India), New Delhi, 2011.

REFERENCE:

1. F.A. Cotton and G.Wilkinson "Advanced Inorganic chemistry", VI edition, Weily India Pvt Ltd., 2008.

EL6303 CHEMICAL PROCESS CALCULATIONS

L	T	P	C
3	0	0	3

OBJECTIVE:

To teach concept of degree of freedom and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I BASIC CONCEPTS 9

Review of basic concepts. Methods of expressing composition of mixtures and solutions. Use of molal units, partial pressure and pure component volume in calculations. Material balance for non reacting systems like distillation, evaporation, drying etc.

UNIT II MATERIAL BALANCE 9

Material balance for reacting systems. Stoichiometry. Limiting and excess reactants. Degree of completion. Multiple reactions. Recycle, bypass and purging. Material balance for unsteady state processes. Tank hold up and discharge.

UNIT III PSYCHROMETRY & CRYSTALLISATION 9

Psychrometry. Basic definitions. Humidification and dehumidification calculations. Use of psychrometric chart. Solubility and crystallization. Material balance and yield calculations in dissolution and crystallization processes.

UNIT IV ENERGY BALANCE 9

Heat capacity of liquid and gaseous mixtures. Use of mean heat capacities. Evaluation of enthalpy changes for systems with and without phase change. Energy balance for reacting and non reacting systems. Adiabatic reaction temperature. Theoretical flame temperature.

UNIT V FUELS AND COMBUSTION 9

Fuels. Ultimate and proximate analyses. Higher and lower heating values of fuels. Combustion chemistry. Incomplete combustion. Theoretical and excess air. Computations involving flue gas analysis and Orsat analysis. Determination of fuel composition.

TOTAL: 45 PERIODS

OUTCOME:

The students would be able to understand chemical engineering calculations, establish mathematical methodologies for the computation of material balances, energy balances.

TEXT BOOKS:

1. R.M Felder and R.W. Rousseau, " Elementary principles of Chemical processes" Fifth Edition, Weily, New york, 2004.
2. K. Asokan "Chemical process calculations" , First edition, Universities Press, Hyderabad, 2007 & CRC Press, Boca Raton ,U.S.A., 2008.

REFERENCES:

1. D.M. Himmelblau, J.B. Riggs**,** " Basic principles and calculations in chemical engineering" Prentice Hall of India, Revised VII Edition, 2012.
2. O.A. Hougen, K.M. Watson and R.A.Ragatz "Chemical Process Principles, Part I (Material & Energy Balances)",III Edition, Reprinted Indian edition, CBS Publishers & distributors, New Delhi, 2004.
3. Venkatramani. V, Anatharaman. N and Meera Shariffa Begam " Process Calculations" Printice Hall of India, New Delhi, 2011.
4. K.V.Narayanan,B.Lakshmipathy,"Stochiometry and Process Calculation", PHI Learning Ltd.(2013).

EL6404 FLUID MECHANICS

L	T	P	C
3	0	0	3

OBJECTIVE:

To impart to the student knowledge on fluid properties, fluid statics, dynamic characteristics for through pipes and porous medium, flow measurement and fluid machineries

UNIT I FLUID STATICS AND MACROSCOPIC BALANCES 9

Fluid types, physical properties, viscosity, continuum hypothesis, pressure distribution in a static fluid, hydrostatic forces on submerged plane surfaces; Archimides principle, streamline, pathlines, streaklines. Reynolds transport theorem macroscopic balances of mass, energy and linear momentum.

UNIT II DIFFERENTIAL BALANCES, DIMENSIONAL ANALYSIS 9

Losses in expansion, force on a reducing bend, jet ejector. Differential equation of mass conservation, differential equation of linear momentum, constitutive equations, Navier-Stokes equations. Applications to Couette flow, flow due to pressure gradient between two fixed plates, fully developed laminar pipe flow-Hagen-Poiseuille flow, Buckingham Pi theorem, introduction of dimensionless numbers.

UNIT III TRANSPORTATION AND METERING OF FLOWS 9

Pipe/Duct flows: Laminar vs turbulent flows, kinetic energy correction factor, momentum flux correction factor, head loss, friction factor, effect of wall roughness, the Moody chart, hydraulic diameter for non-circular conduit, minor losses, equivalent length. Flow meters: Pitot tube, venturi, orifice, rotameter. Flow machinery: Introduction to pumps, efficiency, priming, cavitation and NPSH, performance curve of a centrifugal pump. Introduction to fans, blowers and compressors,.

UNIT IV FLOW PAST IMMERSED BODIES, PACKED BEDS, FLUIDIZED BEDS 9

Flow past immersed bodies: Creeping flow-Stokes law, inviscid flow-Bernoulli equation, introduction to boundary layer, Karman's momentum integral theory, drag on a flat plate for laminar flow, drag on immersed bodies-C_D vs Re plotFlow through packed and fluidized beds: Kozeny-Carman equation, Ergun equation, Fluidization, minimum fluidization velocity. particle settling.

UNIT V APPLICATIONS 9

Filtration: Types of filters, cake filteration, constant flow rate and constant pressure drop operations. Centrifuges and Cyclones: Gravity settling, centrifugal separation, Mixing and Agitation: Types of impeller, flow number, power consumption, mixing times, scale up.

TOTAL : 45 PERIODS

OUTCOME:

At the end of this course, the students would develop skills in analyzing fluid flows through the proper use of modeling and the application of the basic fluid-flow principles

TEXT BOOKS:

1. F. M. White, Fluid Mechanics, 7th edition, Tata McGraw-Hill, New Delhi, 2010.
2. Noel de Nevers," Fluid Mechanics for Chemical Engineers", 3rd edition McGraw-Hill Newyork, 2010.

REFERENCES:

1. Robert W. Fox, Philip J. Pritchard, and Alan T. Mcdonald, Introduction to Fluid Mechanics, 7th Edition, Wiley India, New Delhi, 2009.
2. W.L. McCabe, J.C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th edition , McGraw-Hill, Singapore, 2004.

CH6312 PHYSICAL CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

OBJECTIVE:

To improve the practical knowledge on the properties and characteristics of solvents and mixtures.

LIST OF EXPERIMENTS

1. Determination of molecular weight of a polymer by viscosity method.
2. Determination of partition co-efficient of iodine between two immiscible solvents

3. Determination of partition co-efficient of benzoic acid between two immiscible solvents
4. Determination of Ka of the weak acid
5. Conductometric experiments- Verification of Oswald's Dilution Law
6. Titration of Strong Acid Vs Strong Base
7. Titration of mixture of Strong Acid Weak Acid Vs Strong Base
8. Titration of Weak Acid Vs Weak Base
9. Determination of Rate Constant (K)
10. Determination of Activation Energy (ΔE)
11. Estimation of Ferrous ion concentration by Potentiometric Titration
12. Determination of standard electrode potential (Zn, Cu, Ag)
13. Adsorption studies
14. To study the adsorption of Acetic acid on charcoal and construct the isotherm.
15. Determination of pH metric titration of Strong Acid Vs Strong Base
16. Enzyme catalytic reaction by varying pH.
17. Application of Phase Rule to Phenol-Water system
18. To study the inversion of cane sugar by polarimeter.
    a. Polarimeter-Inversion of cane sugar
    b. Refractometer

TOTAL : 45 PERIODS

OUTCOMES:

The student would be able to determine the properties and characteristics of solvents and mixtures.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Micro Calorimeter
2. Beckman Thermometers. Glasswares,
3. Thermometers 0 to 110 – 0°. Bottle Shakers .pH meters
4. Pressure Glass bottles. Standard Cells. Multimeters
5. Viscometers-Ostwald Cannan Ubbelholde. Voltage Stabiliser
6. Stalalmometer
7. Surface Tension Meter .Tape Heaters
8. Mantle Heaters
9. DC Power Supply. Thermostat. Cyrostats

REFERENCE:

1. Physical Chemistry experiments by Alexander Findley, McGraw-Hill IV Edition, (1976).

CH6367	INORGANIC AND ORGANIC CHEMISTRY LABORATORY	L	T	P	C
		0	0	3	2

OBJECTIVE:

To improve the practical knowledge on the analysis of inorganic/organic compounds.

LIST OF EXPERIMENTS

INORGANIC CHEMISTRY:

(**Any Five experiments**)

1. Analysis of alloy
2. Analysis of cement
3. Analysis of lime stone
4. Proximate and ultimate analysis of coal
5. Analysis of sugars
6. Analysis of soap

ORGANIC CHEMISTRY:
(**Any Five experiments**)

Preparation of organic compounds:

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

TOTAL : 45 PERIODS

OUTCOME:

The students would be able to prepare organic compounds and analyse the inorganic/organic compounds.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Silica Crucible
2. Heating Mantle
3. Muffle Furnace
4. Hot air oven
5. Desiccator
6. Vacuum pump
7. Condenser

REFERENCE:

1. Laboratory Manual prepared by Faculty

EE6368 ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

OBJECTIVES:

- To learn for conducting experiments involving electrical machines and Microprocessors and to analyse and interpret the results.

