ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

R – 2013

B. TECH. POLYMER TECHNOLOGY

Polymer Technology focuses on polymeric materials such as plastics, rubber, latex and composites. These involve synthesis, processing, design and production of polymer products, quality control and the properties of polymers.

PROGRAMME OBJECTIVES:

a. To produce employable graduates with the knowledge and competency in Polymer technology complemented by the appropriate skills and attributes.
b. To produce creative and innovative graduates with design and soft skills to carry out various problem solving tasks.
c. 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.
d. To produce graduates who possess interest in research and lifelong learning, as well as continuously striving for the forefront of technology.

PROGRAMME OUTCOMES:

The students would have

a. An ability to apply knowledge of science and engineering fundamentals in polymer technology and related fields
b. Acquired in-depth technical competence in polymer technology discipline
c. An ability to design a polymer related system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. An ability to function on multi-disciplinary teams to produce polymeric products. An ability to undertake problem identification, formulation and solution in polymer technology
e. An understanding of professional and ethical responsibility
f. An ability to communicate effectively with engineers and the community at large,
g. The knowledge necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context,
h. An ability to acquire knowledge of contemporary issues, and
i. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
j. An ability to apply and integrate knowledge from four elements i.e., polymer structure, properties, process and performance to solve the industrial problems and also to develop an entrepreneur skill

ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

R - 2013

B. TECH. POLYMER TECHNOLOGY

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 NO.	COURSE TITLE	L	T	P	C
THEORY					
MA6351	Transforms and Partial Differential Equations	3	1	0	4
GE6351	Environmental Science and Engineering	3	0	0	3
PT6301	Materials Engineering	3	0	0	3
PT6302	Organic Chemistry and Technology	3	1	0	4
CE6402	Strength of Materials	3	0	0	3
PT6303	Polymer Chemistry	3	0	0	3
PRACTICALS					
PT6311	Polymer Chemistry Laboratory	0	0	3	2
PT6312	Organic Chemistry Laboratory	0	0	3	2
	TOTAL	**18**	**2**	**6**	**24**

SEMESTER – IV

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
MA6468	Probability and Statistics	3	1	0	4
PT6401	Mould Manufacturing Engineering	3	0	0	3
PT6402	Polymer Structure and Property Relationship	3	0	0	3
PT6403	Principles of Chemical Engineering	3	0	0	3
PT6404	Physical Chemistry of Polymers	3	0	0	3
PT6405	Polymeric Materials	3	0	0	3
PRACTICALS					
PT6411	Chemical Engineering Laboratory	0	0	3	2
PT6412	Mould Manufacturing Engineering Laboratory	0	0	3	2
	TOTAL	**18**	**1**	**6**	**23**

SEMESTER – V

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
MA6459	Numerical Methods	3	1	0	4
PT6501	Polymer Rheology and Fluid Mechanics	3	0	0	3
PT6502	Polymer Compounding Technology (Name Change)	3	0	0	3
PT6503	Analysis and Characterisation of Polymers	3	0	0	3
PT6504	Processing Technology I	3	0	0	3
PT6505	Thermoset and composites	3	0	0	3
PRACTICALS					
GE6563	Communication Skills - Laboratory Based	0	0	4	2
PT6511	Polymer Preparation and Characterization Laboratory	0	0	3	2
	TOTAL	**18**	**1**	**7**	**23**

SEMESTER – VI

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
PT6601	Mould and Die Design	3	1	0	4
PT6602	Polymer Reaction Engineering	3	0	0	3
PT6603	Polymer Testing Methods	3	0	0	3
PT6604	Process Control and Instrumentation	3	0	0	3
PT6605	Processing Technology II	3	0	0	3
PT6606	Rubber Technology	3	0	0	3
	Elective – I	3	0	0	3
PRACTICALS					
PT6611	Rubber Processing Laboratory	0	0	3	2
PT6612	Polymer Testing Laboratory	0	0	3	2
		21	**1**	**6**	**26**

SEMESTER – VII

CODE NO.	COURSE TITLE	L	T	P	C
THEORY					
PT6701	Polymer Blends and Alloys	3	0	0	3
MG6851	Principles of Management	3	0	0	3
PT6702	Polymer Product Design	3	0	0	3
PT6703	Rubber Product Manufacturing Technology	3	0	0	3
PT6704	Speciality Polymers and Applications	3	0	0	3
	Elective – II	3	0	0	3
	Elective - III	3	0	0	3
PRACTICALS					
PT6711	Polymer Product Design Using CAD	0	0	3	2
PT6712	Plastic Processing Laboratory	0	0	3	2
PT6713	Comprehension	0	0	2	1
	TOTAL	**21**	**0**	**8**	**26**

SEMESTER – VIII

CODE NO.	COURSE TITLE	L	T	P	C
PRACTICALS					
PT6811	Project work	0	0	12	6
	TOTAL	**0**	**0**	**12**	**6**

TOTAL NO OF CREDITS : 181

LIST OF ELECTIVES

B. TECH. POLYMER TECHNOLOGY

ELECTIVE - I

CODE NO.	COURSE TITLE	L	T	P	C
PT6007	Adhesives and Surface Coatings	3	0	0	3
PL6003	Biodegradable Polymers	3	0	0	3
GE6075	Professional Ethics in Engineering	3	0	0	3
PL6005	Polyurethane Technology	3	0	0	3

ELECTIVE – II

CODE NO.	COURSE TITLE	L	T	P	C
GE6757	Total Quality Management	3	0	0	3
PT6001	Specialty Elastomers	3	0	0	3
PT6071	Fibre Technology	3	0	0	3
PT6002	Tyre Technology	3	0	0	3

ELECTIVE III

CODE NO.	COURSE TITLE	L	T	P	C
PT6003	Plastics Packaging Technology	3	0	0	3
PT6004	Conducting Polymers	3	0	0	3
PT6005	Fibre Reinforced Plastics	3	0	0	3
GE6081	Fundamentals of Nano Science	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

TEXTBOOKS:

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 9

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.

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 EQUIPMENTS 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.

TEXTBOOKS:

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.

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

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and 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)

PT6301 MATERIALS ENGINEERIN L T P C
3 0 0 3

OBJECTIVES:
To enable the students to understand
- Mechanical behavior of materials, types of fractures and testing
- Importance of phase diagram
- Various diffusion processes and heat treatment of steel

UNIT I **9**
Mechanical Behavior of materials - Stress- Strain curve, Elastic deformation- Characteristics of elastic deformations, atomic mechanism of elastic deformation, Inelastic deformation, Strain-Time curves, Damping capacity, Viscous deformation, Plastic deformation, Mechanism of plastic deformation- slip & twinning, Schmidt's law, critical resolved shear stress.

UNIT II **9**
Mechanical testing and fracture of materials - tensile test, stress-strain curves for ductile and brittle materials - mild steel, copper, proof stress, yield point phenomena, Luder's bands, compression test, hardness test - various hardness tests. Impact test - ductilebrittle transitions. Fatigue- Stress cycles for fatigue testing, endurance limit, fatigue limit, S-N curve, Creep-curve, primary creep, secondary creep, tertiary creep. Fracture - ideal fracture stress, brittle fracture- Griffith's theory- fracture toughness, ductile failure, cup & cone type fracture, fatigue failure.

UNIT III **9**
Phase diagram - solid solutions, inter metallic compound, cooling curves, non-equilibrium cooling, phase rule, equilibrium diagrams - Isomorphous diagrams, Eutectic, Peritectic and eutectoid reactions with examples. Ferrous and non-ferrous alloys - Fe-C diagram, Effect of alloying elements on properties of steel, tool steel, heat resisting and die steel. Alloys of copper, aluminium, magnesium, nickel and zinc - compositions and their uses, Polymeric and composite materials, metal matrix composites, refractories, abrasives , shape memory materials.

UNIT IV **9**
Special diffusion process- Aluminizing, Siliconising, Boriding- Laser hardening, Electroplating-hard chrome & nickel plating - Hard dip coating, Cladding - Physical and chemical vapor deposition - Metal spraying - Plastics and rubber coating - Conversion coating - Coating of tools - TiC, TiN, Alumina and diamond coating of tools - Selection of coating of tools - Selection of coating for wear and corrosion resistance - Elastic materials - Applications.