LIST OF EXPERIMENTS

1. Verification of Ohm's law and Kirchhoff's laws.
2. Load test on DC series motor.
3. Load test on three-phase induction motor.
4. Study of half wave and full wave rectifiers.
5. RC coupled transistor amplifier.
6. Applications of operational amplifier.
7. Study of logic gates and implementation of Boolean functions.
8. Implementation of binary adder/ subtractor.
9. Study of programming of 8085 microprocessor
10. Interfacing a stepper motor with 8085 microprocessor

TOTAL : 45 PERIODS

OUTCOMES:

- Understanding the relation between electrical voltage, current and resistance.
- Ability to measure the performance of electrical machine like DC and AC motors.
- Visualizing the usage of logic gates and Microprocessor in motor control systems.

REFERENCE:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	D. C. Motor Generator Set	2
2	D.C. Compound Motor	4
3	Single Phase Transformer	4
4	Three Phase Induction Motor	2
5	Single Phase Induction Motor	2
6	Three Phase Alternator Set	2
7	Ammeter A.C and D.C	20
8	Voltmeters A.C and D.C	20
9.	Watt meters LPF and UPF	12
10.	Resistors & Breadboards	1 set
11.	Cathode Ray Oscilloscopes	4
12.	Dual Regulated power supplies	6
13.	A.C. Signal Generators	4
14.	Voltmeters D.C.	10
15.	Ammeters D.C.	10
16.	Resistors, Capacitors, Diodes	1 set
17.	Transistors (BJT, JFET), SCR, Logic Gates	1 set
18.	Stepper Motor, Interface Card and Power Supply	1 set
19.	Probes	1 set

MA6459 NUMERICAL METHODS L T P C
3 1 0 4

OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology

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 method – Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method - Eigenvalues of a matrix by Power method.

UNIT II INTERPOLATION AND APPROXIMATION 8+3

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

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson’s 1/3 rule – Romberg’s method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson’s 1/3 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 order equations - Multi step 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.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- The students will have a clear perception of the power of numerical techniques, ideas and would be able to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.

TEXT BOOKS:

1. Grewal. B.S., and Grewal. J.S., " Numerical methods in Engineering and Science", Khanna Publishers, New Delhi, 9th Edition, 2007.
2. Gerald. C. F., and Wheatley. P. O., " Applied Numerical Analysis", Pearson Education, Asia, New Delhi, 6th Edition, 2006.

REFERENCES:

1. Chapra. S.C., and Canale.R.P., "Numerical Methods for Engineers, Tata McGraw-Hill, New Delhi, 5th Edition, 2007.
2. Brian Bradie. "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi, 2007.
3. Sankara Rao. K., "Numerical methods for Scientists and Engineers", Prentice Hall of India Private Ltd., New Delhi, 3rd Edition, 2007.

CH6455 CHEMICAL ENGINEERING THERMODYNAMICS

L	T	P	C
3	1	0	4

OBJECTIVES:

Students will learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I ZEROTH AND FIRST LAWS, PROPERTIES OF PURE SUBSTANCES 9

Definitions and Concepts. Property, Thermodynamic State. Equilibrium, Energy, Work. Zeroth Law of Thermodynamics, Temperature Scale. Pure substance, Phase, Simple compressible substance, Ideal gas Equation of State, Law of corresponding states, Compressibility chart, Pressure –Volume and Temperature-volume Phase diagrams. Mollier diagram. First Law of Thermodynamics and its consequences.

UNIT II APPLICATION OF I LAW TO STEADY - STATE PROCESSES, II LAW 9

Application of I Law of Thermodynamics for Flow Process. Steady-state processes. II Law of Thermodynamics and its Applications: Limitations of the I Law of Thermodynamics, Heat Engine, Heat Pump/Refrigerator. II Law of Thermodynamics – Kelvin Planck and Clausius statements. Reversible and irreversible processes, Criterion of reversibility, Carnot cycle and Carnot principles, Thermodynamic Temperature scale, Clausius inequality, Entropy.

UNIT III POWER CYCLES, THERMODYNAMIC POTENTIALS, EQUILIBRIA AND STABILITY 9

Power and Refrigeration Cycles. Thermodynamic Potentials. Maxwell relations. Thermodynamic relations. Equilibria and stability. Maxwell construction, Gibbs Phase Rule. Clapeyron equation and vapor pressure correlations.

UNIT IV PROPERTIES OF PURE COMPONENTS AND MIXTURES 9

Pure component properties: Equation of state. Ideal gas heat capacities, fundamental equations from experimental data, fugacity and corresponding states. Mixture Properties: Mixing function. Gibbs-Duhem relation for mixtures, partial molar quantities. Ideal gas mixtures and fugacities, ideal mixtures and activities, excess functions. Gibbs free energy models, infinite dilution properties. Henry's Law

UNIT V PHASE EQUILIBRIA AND CHEMICAL REACTION EQUILIBRIA 9

Phase Equilibira of Mixtures. Osmotic pressure and Osmotic coefficients. Boiling point elevation and freezing point depression. Chemical Reaction Equilibria. Reaction extent and Independent reactions. Equilibrium criteria and equilibrium constant. Standard enthalpies and Gibbs free energy, temperature and pressure effects on reactions, heterogeneous reaction, multiple chemical reactions

TOTAL (L : 45 +T:15) : 60 PERIODS

OUTCOMES:

The course will help the students to know about engineering thermodynamics and understand the practical implications of thermodynamic law in engineering design.

TEXT BOOKS:

1. Sonntag, Borgnakke, Van Wylen, Fundamentals of Thermodynamics, 7th Edition, Wiley India, New Delhi, 2009.
2. Smith, van Ness and Abbott, "Chemical Engineering Thermodynamics", 7th Edition, McGraw Hill, New York, 2005

REFERENCES:

1. S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, Wiley New York, 2006
2. Y V C Rao, "Chemical Engineering Thermodynamics", Universities Press, Hyderabad 2005.
3. Pradeep ahuja," Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).
4. Gopinath Halder," Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).

EL6401 CHEMICAL REACTION ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

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

OUTCOMES:

Students would have knowledge on the selection and design of reactor for the required reaction.

TEXT BOOKS:

1. H. Scott Fogler, 'Elements of Chemical Reaction Engineering', Prentice-Hall of India, New Delhi 2005.
2. O. Levenspiel, 'Chemical Reaction Engineering', III edition, Wiley – Eastern Ltd, New Delhi, 2005.

REFERENCES:

1. L.D. Schmidt, "The Engineering of Chemical Reactions", II Edition, Oxford Univ. Press, New York, 2009.
2. J.M.Smith, "Chemical Engineering Kinetics", 3rd edition, McGraw-Hill, New York, 1981.

CH6460 MATERIALS TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE:

To provide students with a strong foundation in materials science with emphasis on the fundamental scientific and engineering principles which underlie the knowledge and implementation of material structure, processing, properties, and performance of all classes of materials used in engineering systems.

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, electron diffraction, neutron diffraction, structure of NaCl and diamond, Crystal defects - point, line, surface and volume defects, alloy formation, solid solution types, solidification of castings, structural examination using microscopy.

UNIT II METALLURGICAL PROPERTIES OF MATERIALS 9

Phase diagrams - isomorphous, eutectic, eutectoid and peritectic system. Diffusion - Fick 's laws. Mechanical properties - tension test, hardness test - brinnel, vickers, rockwell, micro hardness test - shore scleroscope. Impact test, fracture - grifiths' theory, fracture toughness, embrittlement phenomena. Fatigue and creep. Strengthening mechanisms

UNIT III TYPES OF MATERIALS 9

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

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. Conductivity of materials, zone refining, crystal growth techniques.

UNIT V NON-METALLIC MATERIALS 9

Ceramic materials - oxides, silicates. Refractories. Glasses, enamels, abrasives, cement and concrete materials. Polymers – classification, reaction, types, mechanisms, deformation of polymers, mechanical, thermal, electrical and chemical behavior. Rubber, silicones, fluoro carbons, composites -FRP, particulates, and laminates.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to understand various material and its properties and manufacturing methods.

TEXT BOOKS:

1. V.Raghavan, “Materials Science and Engineering : A first course”, V Edition, Prentice Hall of India , 2004.
2. Van Vlack L.H , “Elements of Materials Science and Engineering” (Addision Wesley series in metallurgy and materials engineering), VI Edition, Prentice Hall, 6th Edition, 1989.

REFERENCES:

1. WF.Hosford, “Material Science”, Cambridge Univ. Press, New York, 2006.
2. C.Srinivasan, “ Science of Engineering Materials”, John Wiley, New York, 1987.

EL6402 HEAT TRANSFER AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVE:

To enable the students to learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

UNIT I 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. Unsteady state heat conduction. Heisler charts.

UNIT II CONVECTION 9

Heat flow in fluids. Boundary layers. Parallel, counter current and cross flow heat exchangers. Log mean temperature difference. Overall and individual heat transfer coefficients. Application of dimensional analysis to convection. Natural and forced convection. Convective heat transfer in ducts, flat plates, falling film etc for laminar and turbulent regions. Heat transfer correlations and analogies.

UNIT III CONDENSATION & BOILING 9

Heat transfer from condensing vapors. Drop wise and film type condensation, Nusselt equation for vertical and horizontal plates / tubes. Heat transfer to boiling liquids and molten metals. Mechanisms of boiling. Pool boiling. Convective boiling. Correlations. Design of condensers and vaporizers.

UNIT IV HEAT EXCHANGE EQUIPMENTS 9

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

UNIT V RADIATION & EVAPORATION 9

Concept of thermal radiation. Black body and gray body concepts. Laws of radiation. Radiation between surfaces. View factors. 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

OUTCOME:

Upon completion of this course, the students will have knowledge in various heat transfer methodology in process engineering and to design heat transfer equipments such as furnace, boilers, heat exchangers evaporation

TEXT BOOKS:

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", Fifth Edition, Weily – India, New Delhi, 2009.
2. J.P. Holman, "Heat transfer", Ninth Edition, Tata - McGraw Hill, New Delhi, 2009.

REFERENCES:

1. D.Q. Kern, "Process Heat Transfer", Eighteenth Reprint, McGraw Hill, New York, 2008.
2. J.M.Coulson and J.F. Richardson with J.R.Backhurst and J.H.Harker, "Coulson and Richardson's chemical Engineering", Vol.1, "Fluid Flow, Heat Transfer and Mass Transfer", Butterworth Heinmann, 6th Edition, 2000.

EL6403 PRINCIPLES OF ELECTROCHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVE:

To import knowledge on basic principles of electrochemistry and its applications.

UNIT I ION-SOLVENT & ION-ION INTERACTION 9

Ion-solvent interaction – 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 solvation, Ion-Ion Interaction – True and Potential electrolytes, Debye-Huckel (ion-cloud) theory of ion-ion interactions, Activity coefficients and ion-ion interaction

UNIT II ION TRANSPORT IN SOLUTION 9

Diffusion & Diffusion coefficient, Einstein-Smoluchowski equation, Conduction, Molar & Equivalent conductivity, Kohlrausch's Law, Ionic mobility, Stokes-Einstein relation, Nernst-Einstein equation, Transport numbers – determination by Hittorf's & Moving Boundary methods – Walden's rule - Debye Huckel-Onsager equation, Non-aqueous solutions

UNIT III POLARISATION AND OVER POTENTIAL 9

Electrolytic polarization, Dissolution and Decomposition potential, Overvoltage – hydrogen and oxygen overvoltage, applications, Polarography – principles, diffusion layer, limiting current density, polarographic circuit, dropping mercury electrode, merits & demerits, supporting electrolyte, current maxima, polarograms, half wave potential, diffusion current, applications

UNIT IV COLLOIDAL ELECTROCHEMISTRY 9

Electrochemical properties of colloids – Charge on colloidal particles, Electrical Double Layer, Cogulation of colloidal sols, Electrokinetic phenomena - Electro-Osmosis – Determination of zeta potential, Electrophoresis – sedimentation potential (Dorn effect), Determination of colloidal particle size, Surfactant, Emulsion, Emulsifiers, gels - Applications

UNIT V ELECTROACTIVE LAYERS AND MODIFIED ELECTRODES 9

Chemically modified electrodes, Types and methods of modification – chemisorption, covalent bond formation, polymer film coatings, inorganic materials, Langmuir-Blodgett (LB) methods, properties of the modified electrodes, electrochemistry at monolayer and multilayer modified electrodes, characterisation of modified electrodes

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would have knowledge of electrode potentials & Nernst equation, electrode reactions, voltammetry, amperometry, and electrochemical sensors.

TEXT BOOKS:

1. J.O.M.Bockris & A.K.N.Reddy, "Modern Electrochemistry –Vol. I & II" , Plenum Press, New York, 2000.
2. Peter Atkins and Julio de Paula, "Physical Chemistry", VII Edition, Oxford University Press, New York, 2002.

REFERENCES:

1. A.J. Bard and L.R. Faulkner, "Electrochemical Methods – Fundamentals and applications" 3rd edition John Wiley & Sons Inc, 2001.
2. Pallab Ghosh,"Colloid and Interface Science",PHI Ltd,2009.

EL6411 FLUID MECHANICS LABORATORY L T P C
0 0 3 2

OBJECTIVE:

To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS

1. Viscosity measurement of non Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle

TOTAL : 45 PERIODS

OUTCOME:

Practical knowledge on the measurement of Fluid Flow and their characteristics at different operating conditions.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Viscometer
2. Venturi meter
3. Orifice meter
4. Rotameter
5. Weir
6. Open drum with orifice
7. Pipes and fittings
8. Helical and spiral coils
9. Centrifugal pump
10. Packed column
11. Fluidized bed

CH6512 MECHANICAL OPERATIONS LABORATORY L T P C
0 0 3 2

OBJECTIVE:

To enable the students to develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

LIST OF EXPERIMENTS

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill

7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving

TOTAL : 45 PERIODS

OUTCOME:

Students would gain the practical knowledge and hands on various separation techniques like filtration, sedimentation, screening, elutriation, and centrifugation

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Sieve shaker
2. Leaf filter
3. Plate and Frame Filter Press
4. Sedimentation Jar
5. Jaw Crusher
6. Ball Mill
7. Cyclone Separator
8. Roll Crusher
9. Elutriator
10. Drop Weight Crusher
11. Sieves.

GE6674 COMMUNICATION AND SOFT SKILLS - LABORATORY BASED L T P C
0 0 4 2

OBJECTIVES:

- To enable learners to develop their communicative competence.
- To facilitate them to hone their soft skills.
- To equip them with employability skills to enhance their prospect of placements.

CONTENTS:

UNIT I LISTENING AND SPEAKING SKILLS 12

Conversational skills (formal and informal) – group discussion and interview skills – making presentations.

Listening to lectures, discussions, talk shows, news programmes, dialogues from TV/radio/Ted talk/Podcast – watching videos on interesting events on Youtube.

UNIT II READING AND WRITING SKILLS 12

Reading different genres of tests ranging from newspapers to philosophical treatises – reading strategies such as graphic organizers, summarizing and interpretation.

Writing job applications – cover letter – resume – emails – letters – memos – reports – blogs – writing for publications.

UNIT III ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS AND PLACEMENTS 12

International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Graduate Record Examination (GRE) – Civil Service (Language related) – Verbal ability.

UNIT IV SOFT SKILLS (1) 12

Motivation – self image – goal setting – managing changes – time management – stress management – leadership traits – team work – career and life planning.

UNIT V SOFT SKILLS (2) 12

Multiple intelligences – emotional intelligence – spiritual quotient (ethics) – intercultural communication – creative and critical thinking – learning styles and strategies.

TOTAL: 60 PERIODS

Teaching Methods:

1. To be totally learner-centric with minimum teacher intervention as the course revolves around practice.
2. Suitable audio/video samples from Podcast/YouTube to be used for illustrative purposes.
3. Portfolio approach for writing to be followed. Learners are to be encouraged to blog, tweet, text and email employing appropriate language.
4. GD/Interview/Role Play/Debate could be conducted off the laboratory (in a regular classroom) but learners are to be exposed to telephonic interview and video conferencing.
5. Learners are to be assigned to read/write/listen/view materials outside the classroom as well for graining proficiency and better participation in the class.

Lab Infrastructure:

S. No.	Description of Equipment (minimum configuration)	Qty Required
1	**Server**	1 No.
	• PIV System	
	• 1 GB RAM / 40 GB HDD	
	• OS: Win 2000 server	
	• Audio card with headphones	
	• JRE 1.3	
2	**Client Systems**	60 Nos.
	• PIII or above	
	• 256 or 512 MB RAM / 40 GB HDD	
	• OS: Win 2000	
	• Audio card with headphones	
	• JRE 1.3	
3	Handicam	1 No.
4	Television 46”	1 No.
5	Collar mike	1 No.
6	Cordless mike	1 No.
7	Audio Mixer	1 No.
8	DVD recorder/player	1 No.
9	LCD Projector with MP3/CD/DVD provision for Audio/video facility	1 No.

Evaluation:

Internal: 20 marks

Record maintenance: Students should write a report on a regular basis on the activities conducted, focusing on the details such as the description of the activity, ideas emerged, learning outcomes and so on. At the end of the semester records can be evaluated out of 20 marks.

External: 80 marks

Online Test	- 35 marks
Interview	- 15 marks
Presentation	- 15 marks
Group Discussion	- 15 marks

Note on Internal and External Evaluation:

1. Interview – mock interview can be conducted on one-on-one basis.
2. Speaking **–** example for role play:
   a. Marketing engineer convincing a customer to buy his product.
   b. Telephonic conversation- fixing an official appointment / placing an order / enquiring and so on.
3. Presentation – should be extempore on simple topics.
4. Discussion – topics of different kinds; general topics, case studies and abstract concept.