UNIT V **9**
Ceramics- Types- Bonding and their structure –Defects - calcinations, grain growth and solid liquid phase sintering; Ceramic coatings and their deposition; Properties of photonic, electro-optic, magnetic and superconducting ceramics ferrites; Applications of electronic ceramics in various devices including sensors for gases, temperature, pressure and voltage, and in optical communication, magnetic and oxide electronics, and electric power and energy storage devices.

TOTAL : 45 PERIODS

OUTCOMES:
Upon completion of this course, the students
- Will familiarize in mechanical behavior of materials
- Will develop phase diagram for compound material
- Will demonstrate about selection of coating tools

TEXT BOOKS:
1. M. Arumugham, Material Science, Anuradha Agencies, 1st Ed., 1987.

2. G. E. Dieter, Mechanical metallurgy, McGraw-Hill, 2000.
3. William D. Callister, Material Science and Engineering", Seventh Edition, Wiley Publication, 2006

REFERENCES:

1. R. C. Buchanan, Ceramic Materials for Electronics, Marcel Dekker, 1986
2. J. C. Anderson, K. D. Leaver, R. D.Rawlings, J. M. Alexander, Material Science, Donald S. Clark and Wilbur R Warney, Physical metallurgy, Affltd. East west press.
3. C. W. Richards, Engineering material Science, Prentice Hall Of India.
4. V.S. Raghavan, "Material Science",

PT6302 ORGANIC CHEMISTRY AND TECHNOLOGY L T P C
3 1 0 4

OBJECTIVE:

To get know about the basics of organic chemistry, mechanism of organic reactions; preparation, properties and uses of majority of the monomers involved in polymer formation.

UNIT I **9**

Structure reactivity and mechanism: Classification and IUPAC Nomenclature of organic compounds, Functional groups, classification and reactions, bonding in organic molecules – Hybridization - Methane, ethylene, acetylene, and butadiene. - Polarity of bonds- Hydrogen bonding- Dipole Moment - Electron displacement effect - Inductive - Electromeric - Conjugative - mesomeric and Resonance effects- Stereochemistry-General idea of optical and stereoisomerisms, geometrical isomerism-

UNIT II **9**

Types of bond breakage- homolysis and heterolysis, Types of reagents- Electrophiles and Nucleophiles, types of reactions - addition (>C=C<, >C=O) substitution - Electrophilic and Nucleophilic substitution - elimination and rearrangement reactions - Inter and Intra molecular rearrangement - Hoffman, Beckman, Benzidine rearrangements - General conditions and mechanism of each of the above.

UNIT III **9**

Natural gas - Synthesis gas - Petroleum and petroleum products - Coal and coal products- Cellulose and cellulose products. Synthesis, properties and uses of Ethylene - Propylene - Butadiene - Vinyl chloride - Vinylidiene chloride - Vinyl fluoride - Vinylidene fluoride - Vinyl acetate.

UNIT IV **9**

Synthesis and Manufacturing, properties and uses of - Formaldehyde - Epicholorohydrin - Ethylene oxide - Propylene oxide - Ethylene glycol, Propylene glycol – Phenols - Aniline- Bisphenol-A, Phthalic acid - Adipic acid - Maleic acid - Maleic anhydride - Phthalic anhydride-ξ-caprolactam, ξ-Caprolactone

UNIT V **9**

Synthesis, Properties and uses of Styrene – Hexamethylene diamine - Urea - Acrylic acid - Methacrylic acid - Acrylonitrile - Methyl methacrylate – Tolulene diisocyanate (TDI) Hexamethylene diisocyanate (HMDI)- Diphenyl methane diisocyanate (MDI)-Pyrrole, Furan- Thiophene- benzimidazoles, Oxazoles.

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

OUTCOMES:

Upon completion of this course, the students

- Will develop knowledge in functional group of chemicals
- Will understand the mechanism of organic reactions
- Will have knowledge of synthesis properties and uses of organic compound

TEXT BOOKS:

1. Morrison & Boyd, “Organic Chemistry”, Prentice Hall. New Delhi, 6th Edition, 1992.
2. B.S.Bahl and Arun Bhal, “Advanced Organic Chemistry”, S. Chand & Co. Ltd., New Delhi, 18th Edition, 1998

REFERENCES:

1. I.L.Finar, “Textbook of Organic Chemistry”, ELBS, 5th edition, 1996.
2. Jerry March, “Advanced Organic Chemistry”, John Wiley & Sons, New York, 1992.
3. A.Brydson, “Plastics materials”, Butterworth - Heinemann - Oxford, 1995.
4. K.J. Saunders, “Organic Polymer Chemistry”, Chapman and Hall Publishers

CE6402 STRENGTH OF MATERIALS L T P C
3 1 0 4

OBJECTIVES:

To enable the students

- To know the method of finding slope and deflection of beams and trusses using energy theorems and to know the concept of analysing indeterminate beam
- To estimate the load carrying capacity of columns, stresses due to unsymmetrical bending and various theories for failure of material.

UNIT I ENERGY PRINCIPLES 9

Strain energy and strain energy density – strain energy due to axial load, shear, flexure and torsion – Castigliano’s theorems – Maxwell’s reciprocal theorems - Principle of virtual work – application of energy theorems for computing deflections in beams and trusses - Williot Mohr's Diagram.

UNIT II INDETERMINATE BEAMS 9

Concept of Analysis - Propped cantilever and fixed beams-fixed end moments and reactions – Theorem of three moments – analysis of continuous beams – shear force and bending moment diagrams.

UNIT III COLUMNS AND CYLINDER 9

Euler’s theory of long columns – critical loads for prismatic columns with different end conditions; Rankine-Gordon formula for eccentrically loaded columns – Eccentrically loaded short columns – middle third rule – core section – Thick cylinders – Compound cylinders.

UNIT IV STATE OF STRESS IN THREE DIMENSIONS 9

Determination of principal stresses and principal planes – Volumetric strain –Theories of failure – Principal stress - Principal strain – shear stress – Strain energy and distortion energy theories – application in analysis of stress, load carrying capacity.

UNIT V ADVANCED TOPICS IN BENDING OF BEAMS 9

Unsymmetrical bending of beams of symmetrical and unsymmetrical sections – Shear Centre - curved beams – Winkler Bach formula.

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

OUTCOMES:

- Students will have through knowledge in analysis of indeterminate beams and use of energy method for estimating the slope and deflections of beams and trusses.
- They will be in a position to assess the behaviour of columns, beams and failure of materials.

TEXT BOOKS:

1. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 2010.
2. Egor P Popov, "Engineering Mechanics of Solids", 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2012

REFERENCES:

1. Kazimi S.M.A, "Solid Mechanics", Tata McGraw-Hill Publishing Co., New Delhi, 2003
2. William A .Nash, "Theory and Problems of Strength of Materials", Schaum's Outline Series, Tata McGraw Hill Publishing company ,2007.
3. Punmia B.C."Theory of Structures" (SMTS) Vol 1&II, Laxmi Publishing Pvt Ltd, New Delhi 2004.
4. Rattan.S.S., "Strength of Materials", Tata McGraw Hill Education Pvt.Ltd., New Delhi, 2011.

PT6303 POLYMER CHEMISTRY L T P C
3 0 0 3

OBJECTIVE:

To enable the students to understand the mechanism of polymerization, various techniques of polymerization, characterization of polymers by molecular weight, reactions and degradation of polymers.

UNIT I 9

Basic concepts of macromolecules - Monomers- Functionality - Classification and nomenclature of polymers. Types of polymers - plastics and rubbers - Step growth polymerization - Mechanism - Kinetics - Bi-functional systems - Poly functional systems.

UNIT II 9

Addition polymerization Mechanism and kinetics of free radical- Cationic-Anionic Polymerisation - Initiator systems - Chain length and degree of Polymerisation – Control of molecular weight- Chain transfer- Inhibition Coordination polymerisation-Mechanism - Kinetics- Ring opening polymerization - Diene polymerization – Advanced Polymerization Techniques - Atom Transfer Radical Polymerization (ATRP), Group Transfer Polymerization (GTP), Reversible Addition Fragmentation Termination (RAFT).