OUTCOMES:

At the end of the course, learners should be able to

- Take international examination such as IELTS and TOEFL
- Make presentations and Participate in Group Discussions.
- Successfully answer questions in interviews**.**

REFERENCES:

1. **Business English Certificate Materials,** Cambridge University Press.
2. **Graded Examinations in Spoken English and Spoken English for Work** downloadable materials from Trinity College, London.
3. **International English Language Testing System** Practice Tests, Cambridge University Press.
4. Interactive Multimedia Programs on **Managing Time and Stress.**
5. **Personality Development** (CD-ROM), Times Multimedia, Mumbai.
6. Robert M Sherfield and et al. **"Developing Soft Skills"** 4th edition, New Delhi: Pearson Education, 2009.

Web Sources:

http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
http://www.washington.edu/doit/TeamN/present_tips.html
http://www.oxforddictionaries.com/words/writing-job-applications
http://www.kent.ac.uk/careers/cv/coveringletters.htm
http://www.mindtools.com/pages/article/newCDV_34.htm

EL6501 CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVE:

To provide fundamental understanding on aspects of electrochemistry and materials science relevant to corrosion phenomena and Identify practices for the prevention and remediation of corrosion.

UNIT I BASIC ASPECTS OF CORROSION 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 dissolved gases, salts, pH, temperature and flow rates on 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

OUTCOME:

Upon completion of this course, the student would understand the causes of and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, and various modes of environmentally assisted cracking.

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, London, 2006

REFERENCES:

1. E.E. Stansbury, R.A. Buchanan, “Fundamentals of electrochemical corrosion”, ASM International, 2000.
2. M.G.Fontana & N.D. Greene, “Corrosion Engineering”, III Edition, McGraw Hill, New York, 1978.

EL6502 CHEMICAL PROCESS TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE:

To impart knowledge on various aspects of production engineering and make the student understand the practical methods of production in a chemical factory.

UNIT I SULFUR, SULFURIC ACID AND CEMENT 9

Sulfur, Raw materials Sources, Mining and production of Sulfur – Sulfuric acid, Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.

UNIT II FERTILIZER INDUSTRY, FUEL AND INDUSTRIAL GASES 9

Major Components of Fertilizer industries – Nitrogen industries, ammonia, nitric acid, urea – Phosphorus industries - Phosphorus, Phosphoric acid, Super Phosphate – Potassium chloride, Potassium Sulphate – Fuel Gases – Producer gas, Water gas, Coke oven gas, Natural gas, Liquefied natural gas – Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen.

UNIT III PULP, PAPER, SUGAR AND STARCH INDUSTRIES 9

Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products, Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugar industry – Starch – Methods of production, Starch derivations.

UNIT IV PETROLEUM AND PETRO CHEMICAL INDUSTRIES 9

Petroleum – Chemical Composition, Classification of crude petroleum, Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking, Reforming Polymerization, isomerization and Alkylation – petrochemicals – methanol, chloro methanol, Acetylene and ethylene, Isopropanol, Acrylonitrile, Buta diane – Chemicals from Aromatics - Benzene, Toluene and Xylene.

UNIT V RUBBERS, POLYMERS AND SYNTHETIC FIBRE 9

Natural and Synthetic rubber, SBR – Silicone rubber – polymer – physical – chemical structure of polymers, Thermosetting and Thermoplastic materials - Polymer manufacturing processes – polyethylene, polystyrene – Resins phenolic and epoxy resins – Synthetic Fibers – Viscose rayon, Polyamides and polyesters.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course, the student can classify the chemical process industry into industrial categories of base, intermediate end-products and specialty chemicals manufacturers.

TEXT BOOKS:

1. Dryden, C.E, Outlines of Chemical technology, II Ed., Affiliate East West press, 2003.
2. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, Wiley, 2001.

REFERENCES:

1. Austin, G.T., Shreve's "Chemical Process Industries", 5th ed., McGraw-Hill, 1998.
2. Srikumar Koyikkal,"Chemical Process Technology and Simulation",PHI Learning Ltd 2013.

CH6557 MASS TRANSFER - I

L	T	P	C
3	0	0	3

OBJECTIVES:

Students will learn to determine mass transfer rates under laminar and turbulent conditions.

UNIT I DIFFUSION 9

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

UNIT II INTERFACIAL DIFFUSION 9

Interphase mass transfer. Theories of mass transfer, Phase transfer coefficients and over all mass transfer coefficients. Differential and stage wise contact operations. Concepts of NTU and HTU, Equilibrium and operating lines. Number of equilibrium stages.

UNIT III HUMIDIFICATION 9

Dry and wet bulb temperatures. Adiabatic saturation temperature. Humidity. Relative and percentage humidity. Psychrometric chart. Methods of humidification and dehumidification. Design calculations. Cooling towers. Principle and operation.

UNIT IV CRYSTALLISATION & DRYING 9

Crystallisation. Super saturation, nuclei formation and crystal growth. Theory of crystallisation. Design of industrial crystallisers.

Drying. Drying characteristics of materials. Theory and mechanism of drying. Drying rate curve. Estimation of drying time. Design of industrial drying equipments.

UNIT V ADSORPTION & CHROMATOGRAPHY 9

Physical and chemical adsorption. Adsorption isotherms. Industrial adsorbents. Single stage and multi stage cross current operations. Break through curves. Rate equations for porous and non porous adsorbents. Design of adsorption columns. Chromatography.
Production chromatography.

TOTAL: 45 PERIODS

OUTCOMES:

Students would apply the mass transfer concepts in the design of humidification columns, dryers and crystallisers.

TEXT BOOKS:

1. R.E. Treybal, “Mass Transfer Operations”, Third Edition, McGraw Hill, Singapore, 2001.
2. K. Asokan “Mass Transfer Concepts” , First edition, Universities Press, Hyderabad, & CRC Press, Boca Raton ,U.S.A., 2011.

REFERENCES:

1. B.K Dutta, “Principles of Mass Transfer and Separation Processes” Printice Hall of India, New Delhi, 2007.
2. Geankoplis, C.J., “Transport Processes and Separation Process Principles” IV Edition, Printice Hall of India. New Delhi, 2004.
3. Anantharaman. N and Meera Shariffa Begam. K. M., “ Marr Transfer: Theory and Practice” Printice Hall of India, New Delhi, 2011.

EL6505 INSTRUMENTAL METHODS OF ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVE:

To make the students understand the working principles of different types of instruments and their applications.

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 & THERMOMETRY 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.

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

UNIT IV 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.

UNIT V MICROSCOPY 9

Principles and description of optical and electronic microscopy. Techniques. Sample preparation. Scanning and transmission modes. Analyses involving structure determination. Atomic force microscopy. Scanning and tunneling microscopy.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would have knowledge about the Qualitative and quantitative instrument analysis of different materials.

TEXT BOOKS:

1. G.W.Ewing, “Instrumental Methods of Chemical Analysis”, V edition, Mc Graw Hill, New York, 1985.
2. Hobart Hurd Willard, Lynne.L.Merritt and J.A. Dean, “Instrumental Methods of Analysis”, VII Edition, Wadsworth Publishers, 1988.

REFERENCES:

1. C.N. Banwell, “Fundamentals of Molecular Spectroscopy”, 4th Edition, Tata Mc Graw Hill Publishing co., 1996.
2. Brent Fultz, “ Transmission Electron Microscopy and Diffractometry of materials” Springer, New York, 2009.

EL6503 ELECTRODICS AND ELECTROCATALYSIS

L	T	P	C
3	0	0	3

OBJECTIVE:

To impart necessary basic knowledge in order to understand, analyze and solve problems related to electrochemical processes.

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 – working principles of electrochemistry.

TOTAL : 45 PERIODS

OUTCOME:

Student will have the knowledge on electrical double layer, Electrocatalysis and different types of Electrochemical techniques.

TEXT BOOKS:

1. J.O.M Bockris & A.K.N. Reddy, “Modern Electrochemistry”, Vol.2, Plenum Press (Chapter 7 for unit I: Chapters 8 & 9 for unit II ; chapter 10 for unit III), 1996.
2. A.J.Bard & L.R. Faulkner, ”Electrochemical Methods Fundamentals and Applications”, John Wiley & Sons. 3nd Edition, 2001.

REFERENCES:

1. Paul Delahay, “Double Layer Structure and Electrode Kinetics”, 1965 and publication.
2. James A. Plam Beck , “Electroanalytical Chemistry – Basic Principles and Applications”, John Wiley & sons, Wiley Publication, 1982

EL6504 ELECTROCHEMICAL REACTION ENGINEERING L T P C
3 1 0 4

OBJECTIVES:

To familiarize in the aspects of current-voltage relationships & estimation of mass transfer co-efficient, PFR & CSTR systems model

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.

TOTAL (L:45 + T:15) :60 PERIODS

OUTCOMES:

The students will have a practical ability to analyze electrochemical design models, thermal behavior of reactors and electrochemical reactors.

TEXT BOOK:

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

REFERENCE:

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

EL6511 CHEMICAL REACTION ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

OBJECTIVES:

To make the students experimentally determine the kinetic constant of a given reaction, parameters of non-ideal flow models, conversion in a batch reactor, tubular reactor and mixed flow reactor and compare with the theoretically predicted conversions

LIST OF EXPERIMENTS

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: 45 PERIODS

OUTCOME:

Students would develop sound working knowledge on different types of reactors.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Batch Reactor
2. Plug flow reactor
3. CSTR
4. Sono-chemical reactor
5. Photochemical reactor
6. Packed bed reactor

*Minimum 10 experiments shall be offered.

REFERENCE:

1. Laboratory Manual prepared by Faculty

PC6612 HEAT AND MASS TRANSFER LABORATORY

L	T	P	C
0	0	3	2

(**Any Ten experiments**)

OBJECTIVES:

Enable the students to develop a sound working knowledge on different types of heat transfer equipments and mass transfer equipments.

LIST OF EXPERIMENTS

1. Transient state heat conduction
2. Solvent extraction
3. Batch drying
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
12. Double pipe heat exchanger

TOTAL : 45 PERIODS

OUTCOME:

Student would be able to calculate heat transfer by conduction, different types of convection using classical models for these phenomena. Students would demonstrate knowledge on the determination of important data for the design and operation of the process equipment's like distillation, extraction, diffusivity, drying principles which are having wide applications in various industries

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Data Loger
2. Heat Exchanger
3. Condenser
4. Thermal conductivity measurement apparatus
5. Soxlet Extractor
6. Rotating Disc Contactor
7. Controllers of Temperature
8. Convection Apparatus
9. Emissivity measurement apparatus
10. Distillation Apparatus
11. Double pipe heat exchanger
12. Diffusion Apparatus

REFERENCE:

1. Laboratory Manual prepared by Faculty

EL6513 ELECTROCHEMICAL REACTION ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

OBJECTIVE:

To make the students to experimentally determine the kinetic constant and conversion of a given electrochemical, reaction in a batch reactor, tubular reactor and mixed flow reactor and compare with the theoretically predicted conversions

LIST OF EXPERIMENTS

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 batch reactor – Constant current operations for Copper/Titanium/Stainless steel electrode.
5. Electrochemical batch reactor - constant potential operation.
6. Continuous flow stirred tank electrochemical reactor (CSTER)
7. Axial flow electrochemical reactor (PFER) – Single out let
8. Packed bed reactor-flow through configuration - (Glass beeds)
9. Packed bed reactor – Flow through configuration (Copper bed)
10. Axial flow electrochemical Reactor – Three out lets (PFER)

TOTAL: 45 PERIODS

OUTCOMES:
Students would develop a sound working knowledge of electrochemical reaction on different types of reactors

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Electrochemical batch reactor
2. Chemical Bath
3. CSTER
4. PFER
5. Packed bed reactor
6. Axial flow electrochemical Reactor

REFERENCE:

1. Laboratory Manual prepared by Faculty

EL6601 ELECTROCHEMICAL MATERIALS SCIENCE

L	T	P	C
3	0	0	3

OBJECTIVE:
This course will give an introduction to basic electrochemistry, principles of electrochemical devices, electroactive materials used in such devices, and case studies of batteries and sensors.

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 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 IV 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.

UNIT V BIOMATERIALS 9

Biomaterials science – Artificial Organs - heart valve prosthesis – Artificial flip joints – Dental implants – Intraocular lenses – left Ventricular Assist Device – Vascular grafts – stents – Pacemakers – Biocompatibility – Drug Delivery Systems – Surface modification of bio implants – Electrochemical characterization in Artificial saliva – Interaction between bio materials and cell tissues.

TOTAL : 45 PERIODS

OUTCOME:

At the end of this course, the student would know integration of electrochemical principles and materials science for application in modern electrochemical devices

TEXT BOOKS:

1. K.L. Chopra and S.R.Das, "Thin Film solar cells", Plenum New York, 1983. (Chapter 5 &10 for Unit II & V.
2. R.K.Kotnala and N.P.Singh , "Essentials of solar cells", Allied Publishers P.Ltd., New Delhi, 1986 (Chapter 5 to 8 for Unit I, III & IV).

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.

CH6653 MASS TRANSFER - II

L	T	P	C
3	0	0	3

OBJECTIVE:

To provide introduction to physical and thermodynamic principles of mass transfer with an emphasis on how these principles affect the design of equipment and result in specific requirements for quality and capacity.

UNIT I GAS ABSORPTION 9

Absorption. Design of absorption towers. Pressure drop. Loading and flooding in absorption towers. Calculations of HTU, NTU, and number of theoretical stages in absorption towers. Absorption coefficient.

UNIT II DISTILLATION 9

Distillation. Vapor-liquid equilibria. Volatility and relative volatility. Methods of distillation. Batch, flash, steam, low pressure, azeotropic and extractive distillations. Design calculations. Introduction to multi component distillation.

UNIT III 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 and Ponchon – Savarit methods.

UNIT IV 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.

UNIT V MEMBRANE SEPARATION PROCESSES 9

Membranes. Types and characteristics of membranes. Separation of gases. Separation of liquids. Osmosis. Reverse osmosis. Dialysis, Electrodialysis. Pervaporation. Ultra filtration. Industrial applications

TOTAL : 45 PERIODS

OUTCOMES:

Students would have learnt to design absorber and stripper, distillation column, extraction and leaching equipments and adsorber.

TEXT BOOKS:

1. R.E. Treybal, "Mass Transfer Operations", Third Edition, Mc Graw Hill, Singapore, 2001.
2. K. Asokan "Mass Transfer Concepts" , First edition, Universities Press, Hyderabad, & CRC Press, Boca Raton ,U.S.A., 2011.

REFERENCES:

1. J. D. Seader and E.J. Henley, Separation Process Principles, Wiley, New York, 1998.
2. B. K. Dutta "Principles of Mass Transfer and Separation Processes" Printice Hall of India, New Delhi, 2007.
3. Anantharaman. N and Meera Shariffa Begam. K. M. " Marr Transfer: Theory and Practice" Printice Hall of India, New Delhi, 2011

EL6602 INDUSTRIAL METAL FINISHING

L	T	P	C
3	0	0	3

OBJECTIVE:

To enable the students

- To differentiate between the electroplating and anodizing process and
- To compare the various engineering aspects and electroplating process.

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. Sulphuic 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

OUTCOME:

Upon completion of this course, the students will understand the importance and applications of electroplating techniques and anodizing concepts.

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

REFERENCES:

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

EL6603 INSTRUMENTATION

L	T	P	C
3	0	0	3

OBJECTIVE:

To enable the students to get knowledge on how to measure process variables, analytical instrumentation, automatic process controls.

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/SIGNAL CONDITIONING UNIT 9

Block diagram of operational amplifier – ideal operational amplifier – characteristics- Non-inverting mode – inverting mode – definition of CMPR and 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 INPUT/OUTPUT UNIT 9

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

UNIT IV PROCESS INSTRUMENTATION 9

Process control principles and system elements - Pressure measurement using bellows and LVDT – Electrical conductivity measurement of solution –p_H measurement using glass electrodes – temperature measurement – monitoring and control (RTD, Thermister and Thermocouple only).

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

OUTCOME:

The students would have knowledge on control equipments used to control the production process of a chemical factory and the mechanism of control through automation and computers.

TEXT BOOKS:

1. A.K.Sawhney, " A course in Electrical and Electronics measurement and instrumentation", Dhanpat Rai Publication, New Delhi, 1994. (Unit I & II)
2. Curties D.Johnson, "Process Control Instrumentation Technology" 5th Edition, Prentice Hall, New Delhi, 1997. (Unit IV)
3. A.J.Bard & L.R. Faulkner, "Electrochemical Methods Fundamentals and Applications", 3rd Edition, John Wiley & Sons.New York, 2001 (Unit V)
4. Ramesh S Gaonkar, "Microprocessor Architecture, programming and applications with 8085" Printice Hall of India, New Delhi, 2002. (Unit III)

REFERENCES:

1. Howard A Strobel, Electrochemical Instrumentation, a system approach, Addition weiley publishing company, New York, 1973.
2. Albert Paul Malvino, " Electronic Principles", Seventh edition, Tata McGraw - Hill,New Delhi,1998 (Chapter15 to 18).

EL6604 ELECTROCHEMICAL PROCESS TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE:

To provide an adequate mastery in the principles involved in the electrochemical process and its applications.

UNIT I ELECTRODES AND SEPARATORS 9

Electrodes and separators for the electrolytic production of chemicals – preparation, characteristics and applications of graphite, magnetite, lead dioxide coated anodes, noble metal coated anodes, noble metal oxide coated anodes, spinal anodes, Perovskite platinum and nickel 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 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 ELECTRO POLYMERIZATION AND ELECTRO ORGANIC PROCESSES 9

Electro polymerization. Anodic and cathodic polymerization. Electrochemical preparation of conducting polymers - polyacetylene, polypyrrole, polythiophene, polyaniline and their applications. Industrial Electro organic processes - 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.

TOTAL : 45 PERIODS

OUTCOME:

Students would have knowledge on basic electrochemical concepts, electrodes and electrodialysis and electropolymerization.

TEXT BOOKS:

1. D.Pletcher and F.C.Walsh, “Industrial Electrochemistry”, II Edition Chapman and Hall, London,1990.
2. M.M.Baizer, “Organic Electrochemistry”, II Edition, Dekker Inc, Newyork, 1983.