UNIT III 9

Copolymerization - Mechanism and Kinetics of free radical - Ionic copolymerization. Types of copolymers- Copolymer composition - Determination of Monomer reactivity ratios.

Polymerization techniques - Bulk polymerization - Solution polymerization -Suspension polymerization - Emulsion polymerization - Interfacial condensation.

UNIT IV **9**

Molecular weight - Molecular weight averages - Molecular weight distribution- Unidispersity, polydispersity, degree of polymerization - Molecular weight determination -Basic concepts of end group analysis, colligative properties, osmometry, light scattering, and gel permeation chromatography - Viscosity of polymers solutions, size of the polymer molecules.

UNIT V **9**

Chemical reactions of polymers – Hydrolysis – Acidolysis – Aminolysis- Hydrogenation – Addition and substitution reactions – cross linking reactions. Polymer degradation – Mechanical degradation – Mechano-chemical degradation – Oxidative degradation – Hydrolytic degradation – Photo degradation.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the students

- Will develop knowledge in polymerization techniques
- Will be aware about chemical reaction of polymers
- Will be able to determine the molecular weight of the polymer

TEXT BOOKS:

1. F.W. Billmeyer, “Textbook of Polymer Science”, Wiley international publishers, 2000
2. George Odian , “ Principles of polymerisation”, Seymor Robert
3. V.R. Gowariker, “Polymer Science” – New Age International (P) Ltd, Publishers

REFERENCES:

1. JM.G. Cowie, “Polymers: Chemistry and Physics of Modern Materials”, Blackie, and London, 1991.
2. R.J. Young and P.Lovell, “Introduction to Polymers”, 2nd Ed., Chapman & Hall, 1991.
3. Premamoy Ghosh, “Polymer Science and Technology of Plastics and Rubbers”, Tata McGraw- Hill, New Delhi, 1990

PT6311 **POLYMER CHEMISTRY LABORATO** **L T P C**
0 0 3 2

OBJECTIVE:

To study and practice the identification of plastic and rubber materials.

LIST OF EXPERIMENTS

A. Identification of polymers by simple methods like density, melting point, burning Characteristics, solubility and confirmatory test by chemical analysis
   1. Rubbers: NR, SBR, BR, IR, IIR, EPDM, CR, NBR, Hypalon, Thiokol, Silicone.
   2. Plastics: PE, PP, PS, PVC, PVA, PC, ABS, PPO, PA6, PA 6,6 PF, UF, MF, Polyester, Polyacetal

B. Polymer Analysis

Determination of apparent density and bulk density of polymers.

Determination of moisture and volatile content in plastics / rubbers.
Determination of water absorption.
Determination gel time and peak exothermic temperature for thermosetting resins.
Determination melt flow index.
Determination of non carbon black filler content in plastics / rubber

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the students

- will be able to identify the polymers by various methods
- will perform qualitative analysis of polymer

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

- Electronic Balance 1 No.
- Thermostatic Water bath 2 Nos
- Melt flow index 1 No.
- Retort Stand 15 Nos
- Bunsen Burner 15 Nos
- Polymer Samples and Glass wares

REFERENCE:

1. Identification of plastics and rubbers by simple methods, CIPET publications 2002

PT6312	ORGANIC CHEMISTRY LABORATORY	L T P C 0 0 3 2

OBJECTIVE:

To enable the students to learn about the identification, preparation and analysis of organic compounds.

LIST OF EXPERIMENTS

PART A: Identification of Organic compounds of the following types:

1. Alcohols
2. Aldehydes
3. ketones
4. Carboxylic acids
5. Esters
6. Nitro compounds
7. Amines
8. Amides
9. Carbohydrates
10. Halogen compounds
11. Phenols

PART B: Single step preparation of organic compounds by the following methods

1. Nitration
2. Acetylation

3. Bromination
4. Oxidation
5. Hydrolysis

PART C : Quantitative Estimation of

1. Phenol
2. Acetone
3. Urea
4. Formaldehyde
5. Methyl Methacrylate
6. Acrylonitrile

PART D

1. Determination of melting point of organic compounds
2. Determination of boiling point of organic compounds

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- will be able to identify and prepare few organic compounds
- will have the knowledge in quantitative analysis of organic compounds

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

- Conical flask 15 No.
- Liebig condenser 15 No
- Round bottom flask 15 No.
- Burette 15 No.
- Pipette 15 No.
- Iodine flask 15 No.
- Test tubes 01 Gross
- Test tube holder 15 No.
- Tongs 15 No.
- Bunsen burner 15 No.
- Melting Point Apparatus 1 No
- Boiling point Tube & Condenser 15 No
- Required Chemicals

REFERENCE:

1. A.I. Vogel, Organic Qualitative and Quantitative Analysis.

MA6468 PROBABILITY AND STATISTICS L T P C
3 1 0 4

OBJECTIVES:

- This course aims at providing the required skill to apply the statistical tools in engineering problems.

UNIT I RANDOM VARIABLES 9 + 3

Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 9 + 3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS 9 + 3

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 9 + 3

One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.

UNIT V STATISTICAL QUALITY CONTROL 9 + 3

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

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

OUTCOMES:

- The students will have a fundamental knowledge of the concepts of probability. Have knowledge of standard distributions which can describe real life phenomenon. Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

TEXT BOOKS:

1. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
2. Johnson. R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.
3. Papoulis. A and Unnikrishnapillai. S., "Probability, Random Variables and Stochastic Processes " Mc Graw Hill Education India , 4th Edition, New Delhi , 2010.

REFERENCES:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012.
2. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia , 8th Edition, 2007.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.

PT6401 MOULD MANUFACTURING ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

To impart knowledge on mould making techniques such as metal cutting, metal erosion, metal deposition, metal displacement and mould polishing

UNIT I **9**

Mold Making: Materials used in mold making , Introduction of mold parts, Mechanism of metal cutting, types of tools, influence of tool angles, Cutting fluids, Tool materials used including coated tools. Studies of various machining operations: Turning, Shaping, Planning, Drilling, Grinding (Surface, Cylindrical, Tool & Cutter, Rotary Grinding), Milling (Horizontal / Copy Milling / Vertical / Ram / Tool Milling).

UNIT II **9**

Copy milling, Pentograph, Profile grinding, Electrical discharge machining - Types of EDM, design consideration & functions and technological planning. Applications of wire cut EDM in mold making. CNC Controlled Machines (Lathe, milling)

UNIT III **9**

Electroforming for mold manufacturing - discussion of the process, materials for electroforming, design & materials for models, machining for electroformed blanks, mold cavities, economy & service life.

Hobbing for mold making - Discussion of the hobbing process & its advantages, elements of hobbing like hobbing punch, shape of the hob, materials used for cavity, lubrication, and depth of hobbing, Hobbing presses, Hobbing operations & its economy with examples.

UNIT IV **9**

Polishing technology in mold making: Definition of surface roughness, basis of polishing technology, Effect of mold materials on polishability, Types of polishing tools, Methods of polishing - Basic information on Electro sonic polishing - Principles of Electro deposition in damaged molding surfaces.

Surface Texturing of molds - Process description, types of molds, types of patterns and mold shapes, metals that can be etched, mold preparation, limitations of chemical texturing.

UNIT V **9**

Metrology and inspection: Scope of inspection, Procedures, Choices of basic measuring instruments, Vernier, Micrometer, Surface Plates, Angle plates, Squares, Vernier height gauges, Depth gauges, Slip gauges, Dial gauges, Hardness testing, Comparators, Optical profiles projectors, Tool makers microscope, Optical flats - types and uses.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- will demonstrate mold making process
- will have the knowledge in surface finishing of mold
- will acquire skills in inspection of mold

TEXT BOOKS:

1. Klus Stokhert (Edt.), Mold making handbook for Plastic Engineers, Hanser Publishers, NY, 1983.
2. HMT Production Technology, TMH (India), 1992
3. Plastics Mould design , CIPET Publications , 2007

REFERENCES:

1. Bhattacharya, A New Technology, IB Publishers, 1984
2. C-B & Liv C.N.K. Computer aided design & manufacture, East West Press P.C.Pandey & H. S. Shah, Modern Machining Processes, TMH, 1990
4. R.G.W.Pye, Injection Mold Design, East West Press Pvt. Ltd., New Delhi.

5. Stoeckhert & Menning, Mold making handbook, 2nd edition, Hanser Publishers, Munich.
6. W.A.J Chapman, Workshop Technology, Vol I & II, ELBS.
7. Herbert Rees, Mold Engineering, Hanser Publishers, NY.
8. George Menges & Paul Mohren, How To Make Injection Molds, Hanser Publishers.

PT6402 POLYMER STRUCTURE AND PROPERTY RELATIONSHIP L T P C
3 0 0 3

OBJECTIVES:

To enable the students to understand

- The structure of polymers and prediction of polymer properties
- The relationship between polymer structure and properties such as mechanical, thermal, electrical, optical and chemical properties

UNIT I **9**

Structure and properties of polymers- Linear, branched, crosslinked, and network polymers-Homochain and hetero atomic chain polymers- Copolymers and its types- Linear and cyclic arrangement - Prediction of polymer properties, group contribution techniques, topological techniques- Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

UNIT II **9**

Mechanical properties - Stress-strain properties of polymers - Effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness - Crazing in glassy polymers - Ductile brittle transition. Effect of additives on mechanical properties of polymers - Creep, stress relaxation, and fatigue.

UNIT III **9**

Thermodynamic and transition properties - Transition temperature in polymers, glass transition (T_g), melt transition (T_m), relationship between T_g and T_m - other transitions like β-transitions, upper and lower glass transition, crystallization & cold crystallization temperatures - Prediction of T_C, Tg and T_m of polymers by group contributions. Calorimetric properties - Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy - Calculation of heat capacities of polymers.

UNIT IV **9**

Electrical and optical properties - Effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor - effect of frequency of voltage and temperature on dielectric properties - Prediction of molar polarization and effective dipole moment. Effect of additives - Factors affecting the electrical conductivity of polymers.

Optical properties -Effect of polymer structure on optical properties -clarity, transparency, haze, transmittance, absorbance, reflectance, and gloss- Prediction of refractive indices of polymers by group contributions, Static charges, volume & surface resistivity, arc resistance.

UNIT V **9**

Chemical Properties - Cohesive energy, cohesive energy density, solubility parameter, determination of solubility parameter of polymers - Prediction of solubility parameter -Effect of polymer structure on solubility in solvents and oils - Influence of structure in prediction of flame retardancy, water repellency - Chemical resistance of polymers -Polymer toxicity.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will understand the influence of polymer structure in its properties
- Will understand the importance of glass transition temperature in polymer
- Will able to determine solvents for polymer using solubility parameter

TEXT BOOKS:

1. D.W. Van Krevelen And P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific Publishing Company Amsterdam - Oxford - New York. 1990.
2. J.E. Mark Ed. AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.

REFERENCES:

1. D.A.Seanor, ed., Electrical properties of polymers, Academic press, New York, 1982.
2. Jozef.Bicerano, Prediction Of Polymer Properties, Second Edition, Marcel Dekker Inc. New York, 1995.
3. J.M.Margolis (Ed.), Engineering Thermoplastics Properties & Applications, Marcel Dekker, New York 1985.
4. R.J.Samuels, Structured Polymer Properties, John Wiley & Sons, New York, 1974.
5. I.M.Ward & D.W.Hadley, An Introduction to the Mechanical Properties of Solid Polymers, John Wiley & Sons, Chichester, England, 1993.
6. C.C.Ku & R.Liepins, Electrical Properties of Polymers, Hanser Publications, Munich, 1987.
7. F. Bueche, Physical properties of polymers, Wiley, New York, 1962.
8. J.Mort & G.Pfister, eds., Electronic properties of polymers, Wiley Interscience, New York, 1982.

PT6403 PRINCIPLES OF CHEMICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

To enable the students to learn about the fluid flow, heat transfer and mass transfer in engineering applications.

UNIT I FUNDAMENTALS OF CHEMICAL ENGINEERING AND FLUID FLOW 9

Introduction, units, concept of atomic weight, equivalent weight and moles, composition of Solids, liquids and solutions, gas constant, ideal gas law, Fluid Flow: Newtonian and Non-Newtonian fluid- flow characteristics- Bernoulli's theorem-Hagen Poisuille equation, measurement of fluid flow.

UNIT II MECHANICAL OPERATIONS 9

Properties of solids - Sieve analysis; Laws of crushing, Crushers and grinders. Principle of separation and selection and details of equipment for screening, sedimentation, cyclones and hydro cyclones.

UNIT III HEAT TRANSFER 9

Modes of heat transfer; Heat transfer by conduction - Fourier's law, conduction across composite walls. Film concept and convective heat transfer coefficient. Heat transfer by natural & forced convection. Co current, Counter current, shell & tube heat exchangers.

UNIT IV MASS TRANSFER 9

Principles of diffusion, theory of diffusion, Two film theory and mass transfer coefficients Humidification - operation, humidity chart, equipments - cooling towers and spray chambers Drying - Principles and definitions. Rate of batch drying- Equipments for drying.

UNIT V UNIT OPERATIONS 9

Absorption - Principle and equipment (packed towers and plate columns). Distillation - Vapour liquid equilibria, flash distillation, and Binary distillation. Industrial equipments for distillation Adsorption - Principle and equipment for adsorption. Extraction - Principle and equipment for adsorption. (Basic principles and equipment description only. Mathematical consideration not required for absorption adsorption, extraction)

TOTAL : 45 PERIODS

OUTCOMES:

On completion of the course, students

- Will attain knowledge in fluid behavior and solid properties
- Will understand conduction of heat and mass
- Will familiarize in equipments for distillation.

TEXT BOOKS:

1. W.L .Mc Cabe, J.C. Smith, “Unit Operations of Chemical Engineering”, McGraw-Hill, 1993.
2. W.L.Badger, J.T. Banchero. “Introduction to Chemical Engineering”, McGraw-Hill, UK, 1997.

REFERENCES:

1. Richardson and Coulson, “Chemical Engineering”, Vol. 1 & Vol. 2, Asian Books Pvt. Ltd., India, 1996.
2. Chemical Engineer’s handbook - Perry and Chilton.
3. Principles of Unit Operations - Foust A.S., Walzel.L.A. , John Wiley.

PT6404 PHYSICAL CHEMISTRY OF POLYMERS L T P C
3 0 0 3

OBJECTIVES:

To make the students understand

- Physical and conformational properties of polymeric materials
- Molecular arrangement in polymers and their orientation under the influence of stress.
- Solubility behavior of polymers

UNIT I 9

Potential energy and conformational energy of molecules - Staggered and eclipsed states - conformations and configurations, isomeric states and isomerism in polymers -Tacticity, stereoisomerism, geometric isomerism - Unperturbed and Gaussian chains -Random coils and average end to end distance - Freely jointed and freely rotating chain models - Random flight analysis.

UNIT II 9

Thermodynamics - First and second law of Thermodynamics, Carnot cycle - Entropy and enthalpy- Energy driven and entropy driven elasticity - Thermo elasticity -Thermodynamic treatment of rubbers - entropic and energetic contributions to the elastic force in rubbers - Stastical mechanical theory.

UNIT III **9**

Amorphous State - Transition temperatures - Glass transition temperature- Free volume, kinetic, and thermodynamic views of glass transition - Factors influencing glass transition temperature.

Crystalline State - Crystal systems, unit cells, primitive cell, Bravais lattices, polymorphism - Polymer single crystals, lamellae, spherulites, supermolecular structures, fringed micelle model - Degree of crystallinity, factors affecting crystallinity -X-ray diffraction.

UNIT IV **9**

Chain orientation - Concept of chain orientation - orientation in amorphous and crystalline polymers - Uniaxial and biaxial orientation practical significance – Orientation processes - fibre spinning, blown film extrusion, solid state extrusion, profile extrusion - Properties of oriented polymers - Birefringence.