REFERENCES:

1. M.R. Rifi and F. H. Covitz, “Introduction to Organic Electrochemistry”, Marcel Dekker Inc. NewYork, 1994.
2. D. Kyriacou, “Modern Electro Organic chemistry” Springer, New York, 1994.

EL6605 PROCESS DYNAMICS AND CONTROL L T P C

3 1 0 4

OBJECTIVE:

To introduce open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation.

UNIT I INSTRUMENTATION 9

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS 9

Laplace transformation and its application in process control. First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

UNIT III CLOSED LOOP SYSTEMS 9

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE 9

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules.

UNIT V ADVANCED CONTROL SYSTEMS 9

Introduction to advanced control systems, cascade control, feed forward control, Smith predictor, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

TOTAL (L : 45 + T : 15) : 60 PERIODS

OUTCOME:

Upon completion of this course, the students will understand and discuss the importance of process control in process operation and the role of process control engineers They also Understand and design the modern hardware and instrumentation needed to implement process control.

TEXT BOOKS:

1. Stephanopoulos, G., "Chemical Process Control", Prentice Hall of India, 2003.
2. Coughnowr, D., " Process Systems Analysis and Control ", 3rd Edn., McGraw Hill, New York, 2008.

REFERENCES:

1. Marlin, T. E., " Process Control ", 2nd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edn., John Wiley, New York, 1997.
3. Jason L. Speyer, Walter H.Chung, "Stochastic Processes, Estimation, and Control",PHI Ltd (2013).

EL6611 EQUIPMENT DESIGN

L	T	P	C
0	0	3	2

(All Tables/Chemical Engineers' Handbook/Data Books are permitted during the Examination.)

OBJECTIVE:

To develop skill to design and install process equipments used widely in a chemical industry.

UNIT I

Fundamental principles, equations, general design and drawing considerations of cooling towers, evaporators and driers.

UNIT II
Heat exchangers, condensers and reboilers.

UNIT III
Distillation columns- sieve tray, and bubble cap tray columns and packed column.

UNIT IV
Equipments for absorption and adsorption of gases.

UNIT V
Equipments for liquid-liquid extraction and solid-liquid extraction.

TOTAL :45 PERIODS

OUTCOME:
Students would gain knowledge to develop key concepts and techniques to design the process equipment in a process plant. These key concepts would be utilized to make design and operating decisions.

TEXT BOOKS:
1. Joshi M.V., Mahajani V.V., and Umerji.S.B., : "Process Equipement Design", MacMillan, Delhi, 2010.
2. Coulson – Richardson Chemical Engineering Series Vol 6: Ray Sinnott and Gavin Towler "Chemical Engineering Design", Elsevier, Oxford, 2009.

REFERENCES:
1. Brownell, L.E, and Young, E.H.:"Process Equipment Design", Wiley Eastern, New Delhi, 1977.
2. Backhurst, J.R. and Harker, J.H. "Process Plant Design", American Elsevier, New York, 1973.
3. Suresh C. Madigarai,"Chemial Process Equipment Design and Drawing" Vol 1,PHI,2012

EL6612	COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING LABORATORY (Any Ten experiments)	L	T	P	C
		0	0	3	2

OBJECTIVES:
To train the students in application of computers for chemical engineering processes

LIST OF EXPERIMENTS
1. Introduction to computer applications and introduction to Excel and Matlab
2. Introduction to Aspen
3. Equations of state
4. Vapor-Liquid Equilibrium
5. Chemical reaction Equilibrium
6. Mass balances with recycle streams
7. Simulation of Mass transfer equipment
8. Process simulations
9. Introduction to Comsol
10. Chemical Reactors
11. Transport processes in one dimension
12. Fluid flow in two and three dimensions
13. Convective diffusion equation in two and three dimensions

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this programme, the students would be able to apply computer programming for chemical engineering processes.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Mat Lab Software
2. ASPEN software
3. COMSOL software
4. CFD software

TEXT BOOK:

1. B. A. Finlayson, "Introduction to Chemical Engineering Computing", Wiley India, New Delhi,2006

REFERENCES:

1. Computer methods in chemical engineering, N. Ghasem, CRC Press Boca Raton, 2011
2. Process simulations and control using ASPEN, A. K. Jana, Prentice-Hall India, New Delhi, 2010

EL6613	CORROSION AND METAL FINISHING LABORATORY	L	T	P	C
		0	0	3	2

OBJECTIVE:
To train the students to understand the techniques to measure the corrosion rate and hands-on experience in metal finishing.

LIST OF EXPERIMENTS

CORROSION

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

METAL FINISHING
(Any Five experiments)

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 & Analysis of nickel plating solution
7. Electrophoretic deposition
8. Electroless Plating

TOTAL : 45 PERIODS

OUTCOMES:
Students would have knowledge on the determination of corrosion rate and techniques for metal finishing

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Electroplating Bath
2. Hull Cell Electroplating Bath
3. Sacrificial anode system
4. Rectifier
5. Galvanostatic polarization apparatus

REFERENCE:

1. Laboratory Manual prepared by Faculty.

CH6751 PROCESS MODELING AND SIMULATION

L	T	P	C
3	0	0	3

OBJECTIVE:

To give an overview of various methods of process modeling, different computational techniques for simulation.

UNIT I INTRODUCTION 3

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS 9

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS 9

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM 7

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES 13

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations. Empirical modeling, parameter estimation, population balance and stochastic modeling.

TOTAL : 45 PERIODS

OUTCOME:

Student whould have understood development of process models based on conservation principles and process data.

TEXT BOOKS:

1. Ramirez, W.; " Computational Methods in Process Simulation ", II Edition, Butterworths , New York, 2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ", II Edition, McGraw-Hill New York, 1990.

REFERENCES:

1. Felder, R. M. and Rousseau, R. W., " Elementary Principles of Chemical Processes", II Edition, John Wiley, 2000.
2. Jana, A.K., " Chemical Process Modeling and Computer Simulation" Printice Hall of India, New Delhi,2008.
3. Amiya K. Jana,"Process Simulation and Control Using ASPEN", 2nd Edn,PHI Learning Ltd (2012).
4. Amiya K. Jana,"ChemicalProcess Modelling and Computer Simulation" 2nd Edn,PHI Learning Ltd (2011).

EL6701	PROCESS SYNTHESIS AND DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVE:

To enable the students to understand the process creation, heuristics and economics. To give exposure in the process scheduling, optimization and plant wide control.

UNIT I PROCESS CREATION, HEURISTICS AND ECONOMICS 9

Introduction to process design and process creation, role of process simulation in design, heuristics for process synthesis, introduction to process intensification, cost accounting and capital cost estimation, annual costs, earning and profitability analysis

UNIT II HEAT AND POWER INTEGRATION, SEPARATION TRAIN SYNTHESIS 9

Minimum utility targets, networks for maximum energy recovery, minmum number of heat exchangers, threshold and optimal approach temperature, superstructure for minimization of annual costs, multiple utilities and heat-integrated distillation trains, heat engines and heat pumps, Criteria for selection of separation methods, Sequencying of ordinary distillation columns for separation of nearly ideal and non-ideal fluid mixtures, Separation systems for gas mixtures, Separation sequencing for solid-fluid systems

UNIT III ALGORITHIMIC METHODS 9

Reactor design and reactor network synthesis, Principles of attainable regions, Locating the separation section with respect to the reactor section, Tradeoffs in processes involving recycle, Optimal reactor conversion, Recycle to extinction, Snowball effect and control of processes involving recycle

UNIT IV DESIGN, EQUIPMENT SIZING AND OPTIMIZATION 9

Review of heat exchanger design, heat transfer coefficients and pressure drop, Design of Shell-Tube heat exchanger, Overview of separation tower design Fenske-Underwood-Gilliland Shortcut method for ordinary distillation, Kemser method for absorption and stripping, Plate efficiency and HETP, Tower diameter, Pressure drop and Weeping, Design of pumps, compressors and expanders

UNIT V PROCESS SCHEDULING, OPTIMIZATION, PLANTWIDE CONTROL 9

Optimal design and scheduling of batch processes, Design of reactor-Separator Processes, Design of single and multiproduct processing sequence, general formulation and classification of the process optimization problem, Linear and non-linear programming with a single variable, Conditions for Non-linear programming by gradient methods with two or more design variables, Introduction to optimization algorithm, Introduction to plant-wide control.

TOTAL: 45 PERIODS

OUTCOMES:
Students whould have learnt the process synthesis, algorithm methods and able to design the chemical process.

TEXT BOOK:
1. W. D. Seider, J. D. Seader and D. R. Lewin, " Product and process design principles", 3nd edition, Wiley - India, New Delhi, 2005

REFERENCES:
1. L. T. Biegler, E. I. Grossmann, A. W. Westerberg, "Systematic methods of chemical process design", Prentice-Hall, Newyork, 1997
2. G. Towler and R. Sinnott, "Chemical Engineering Design", Butterworth Heinemann, Maryland Heights, 2012.