UNIT V **9**

Polymer solutions - Terms and definitions, types of solutions - Hilderbrand approach, Flory Huggins theory - Thermodynamic view of miscibility, upper critical solution temperature (UCST), lower critical solution temperature (LCST) - Concentration regimes in polymer solutions - theta conditions.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will be aware of molecular arrangement in polymers
- Will able to demonstrate the orientation processes in polymer
- Will acquire the knowledge in soluble behavior of polymers

TEXT BOOKS:

1. S. Glasstone and D. Lewis, Elements of Physical Chemistry, Macmillan India Press, Madras, 1995.
2. Ulf W. Gedde, Polymer Physics, Chapman & Hall, 1995.

REFERENCES:

1. Ulf W. Gedde, Polymer Physics, Chapman & Hall, 1995.
2. Paul C. Painter and Michael M. Coleman, Fundamentals of Polymer Science, Technomic Publishing Co. Inc., Lancaster, USA, 1994.

PT6405 **POLYMERIC MATERIALS** **L T P C**
3 0 0 3

OBJECTIVE:

To enable the students to understand the methods of preparation, properties and applications of thermoplastic materials covering commodity, engineering and high performance plastics.

UNIT I **9**

Methods of manufacturing - Properties and applications of polyethylene - LDPE -LLDPE- HDPE, HMWHDPE- UHMWHDPE - Crosslinked polyethylene- Chlorinated polyethylene - Polypropylene - Homopolymers - Copolymers.

UNIT II **9**

Methods of manufacturing - Properties and applications of poly(vinyl chloride)- Poly (vinylidene chloride)- Poly(vinyl alcohol) - Poly(vinyl acetate)- Chlorinated poly(vinyl chloride)- Plastisols, Poly vinylpyrrolidiene,Polystyrene, HIPS, EPS, SAN, EVA, EPDM, ABS.

UNIT III **9**

Methods of manufacturing - properties and applications of Acrylates - Poly (methyl methacrylate)- Polyacrylonitrile. Aliphatic polyamides –Aromatic polyamides- Polyethylene terephthalate - Polybutylene terephthalate - Polyacetals and copolymers -Polycarbonates- Thermoplastic polyurethane (TPU)

UNIT IV **9**

Methods of manufacturing- Properties and applications of Fluoro polymers - Polytetrafluoroethylene, Polychlorofluoroethylene, Thermoplastic polyurethanes, Biodegradable polymers - poly ξ–caprolactone and copolymers - polylactic acid-Bacterial polyhydroxy alkonates.

UNIT V **9**

Preparation, properties and applications of High performance Thermoplastic materials PPS, PO, Polysulphone, Polyether Sulphone, PEEK, Polyimide. Biopolymer-cotton wool, collagen, hyaluroran.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize in manufacturing process of plastic
- Will acquire skills in selecting polymeric materials for specific applications
- Will have basic knowledge of degradable plastics

TEXT BOOKS:

1. J.A.Brydson, “Plastics Materials”, Butterworth- Heinemann - Oxford, 6th Ed., 1995.
2. Feldman.D and Barbalata.A, “Synthetic Polymers”, Chapman Hall, 1996.

REFERENCES:

1. Olagoke Olabisi, “Hand Book of Thermoplastics”, Marcel Decker, inc., 1997
2. K.J. Saunders, “Organic Polymer chemistry”, Chapman & Hall, NY, 1988.
3. Irvin.I. Rubin, “Hand Book of Plastic Materials and Technology”, Wiley Interscience, NY, 1990.
4. Charles Gebelein, Biotechnological Polymers: Medical, pharmaceutical and industrial applications, CRC press,1993

PT6411 CHEMICAL ENGINEERING LABORATORY **L T P C**
0 0 3 2

OBJECTIVE:

To train on various techniques for reducing and separating of particles, flow properties of fluids.

LIST OF EXPERIMENTS:

1. Flow through rough and smooth pipes.
2. Centrifugal pump.

3. Calibration of orifice meter.
4. Air compressor
5. Calibration of rotameter
6. Pressure drop in packed bed
7. Fluidization
8. Flow through weirs
9. Air-lift pump.
10. Open orifice and drainage time
11. Thermal conductivity of solids.
12. Heat exchanger
13. Stefan-Boltzman constant
14. Jaw crusher
15. Ball Mill
16. Screening efficiency.
17. Simple distillation
18. Steam distillation
19. Particle size and Surface area of filler particles.

(Any nine Experiments)

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will be able to apply the different technique for size reduction
- Will attain skill in function of fluid pressure apparatus.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Fluidized bed	1 No.
Packed bed	1 No.
Stop watch	2 No.
Measuring cylinder (1 Lit)	2 No.
Sieve shaker and sieve set	1 No.
Ball mill	1 No.
Jaw crusher	1 No.
Electronic balance	1 No.
Plastics tray	2 No.
Friction pipe apparatus	1 No.
Single speed centrifugal pump	1 No.
BET surface analyser	1 No
Venturi meter apparatus	1 No.
Orifice/mouth piece apparatus	1 No.
Stop watch	2 No.
Meter scale	2 No.
Vernier caliper	2 No
Flow measuring meters	3 No.
Stop watch	2 No.
Thermometer	5 No.
Tacho meter	1 No.
Measuring jar (2 lit and 1 Lit each one)	2 No.
Air compressor	1 No.
Parallel and counter flow heat exchanger	1 No.
Stephen Boltzman apparatus	1 No.
Thermal conductivity Apparatus	1 No.

REFERENCES:

1. W.L. Mc cabe and J.C Smith, Unit operations In Chemical Engineering, McGraw-Hill Book Co., 1976.
2. W.L. Badger and J.P Bancro, Introduction to Chemical Engineering, McGraw-Hill Book Co., 1982.

PT6412 MOULD MANUFACTURING ENGINEERING LABORATORY L T P C
0 0 3 2

OBJECTIVE:

To train the students about the mould making techniques such as metal cutting, metal erosion, metal deposition, metal displacement and mould polishing.

LIST OF EXPERIMENTS

1. Exercise on Shaping machine - making stepped block
2. Exercise on Shaping machine - making beveled block
3. Exercise on Horizontal Milling-Gear cutting
4. Exercise on Vertical Milling
5. Exercise on lathe - external thread
6. Exercise on lather- taper turning
7. Exercise on Surface Grinding.
8. Exercise on Slotting Machine.
9. Grinding of Cutting tools.
10. Study of different types of Cutting tools.
11. Measurements using Micrometer, vernier, Height gauge and Slip gauge.
12. Measurement of angle using Sine Bar.
13. Checking of straightness using auto collimeter.
14. Application of Dial gauge.

(Any 8 experiments from the above)

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will understand the mould parts manufacturing technique
- Will attain knowledge in machining process
- Will know about the polishing methods

DEMOMSTRATION EXPERIMENT:

To make a simple mold for hand molding machine

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

- Shaping machine 2 No.
- Vertical milling machine 1 No.
- Horizontal milling machine 1 No
- Lathe 10 No.
- Plain surface grinding machine 1 No.
- Bench grinder 2 No.
- Vernier caliper 2 No.
- Vernier height gauge 2 No.
- Vernier Depth Gauge 1 No
- Micrometer 2 No
- Sine bar 2 No.

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.

PT6501 POLYMER RHEOLOGY AND FLUID MECHANICS L T P C
3 0 0 3

OBJECTIVE:
To enable the students to understand mechanical behaviour of polymeric materials under applied load for short term and long term Flow behavior of polymer melts and the experimental techniques for measuring the rheological properties.

UNIT I **9**
Introduction and Basic concept of Rheology, classification of fluids, Newtonian and non Newtonian fluids, shear stress, shear strain and shear rate, shear modulus, bulk modulus, Zero shear viscosity, Dependence of viscosity with temp, shear stress, shear rate fluid through channel- Viscoelasticity - effect of rate of strain, temperature and time on mechanical behaviour of polymeric materials

UNIT II **9**
Mechanical models - stress strain response of spring and dashpot - viscoelstic models Maxwell element - Voigt kelvin element - response to creep and stress relaxation -four-parameter model - dynamic mechanical properties - Boltzman principle - time temperature super position principle - WLF equation.

UNIT III **9**
Viscosity of polymer melts - die- swell and melt fracture - Weissenberg effect - Elongational viscosity. Measurements of rheological properties - capillary rheometers – cone and plate viscometer - torque rheometers - Mooney viscometer - Applications of rheology to polymer processing (injection moulding, extrusion and blow moulding)

UNIT IV **9**
Fluid flow phenomena: Fluid as a continuum, Terminologies of fluid flow, velocity – local, average, maximum, flow rate – mass, volumetric, velocity field; flow visualization – streamline, path line- laminar and turbulent flows of Newtonian fluids - power law – general treatment of isothermal viscous flow in tubes – Reynolds number—its significance

UNIT V **9**
Bernoulli‘s equation–kinetic energy correction factor; head loss; friction factor; major and Minor losses- Flow measurement: Introduction; general equation for internal flow meters; Orifice meter; Venturimeter;concept of area meters: rotameter; Local velocity measurement: Pitot tube

TOTAL : 45 PERIODS

OUTCOMES:
Upon completing this course, the students
- Will understand the influence of rheology in polymer properties.
- Will acquire knowledge in handling rheological instruments
- Will attain the knowledge in flow behaviour of polymers.

TEXT BOOKS:
1. J.A.Brydson, Flow properties of polymer melts, life books, London, 1978.
2. R.J. Crawford, Plastics Engineering, Butterworth - Heinemann, Oxford, 1998

REFERENCES:
1. P.N.Cogswell, Polymer Melt Rheology, A guide for Industrial Practice, George Godwin
2. Richard C. Progelhof and James L. Throne, Polymer Engineering Principles, Hanser Publishers, New York, 1993.

3. John M. Dealy and Kurt F. Wissburn, Melt rheology and its role in plastics processing, Chapman, London, 1995.
4. R.S. Lenk, Polymer Rheology, Applied Science, London, 1978.
5. J.D. Ferry, Viscoelastic Properties of Polymers, john Wiley & Sons, New York, 1986.
6. Chang Dae Han. Rheology in Polymer Processing, Academic Press, New York, 1976

PT6502 POLYMER COMPOUNDING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

To make the students learn about the additives, mechanism of mixing, its machinery and compounding technique of various materials.

UNIT I INTRODUCTION 9

Introduction - limitations of polymeric materials - additives for plastics- Properties and technical requirements of additives - classification - types - chemistry and mechanisms- Limitations, selection, general effect on properties -antioxidants – lubricants - plasticizers- fillers and reinforcements.

UNIT II ADDITIVES 9

Processing aids - toughening agents - antistatic agents - anti-blocking agents - slip and anti-slip agents - Ultra violet absorbers and stabilizers - Fire retardants - Blowing agents – Coupling agents- Colorants- master batch – color matching - miscellaneous additives.

UNIT III MECHANISM OF MIXING 9

General consideration formulation methods of incorporation of additives and mixing and compounding basic concepts, mechanism of mixing and dispersion, mixing of solid-solid, liquid-liquid and liquids-solids, dispersive mixing, distributive mixing and laminar mixing, mixing entropic measures and its applications, mixing indices, scale of segregation and intensity of segregation, kinetics of mixing, rheology of filled polymers

UNIT IV COMPOUNDING 9

Introduction, types and characteristics of compounds – polymer blends, polymer formulations, filled polymers and polymer composites, compounding practice - selection of polymer - selection of compounding ingredients - methods of incorporation of additives into polymeric materials- Compounding of PVC, PE and PP - mixing types, solid additives, morphology of filler, compatibilizers – mechanism and theory, filler surface modification and interfacial agents, dispersion of polymer and nanoparticles in polymer melt.

UNIT V MIXING MACHINERY AND DEVICES 9

Overview of polymer mixing and blending machinery- Batch and internal mixers, single screw extruder, kneaders, modular co-rotating and counter rotating twin screw extruders, continuous mixers, co-kneader, mixing mechanisms in kneader, modeling of kneader, residence time distribution, feeding and feeder, distributive mixing sections, cavity mixers, pin mixers, slotted fight mixers, variable depth mixers, dispersive mixing, blister ring, fluted mixing section, planetary gear mixers, CRD mixers.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will attain the knowledge in role of additives at polymers
- Will demonstrate the mixing methods
- Will have knowledge in selection of compounding ingredients

TEXT BOOKS:

1. George Mathews, "Polymer mixing technology", Applied science, London,1984
2. Gatcher and Muller, “Handbook of Plastics Additives”, Hanser Publishers, New York.

REFERENCES:

1. J.L. White, A.L. Coran and A. Moet, “Polymer Mixing Technology and Engineering”, Hanser Gardner Publications Ltd., USA, 2001.
2. Manas Chanda and Salil K. Roy, “Plastics Technology Handbook “, Marcel Dekker, New York.
3. Marcel Dekker, "Mixing in polymer processing "- Edited by Chris Rawendaal,.
4. Z. Tadmor, C.G. Gogos, “Principles of Polymer Processing”, Second Ed., Wiley-Interscience, 2006.

PT6503 ANALYSIS AND CHARACTERISATION OF POLYMERS L T P C
3 0 0 3

OBJECTIVES:

To prepare the students with methodology for facing the industrial and academic challenges in

- Identifying various polymers
- Controlling the quality of incoming raw materials and processing characterizing different fluid of polymers
- Analyzing polymers through various instrumental methods

UNIT I IDENTIFICATION AND ANALYSIS 9

Chemical analysis, Determination of purity, refractive index, pyrolytic behaviour, Thermoplastics - melting point, density, viscosity, melt flow index, K-value. Thermo sets - moisture analysis, particle size, apparent density, spiral flow test, cup flow test, gel time and peak exothermic temperature. Resins - acid value, hydroxyl value, isocyanate index, epoxy equivalent, acetyl number, iodine number

UNIT II SPECTRAL ANALYSIS OF POLYMERS 9

UV, FTIR spectroscopy & NMR spectroscopy –^{1}H and ^{13}C – Instruments, Experimental technique and specimen preparation- Structural elucidation studies – Orientation and measurement of crystallinity

UNIT III MOLECULAR CHARACTERIZATION OF POLYMERS 9

Determination of molecular weight- molecular weight distribution- gel permeation chromatography (GPC) high-performance liquid chromatography (HPLC)-Light scattering technique. X-ray diffraction analysis -wide and small angle X-ray diffraction techniques structural determination of polymers

UNIT IV THERMAL ANALYSIS OF POLYMERS 9

Thermal Analysis: Thermal transitions and their classification in polymers, glass transition temperature and its mechanism, melting point of semi crystalline polymers, characterizing polymer and polymer blends using differential thermal analysis (DTA), derivative thermogravimetry (DTG) and differential scanning calorimeter (DSC) techniques, thermal conductivity in polymers, use of DSC for determination of kinetics of crystallization, thermogravimetric analysis (TGA), thermomechanical analysis (TMA), dynamic mechanical analysis (DMA), dynamic mechanical thermal analysis (DMTA).

UNIT V MICROSCOPY AND SURFACE PROPERTIES 9

Microscopy: Basic principle of electron microscopy; specimen preparation, replication, coating and surface pretreatment, structure determination of semi-crystalline polymers by scanning electron microscope (SEM), transmission electron microscopy (TEM) and atomic force microscopy (AFM), Lameller, fibrillar globular and spherulite structures in polymers. Surface properties: Surface energy, contact angle measurements of polymers and evaluation of compatibility of polymer in polymer blends by surface properties.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize about the thermal analysis of polymers
- Will be able to determine the molecular weight of polymers
- Will demonstrate the function of spectroscopy in analysis of polymers

TEXT BOOKS:

1. Chermisinoff, Polymer Characterization - Laboratory Techniques and Analysis. Hunt & James, Polymer Characterization, Chapman & Hall, London, 1993
2. Polymer Characterization: Physical Techniques, D. Campbell and J. R. White; Chapman & Hall, London (1989).

REFERENCES:

1. Polymer sequence determination: carbon- 13 NMR method by James Crandall, Academic press.
2. ASTM - 9.01 & 9.02; 8.01 & 8.04, 2000
3. Kampff, Characterization of Plastics using physical methods, Experimental Techniques and practical applications
4. D. Campbell & J.R. White, Polymer Characterization, Chapman & Hall, 1989.