GE6351 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:
To the study of nature and the facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 12
Definition, scope and importance of Risk and hazards; Chemical hazards, Physical hazards, Biological hazards in the environment – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers-Oxygen cycle and Nitrogen cycle – energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds
Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 10

Definition – causes, effects and control measures of: (a) Air pollution (Atmospheric chemistry- Chemical composition of the atmosphere; Chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, oxygen and ozone chemistry;- Mitigation procedures- Control of particulate and gaseous emission, Control of SO_2, NO_X, CO and HC) (b) Water pollution : Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters – physical, chemical and biological; absorption of heavy metals - Water treatment processes. (c) Soil pollution - soil waste management: causes, effects and control measures of municipal solid wastes – (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards–role of an individual in prevention of pollution – pollution case studies –

Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Energy Conversion processes – Biogas – production and uses, anaerobic digestion; case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Introduction to Environmental Biochemistry: Proteins –Biochemical degradation of pollutants, Bioconversion of pollutants.

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

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air act – Water act – Wildlife protection act – Forest conservation act –The Biomedical Waste (Management and Handling) Rules; 1998 and amendments- scheme of labeling of environmentally friendly products (Ecomark). enforcement machinery involved in environmental legislation- central and state pollution control boards- disaster management: floods, earthquake, cyclone and landslides.

Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- -GIS-remote sensing-role of information technology in environment and human health – Case studies.

TOTAL : 45 PERIODS

OUTCOMES:

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2006).

REFERENCES:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia',Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005)

EL6703 TRANSPORT PHENOMENA

L	T	P	C
3	0	0	3

OBJECTIVE:

To impart knowledge on different types of fluids, their flow characteristics and different mathematical models; enable the students to apply to actual situations.

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

OUTCOME:

Upon completion of this course, the students would have knowledge of fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes.

TEXT BOOKS:

1. Bird R.B, Stewart W.E and Lightfoot E.W, "Transport Phenomena", second edition, Wiley India, New Delhi, 2006.
2. Welty J.R, Wicks C.E and Wilson R.E, "Fundamentals of Momentum, Heat and Mass Transfer", V Edition, Wiley-India, New Delhi, 2007.

REFERENCES:

1. Geankoplis C.J, "Transport Processes and Separation Process Principles", IV Edition, Printice Hall of India, New Delhi, 2004.
2. Bennett, C.O., and Meyers, J.E.," Momentum, Heat and Mass Transfer" Tata - Mc Graw Hill, New Delhi, 1983.

EL6702 ELECTROMETALLURGY AND THERMICS

L	T	P	C
3	0	0	3

OBJECTIVE:

This course aims to provide the basics of hydrometallurgy and electrometallurgy techniques that are used in the processing of minerals

UNIT I INTRODUCTION 9

Metallurgical industries in India with special reference to electrometallurgical industries. Preparation of cell feed for copper, zinc, aluminium, magnesium and electrolytic cells. Principles of solvent extraction/ ion exchange for the recovery of metallic values. Pollution and control measures adopted/recom. mended in electrometallurgical Industries like Al, 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 lead and silver.

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

OUTCOME:

Upon completion of this course, the students would understand the electrometallurgy techniques that are used in the various Industries.

TEXT BOOKS:

1. K. I. Popov, S. S. Djokic and B. N. Grgur. "Fundementals of Electrometallurgy", Kluwer Academic Publishing, 2002
2. H.S. Ray, Sridar and K.P. Abraham, "Extraction of Non-ferrous metals", Affiliated East-West press, New Delhi, 1985.

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.

EL6711	BATTERIES AND ELECTROCHEMICAL MATERIALS SCIENCE LABORATORY	L	T	P	C
		0	0	3	2

OBJECTIVES:

To enable the students understand the techniques to measure the battery characteristic and photo-conductive cells.

LIST OF EXPERIMENTS

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 dc 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 graphicalmethods.

ELECTROCHEMICAL MATERIAL SCIENCE

(Any Five experiments)

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 semiconducting thin films by the electrochemical route and find the growth rate of thickness for different time intervals.
7. Power Characteristics of Photoelectrochemical cell

DEMONSTRATION

1. Mott-Schottky plot from capacitance measurements and estimation of the flat-band potential and carrier concentration (Demonstration)
2. Preparation of thin films by physical vapor deposition methods (Electron Beam Evaporation and Pulsed Laser Deposition) [Demonstration]

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this practical course, the students will have in-depth knowledge on characterization of batteries.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Water Inhibition Apparatus
2. Rectifier
3. Constant current discharge apparatus
4. Constant current charge apparatus
5. Chemical bath deposition apparatus
6. Photo-conductivity meter
7. Solar cell apparatus
8. Photo electrochemical cell

REFERENCE:

1. Laboratory Manual prepared by Faculty.

EL6712	**ELECTROCHEMICALS AND ELECTRO METALLURGY LABORATORY**	**L T P C 0 0 3 2**

OBJECTIVES:

To train the students on methodology of the preparation of electrochemicals.

LIST OF EXPERIMENTS

ELECTROCHEMICALS

(Any Five experiments)

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

ELECTROTHERMICS
(Any Five experiments)

7. Electro winning of zinc.
8. Determination of etching rate of copper in acidic/ammonical medium.
9. Determination of limiting current for electrodeposition of copper.
10. Determination of decomposition potential for electrodeposition of copper
11. Stripping and extraction efficiency of D2EHPA for zinc ion.
12. Recovery of metals by ion exchange resins.

TOTAL: 45 PERIODS

OUTCOMES:

Students would have knowledge on the preparation of electrochemicals and electrometallurgy techniques that are used in the various Industries.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Ion exchange apparatus
2. Electrochemical bath
3. Membrane Cell
4. Electrolytic Cell
5. Etching apparatus
6. Hull Cell
7. Packed bed resin column

REFERENCE:

1. Laboratory Manual prepared by Faculty.

EL6713	PROCESS DYNAMICS AND CONTROL LABORATORY	L T P C 0 0 3 2

OBJECTIVE:

To train the students to determine experimentally the methods of controlling the processes including measurements using process simulation techniques.

LIST OF EXPERIMENTS

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a level system
10. Tuning of a pressure system
11. Tuning of a thermal system
12. Flow co-efficient of control valves
13. Characteristics of different types of control valves
14. Closed loop study on a pressure system
15. Tuning of pressure system
16. Closed loop response of cascade control system

*Minimum 10 experiments shall be Offered.

TOTAL : 45 PERIODS

OUTCOMES:
Upon completion of this practical course, the students would know development and use of right type of control dynamics for process control under different operative conditions.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS:
1. U tube manometer with controller
2. Interacting Tank
3. Non Interacting Tank
4. Open loop control system
5. Closed loop control system
6. ON/OFF controller
7. Control valve characteristics
8. Pressure Tuner
9. Temperature Tuner
10. Proportional Controller
11. Flow Transmitter
12. Level Transmitter
13. Cascade control system

EL6801	ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE	L	T	P	C
		3	0	0	3

OBJECTIVES:
To enable the students to gain the knowledge of principle and applications of batteries and fuel cells.

UNIT I FUNDAMENTALS 9
EMF, reversible and irreversible cells, free energy, effect of cell temperature, thermodynamic calculation of the capacity of a battery, calculations of energy density of cells.

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, charging methods, battery age & storage condition.

UNIT III STORAGE BATTERIES 9
Principle, design, construction, performance characteristics, advantage and disadvantages. Primary batteries - Zn-MnO_2 carbon-zinc, carbon-zinc chlorides, and zinc-silver oxide. Secondary batteries – lead-acid, nickel-cadmium, nickel-metal hydride, silver oxide-zinc system, lithium-ion, lithium- polymer.
Batteries for electric vehicle applications, Micro batteries.

UNIT IV TESTING & EVALUATION 9
Evaluation of active mass, surface area measurement - BET method. Internal resistance of cells - A.C. methods impedance method. Testing of capacity, retention of charge, vibration, life, efficiency, leakage for sealed cells, High rate discharge, testing of separators.

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. Polymer electrolyte and solid oxide fuel cells. Material related challenges. Stack engineering. Microbial fuel cells.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the students would know designing of batteries and fuel cells for various applications.

TEXT BOOKS:

1. M. Mench, "Fuel Cell Engines", John Wiley, New York, 2008.
2. B. E. Conway, "Electrochemical Supercapacitors : Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum publishers, New York, 1999.

REFERENCES:

1. Gholam Abbas Nazri, "Lithium Batteries – Science and Technology", Springer, New York, 2009.
2. D.Pavlov, "Lead – Acid Batteries: Science and Technology", Elsevier, Amsterdam, 2011.

EL6802 SURFACE SCIENCE

L	T	P	C
3	0	0	3

OBJECTIVE:

To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES 9

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, absorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

UNIT III LIQUID INTERFACES 9

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

UNIT IV HETEROGENEOUS CATALYSIS 9

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fishcher-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

TEXT BOOK:

1. K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

REFERENCE:

1. Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.

EL6811 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/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 an Electrochemical Engineer on a new manufacturing proposal.

VIVA – VOCE

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

CH6018 PROCESS PLANT UTILITIES

L	T	P	C
3	0	0	3

OBJECTIVE:

To enable the students to understand the process plant utilities and optimization techniques to optimize various parameters in chemical industries.