PT6504 PROCESSING TECHNOLOGY - I L T P C
3 0 0 3

OBJECTIVE:

To make the students learn about different plastic processing techniques such as injection, blow moulding and thermoforming to learn about various compounding machinery and technology

UNIT I 9

Introduction to polymer processing - Plastics processing techniques - Injection moulding - terminology - Process description- Theory of injection moulding -Design and consideration - moulding cycle - Classification and functions of moulds -Cavity lay out - Setting up of mould - Trouble shooting operations.

UNIT II 9

Types Injection unit & Elements of plasticating process - Classification of screw - Screw design - Process control - Clamping unit - Classification of Machine Hydraulics -Ancillary equipment - Computer operation

UNIT III 9

Non Conventional Injection Moulding, Gas injection moulding –water injection moulding-injection foam moulding-types, microcellular injection foam moulding, nucleation and pressure

profiles during filling, powder metal injection moulding - process and steps involved, microinjection moulding - types and process details.
Troubleshooting: Microstructure development in slow crystallizing and fast crystallizing polymers, molecular orientation, effect of crystallinity on material properties, volumetric and anisotropic shrinkage, weld lines and methods of removal of weld lines.

UNIT IV **9**

Blow moulding – Fundamentals of the process, complete blow moulding operation, accumulator based machines, extrusion blow moulding, injection stretch blow moulding, Blow moulding machines, start-up and shut-down procedures, process control, blow moulding plants, parisan wall thickness control, parisan swell, parisan inflation, cutting devices, process parameters and their effect on product quality control, moulding defects - causes and remedy.

UNIT V **9**

Thermoforming – Basic process, thermoforming machines and plants, thermoforming materials, analysis of sheet heating, stretching and wall thickness distribution, simple vacuum forming, drape forming, air-slip forming, pressure forming, drape forming, blister forming, solid-phase pressure forming, plug-assist forming. Process factors in thermoforming, overtation and heat reversion, defects in thermoformed articles and remedies, equipment details.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize basic processing method employed for Plastics.
- Will apply the knowledge in troubleshooting operations.
- Will demonstrate the thermoforming products manufacturing process

TEXT BOOKS:

1. D.V. Rosato Kluwer, “Injection Moulding Handbook”, Academic Publishers Boston 2nd Edition 1995
2. Richard C. Progelhof James. L. Throne, “Polymer Engg. Principles”, Hanser Publisher Munich 1993
3. Frados J. Van Nostrand Reinhold, “Plastic Engineering Handbook of the Society of the Plastics Industry”, N.Y. (4th edition).

REFERENCES:

1. N.P. Charemisinoff & P.N. Chere, “Handbook of Applied Polymer Processing Tech”, Marcel Dekker, Inc, NY 1996.
2. Herbert Recs, “Understanding of Injection Moulding Tech.”, Hanser Pub., Munich 1994.

PT6505 THERMOSETS AND COMPOSITES **L T P C**
3 0 0 3

OBJECTIVE:

To enable the students to learn about resins, thermosets, composites processing and testing of composites.

UNIT I GENERAL PURPOSE RESINS **9**

Methods of manufacturing- properties, curing characteristics and applications of unsaturated polyesters - vinyl ester -phenol formaldehyde resin-urea formaldehyde resin-melamine formaldehyde resin.

UNIT II SPECIAL PURPOSE THERMOSETS 9

Methods of manufacturing, properties, curing characteristic and applications of epoxies-diglycidylether of bisphenol-A resins, epoxy-novalacs, cycloaliphatic epoxies thermoset polyurathenes- Thermoset polyimides- Bismaleimides (BMIs), Cyanate esters (CEs), Benzoxazines and Phthalonitriles.

UNIT III POLYMER COMPOSITES 9

Composites- classifications - metal matrix composites, ceramic matrix composites, Polymer Composites- general properties and applications- Reinforcements: Properties and applications of - various types of glass fiber, carbon fibers, Kevlar fibers, polymeric fibers, boron fibers, ceramic fibers, natural fibers and Particulate filler -nanofillers – nanoclays, carbon nanotubes, graphene

UNIT IV PROCESSING OF COMPOSITES 9

Processing of composites: Prepegs- lay-up, wet lay-up, spray up, compression moulding of thermosets, injection moulding of thermoset, contact moulding process-vacuum bag moulding - hydro-thermoforming and thermoforming- autoclave processing- sheet moulding compounds, bulk moulding compounds - resin transfer moulding- reaction injection moulding- filament winding-pultrusion-processing of thermoplastic matrix composites. Machining, joining and repair.

UNIT V LAMINATES & TESTING OF COMPOSITES 9

Mechanics of composites-Mechanism of reinforcement and fibre/matrix adhesion-Fracture and damage mechanics - laminates -delamination- Design consideration - sandwich structures-Measurement of physical and mechanical properties: density-fibre volume fraction-void content fibre/matrix interface test- test for tensile-compression- flexural in fiber direction – shear and inter laminar strength.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will acquire skills in preparation of polymers in various polymerization techniques.
- Will develop the conversion of polymeric materials into product.
- Will be able to characterize the resin behaviour.

TEXT BOOKS:

1. J.A.Brydson, "Plastics materials", Butterworth- Heinemann - Oxford, 6th Ed., 1995.
2. G Lubin, “Hand Book of Composites”, 2nd Ed, Van Nostrand Reinhold, New York, 1982.

REFERENCES:

1. Irvin .I. Rubin, ' Hand Book of Plastic Materials and Technology', Wiley Interscience, NY, 1990.
2. F.L. Matthews and R.D. Rawlings, 'Composite materials: engineering and science', Chapman and Hall, 1994.
3. P.K. Mallick, 'Composites Engineering Handbook', Marcel Dekker Inc.NY.,1997.
4. Feldman.D and Barbalata.A, "Synthetic Polymers", Chapman & Hall, 1996.
5. D. Hull and T. W. Clyne, "An introduction to Composite Materials 2nd Ed", Cambridge, 1996

GE6563 COMMUNICATION SKILLS – LABORATORY BASED L T P C
0 0 4 2

OBJECTIVES:

- To provide opportunities to learners to practice their communicative skills to make them become proficient users of English.
- To enable learners to fine-tune their linguistic skills (LSRW) with the help of technology to communicate globally.
- To enhance the performance of learners at placement interviews and group discussions and other recruitment procedures.

CONTENTS:

UNIT I LISTENING/VIEWING 10

Listening and note-taking – Listening to telephonic conversations – Ted talks – Inspiring Speeches – Watching documentaries on personalities, places, socio-cultural events, TV news programmes and discussions to answer different kinds questions, viz., identifying key idea and comprehension questions… so on.

UNIT II SPEAKING 12

Conversation practice – Interview – Group Discussion – Introducing oneself and others – Role play – Debate – Presentation – Panel discussion – Neutral accent.

UNIT III READING 10

Different genres of text (literature, media, technical) for comprehension – Reading strategies like note-making – reading graphs, charts and graphic organizer – Sequencing sentences – reading online sources like e-books, e-journals and e-newspapers.

UNIT IV WRITING 12

Blogs – Tweets – Online resume/ – e-mails – SMS and Online texting – Report writing - Describing charts and tables – Writing for media on current events.

UNIT V VOCABULARY 8

Idioms and Phrases – Proverbs – Collocations – Chunks of language.

UNIT VI GRAMMAR 8

Sentence structures – Subject-Verb agreement – Pronoun-Antecedent agreement – Tense forms – Active and passive voices – Direct and Indirect speeches – Cohesive devices.

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:

Sl. 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 System	
	• 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. Barker, A. **Improve Your Communication Skills.** New Delhi: Kogan Page India Pvt. Ltd., 2006.
2. Craven, Miles. **Listening Extra – A resource book of multi-level skills activities**.Cambridge University Press, 2004.
3. Gammidge, Mick. **Speaking Extra - A resource book of multi-level skills activities.** Cambridge University Press, 2004.
4. Hartley, Peter. **Group Communication**. London: Routledge, 2004.
5. John Seely. **The Oxford Guide to Writing and Speaking**. New Delhi: Oxford University Press, 2004.
6. Naterop, Jean & Rod Revell. **Telephoning in English**. Cambridge University Press, 1987.
7. Ramesh, Gopalswamy and Mahadevan Ramesh. **The ACE of Soft Skills**. New Delhi: Pearson, 2010.