UNIT I IMPORTANCE OF UTILITIES 9

Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

UNIT II STEAM AND STEAM GENERATION 9

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

UNIT III REFRIGERATION 9

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.

UNIT IV COMPRESSED AIR 9

Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air –Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.

UNIT V FUEL AND WASTE DISPOSAL 9

Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. Internal Combustion Engine, Petrol and Diesel Engine. Waste Disposal.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of this course, the students will understand the importance of health, safety and the environment in process industries. Steam, power, water, air are extensively used in process industries and their efficient operation is imperative for economic and safe operation is essential for the survival of industries

TEXT BOOKS:

1. Eckenfelder, W. W, Jr. “Industrial Water Pollution Control” McGraw-Hill: New York, 2006.
2. P. L. Ballaney, “Thermal Engineering”, Khanna Publisher New Delhi, 2010.
3. P. N. Ananthanarayan, “Basic Refrigeration & Air conditioning”, Tata McGraw Hill, New Delhi, 2007.

REFERENCE:

1. Perry R. H. Green D. W. “Perry's chemical Engineer's Handbook”, McGraw Hill, New York, 2007.

EL6001 OPTIMIZATION OF CHEMICAL PROCESSES

L	T	P	C
3	0	0	3

OBJECTIVE:

To acquaint the student with the concepts and techniques of single and multivariable optimization techniques using numerical search and analytical methods

UNIT I INTRODUCTION 5

Introduction to optimization; applications of optimization in chemical engineering; classification of optimization problems.

UNIT II SINGLE VARIABLE OPTIMIZATION 9

Necessary and sufficient conditions for optimum; region elimination methods; interpolation methods; direct root methods.

UNIT III MULTIVARIABLE OPTIMIZATION WITHOUT AND WITH CONSTRAINTS 9

Necessary and sufficient conditions for optimum; direct search methods; indirect search methods.

UNIT IV OTHER OPTIMIZATION METHODS 9

Introduction to geometric, dynamic and integer programming and genetic algorithms.

UNIT V APPLICATIONS OF OPTIMIZATION 13

Formulation of objective functions; fitting models to data; applications in fluid mechanics, heat transfer, mass transfer, reaction engineering, equipment design, resource allocation and inventory control.

TOTAL : 45 PERIODS

OUTCOME:

At the end of the course, the students will be able to optimize the problems related to design, planning and operations involved in a chemical industry

TEXT BOOKS:

1. Rao, S. S., “Engineering Optimization - Theory and Practice” , John Wiley, New York, 1996.
2. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes ", McGraw-Hill, New York, 1985.
3. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimisation ", John Wiley, New York, 1980.

EL6002	ADVANCED ELECTROCHEMICAL REACTION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE:

To make the students learn the kinetics of electrochemical engineering

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, p 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

OUTCOME:

At the end of this course, the student would be in a position to understand advanced electrochemical reaction, plug flow reactors and migration & current distribution in reactors.

TEXT BOOKS:

1. Scott. K, “Electrochemical Reaction Engineering”, Plenum Press, New York, 1991.
2. T.Z Fahidy, “Principles of Electrochemical Reactor Analysis,” Elsvier science publishers, New York, 1985.

REFERENCES:

1. New man – J.S., Alyear K.E., “Electrochemcial Systems” JohnWiley, New York, 2004.
2. F.Goodridge and Scott, K.. “Electrochemical Processes Engineering” Springer, New York 1995.

EL6003 TOTAL QUALITY MANAGEMENT AND ENGINEERING ECONOMICS

L	T	P	C
3	0	0	3

OBJECTIVE:

To provide the student with the underlying principles and techniques of Total Quality Management (TQM) with emphasis on their application to technical organizations.

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

OUTCOME:

Students will learn to view quality from a variety of functional perspectives and in the process, gain a better understanding of the problems associated with improving quality, also quality tools utilized in service and international/environment.

TEXT BOOKS:

1. Dale H. Besterfiled, et al., “Total Quality Management”, Pearson Education Inc, New Jersey, 2003.
2. Schweyer , H.E, “Process Engineering Economics” McGraw Hill, New York, 1955.

REFERENCES:

1. Feigenbaum. A.V. “Total Quality Control” , McGraw Hill, New York, 1991.
2. Oakland.J.S. “Total Quality Management” Butterworth – Hcinemann Ltd., Oxford, 1994.

EL6004 CHLOR - ALKALI TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

To enable the students to understand the process of Chlor alkali technology and the unit operations involved in the process.

UNIT I ELECTRODES AND SEPERATORS 9

Anodes, cathodes and separators for chlor – alkali production. Graphite anodes and metal anodes. Steel cathodes, coated cathodes, and gas diffusion cathodes. Asbestos diaphragms and polymer diaphragms. Cation exchange membranes – different types, preparation and characteristics.

UNIT II CONVENTIONAL PROCESSES 9

Diaphragm cell process, different cell designs and 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 and 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

OUTCOMES:

Students would be able to explain the material requirements, chemical reactions and operations carried out in production of Chlor-Alkali industry

TEXT BOOKS:

1. S.Sealey, (Ed) "Modern Chlor – Alkali Technology – Volume 7", Society of Chemical Industry, London, 1998.
2. J.Moorehouse (ED), "Modern Chlor – Alkali Technology – Volume 8" Blackwell Science, London, 2001.

REFERENCES:

1. "Ullmann's Encyclopedia of Industrial Chemistry", Vol.8, Weinheim, Wiley Interscience, New York, pp. 92-204, 2012
2. Othmer, " Encyclopedia of Chemical Technology", 5th Edition, Vol : 6, pp 531-622, 2004.

EL6005 CATHODIC PROTECTION & ELECTRO PHORETIC COATINGS

L	T	P	C
3	0	0	3

OBJECTIVES:

To familiarize the students with the basics of cathodic protection and electrophoretic coatings.

UNIT I BASICS OF CATHODIC PROTECTION 9

Basics of cathodic protection. 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. Protective potentials for different methods.

UNIT II SACRIFICIAL ANODE SYSTEM & IMPRESSED CURRENT SYSTEM 9

Cathodic protection system, components of galvanic systems, galvanic anodes, fields of application and backfills for sacrificial anodes. Advantages and disadvantages of sacrificial anode system. Impressed current system, impressed current anodes, fields of application and backfills for impressed current anodes.

UNIT III DESIGNING OF CP SYSTEM 9

Design parameters in cathodic protection, soil resistivity measurement, pipe to soil potential data, pH determination, redox potential measurement, coating resistance, stray current measurement and cathodic protection interferences designing of sacrificial anode system - designing of impressed current system - designing of cathodic protection to ship hull

UNIT IV BASIC CONCEPTS OF ELECTRO PHORETIC COATINGS 9

Electrical Constitution of Aqueous Solutions, Dispersions and Suspensions of Paint Binders-Electrokinetic Effects-Electrochemical Parameters of Colloid Particles- Electro-osmosis-Voltage and current Relations in Elctropainting-Throwing power & other factors in Elctropainting- Pretreatment for Elctropainting-Synthetic resins used for Elctropainting.

UNIT V APPLIED ASPECTS OF ELECTRO PHORETIC COATINGS 9

Installations for Elctropainting- Paint bath stability, Control, & Replenishment-Testing of paint bath-Effluent treatment-Process involved in Elctropainting installations-Economics.

TOTAL : 45 PERIODS

OUTCOMES:

Students would be able to design the cathodic protection systems and applied aspects of electrophoretic coatings.

TEXT BOOKS:

1. Zaki Ahmad, “Principles of Corrosion Engineering and Corrosion Control”, Butterworth - Heinemann, London, 2006.
2. Willibald Machu, ”Hand book of Electro Painting Technology” Electrochemical Publications Limited, 1978.

REFERENCE:

1. Peabody A.N and Blanchetti R.L. , “Control of Pipeline Corrosion”, NACE Int., Texas, 2001.

EL6006 FUNCTIONAL MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVE:

The course emphasis on the molecular safe assembly and materials for polymer electronics

UNIT I INTRODUCTION 9

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

UNIT II MOLECULAR SELF ASSEMBLY 9

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

UNIT III BIO-INSPIRED MATERIALS 9

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, ‘Bionics’-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization- En route to Nanotechnology.

UNIT IV SMART OR INTELLIGENT MATERIALS 9

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composities.

UNIT V MATERIALS FOR POLYMER ELECTRONICS 9

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

TOTAL : 45 PERIODS

OUTCOME:

Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

TEXTBOOK:

1. Vijayamohanan K. Pillai and Meera Parthasarathy, "Functional Materials: A chemist's perpective", Universities Press Hyderabad (2012).

REFERENCE:

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

EL6007 ORGANIC ELECTROCHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVE:

To impart the knowledge of fundamental aspects of electrochemistry, as well as techniques for characterizing surfaces under electrochemical conditions.

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, photoelectron chemistry, paired electro synthesis.

TOTAL: 45 PERIODS

OUTCOME:

Upon completion of this course, the students will be able to analyse and answer questions on a number of electrochemical reactions such as metal deposition and electroorganic reactions.

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.