PT6511 POLYMER PREPARATION AND CHARACTERIZATION LABORATORY L T P C
0 0 3 2

OBJECTIVES:

To prepare the students with Methodology for facing the Industrial and academic challenges in

- Identifying various polymers
- Controlling the quality of incoming raw materials and processing
- Analyzing polymers through various instrumental methods

LIST OF EXPERIMENTS

Part A Preparation

- Preparation of phenol - formaldehyde (Novalac) resin.
- Preparation of phenol - formaldehyde (Resol) resin.
- Preparation of Urea formaldehyde resin.
- Preparation of Bisphenol - An epoxy resin.
- Bulk polymerization of styrene.
- Regneration of Cellulose
- Emulsion Polymerization of styrene.
- Solution Polymerization of acrylonitrile.
- Suspension Polymerization of Methyl methacrylate.
- Interfacial Polymerization of heamethylene diamine and sebacoyl chloride
- Copolymerization of styrene and methyl methacrylate.
- Ring opening polymerization of Caprolactone

(Any seven of the above)

Part B Characterization

- Determination of molecular weight by end group analysis (COOH group)
- Determination of molecular weight of polymers by viscosity method.
- Determination of epoxy equivalent.
- Determination of acid value of polyester resin.
- Determination of K - value of PVC resin
- Estimation of extent of swelling of polymer in different solvents
- Acetyl contents of cellulose acetate

(Any Five of the above)

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will acquire skills in preparation of polymers using various polymerization techniques.
- Will develop the conversion of polymeric materials into product.
- Will be able to characterize the resin behavior.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Magnetic stirrer	10 Nos.
Thermostatic Water bath	2 Nos.
Vacuum Pump	1 No
Heating Mantle	8 Nos.
Water distillation set up	1 No
Bunsen burner	15 Nos.
Electronic balance	2 Nos.
Air oven	1 No
Melting point apparatus	1 No
Retard stands	15 Nos.
Burette	
Pipette	
Funnel	

PT6601 MOULD AND DIE DESIGN L T P C
3 1 0 4

OBJECTIVE:

To enable the students to learn the design of moulds such as injection, compression, transfer, blow and extrusion dies and moulds.

UNIT I **12**

Classification of Injection Moulds - Methodical Mould Design – Calculation related to-Number of Cavities, Clamping force, shot weight, Selection of Injection Moulding Machine, Layout of Cavities in multi-impression Mould, Feed Systems - Design of Runners & gate, Ejection Systems, Cooling Systems, Venting - Other aspects in Injection Mould Design-Split actuation techniques, Heater circuits for Hot runner mould.

UNIT II **12**

Classification of Compression Moulds - Factors that Influence Thermoset Moulding -Materials Selection in Relation to Moulding Conditions- Calculation related to-Number of Cavities, Clamping force, shot weight- Design of Mould Cavity -Advantages and Disadvantages of Compression moulds. Design of Rotational mould.

Transfer Moulding - Types, principles, Design of Pot and Plunger, Feed System, Economic determination of the number of cavities, Technological determination of the number of cavities, design of mould cavity, design of loading chamber, Transfer tonnage, shot weight- Heat losses and energy requirement to heat the mould - Advantages and disadvantages of Transfer mould.

UNIT III **12**

Blow Mould Design - Materials Selection, Mould Cooling, Clamping Force, Mould Venting, Pinch-off, Head die design, Parison Diameter Calculation, Clamping force, Wall Thickness,

Vertical-load strength, Blow ratio, Base pushup, Shapes, Design based consideration - Shrinkage, Neck and Shoulder Design, Thread and beads, Bottom Design.

UNIT IV **12**

Extrusion die design-Construction features of an extruder, Process, Characteristics of Polymer melt, Die geometry, Die head Pressure, characteristics of land length to Profile thickness, Extrudate die swell, Die materials, Classification of dies-Dies for Solid Section, Dies for Hollow Profiles, Blown film dies, Flat film dies, Parison dies, Wire and cable Coating dies, Spiral mandrel die, Fish tail die, Adjustable Core die.

UNIT V FLOW ANALYSIS **12**

Understanding of flow analysis by simulation and its use for injection mold design, constitutive equations for flow analysis, modeling for flow analysis, optimum gate locations, pressure drops across runner, gate, fill analysis, packing profile analysis, shrinkage and warpage, introduction to finite element analysis

TOTAL : 60 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will develop the knowledge in selection of mould for different processing techniques.
- Will be able to design a mould for a new product
- Will familiarize about dies for products

TEXT BOOKS:

1. P.S.CRACKNELL and R.W DYSON, “Hand Book of Thermoplastics - Injection Mould Design”, Chapman & Hall, 1993.
2. Laszlo Sors and Imre Balazs, “Design of Plastics Moulds and Dies”, Elsevier, Amsterdam Oxford - Tokyo - NY, 1989.

REFERENCE:

1. R.G.W.PYE, Injection Mould Design, SPE Publication.

PT6602 POLYMER REACTION ENGINEERING **L T P C**
3 0 0 3

OBJECTIVE:

To make the students understand the kinetics of different types of chemical reaction and design the reactors for chemical and polymer industries

UNIT I **9**

Introduction to chemical kinetics. Representation of expression for reaction rate, Temperature dependent and concentration dependent Interpretation of Batch Reactor data for various types of reactions taking place in constant volume and variable volume batch reactors

UNIT II **9**

Reactor design - performance equations for batch and flow reactors - design for single reactions - multiple reactions. Heat effects in reactors - conversions - equilibrium -non-ideal flow in reactors

UNIT III **9**

Batch, CSTR and Plug Flow Reactors Reactor choices for single and multiple reactions Viz. Series and parallel reactions. Residence time distribution in non-ideal flow reactors.

UNIT IV **9**

Reaction equilibria – equilibrium in chemically reactive system – evaluation of equilibrium constant – effects of temperature on equilibrium – equilibrium composition evaluation. Reactor stability – criteria for stability of reactors, limit cycles and oscillating reactions

UNIT V **9**

Polymerisation reactors - by free radical mechanism - characterization of mixtures of polymers-mechanism - rate equations - design of reactors for free radical polymerisation-stepwise addition and condensation polymerisation and copolymerisation - analysis of rate equation - polymerisation in batch reactors - flow reactors.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will have basic understanding in kinetics of chemical reaction
- Will be able to design the reactors for polymer industries
- Will determine the choices of reactor for reaction

TEXT BOOKS:

1. J .M. Smith, “Chemical Engineering Kinetics”, McGraw-Hill, 1975.
2. H. Scott Fogler, “Elements of Chemical Reaction Engineering, PHI, 1992.

REFERENCES:

1. M.Kh. Karapetyants, “Chemical Thermodynamics”, Mir Publications, USSR, 1978.
2. G.N.Pandy, J.C.Chaudari, “Chemical Engg. Thermodynamics”, Khanna Publishers.
3. L.H.Sperling, “Introduction to Physical Polymer Science”, John Wiley & Sons.
4. London.Octave Levenspiel, “Chemical Reaction Engineering”, Wiley Eastern Ltd.
5. C.D. Holland & G. Rayboard Anthony, “Fundamentals of Chemical Reaction Engineering”.

PT6603 **POLYMER TESTING METHODS** **L T P C**
3 0 0 3

OBJECTIVES:

- To familiarize the students with standards and methodology in preparing various polymers specimen
- To enable the students to understand the testing of raw materials and components for evaluating various properties; testing the products for predicting product performance

UNIT I STANDARDS AND SPECIMEN PREPARATION **9**

Standards - BIS, ASTM, ISO, specifications and their importance with reference to polymer Preparation of test specimen by various techniques for thermoplastics, thermo sets, and elastomers conditioning and test atmospheres- Analytical tests: determination of specific gravity, density by density gradient method, bulk density, moisture absorption, particle size analysis.

UNIT II MECHANICAL PROPERTIES 9

Tensile, compression, flexural, shear, tear, impact, abrasion, hardness, permanent set, resilience, flex and cut growth resistance. Creep and stress relaxation, fatigue.

UNIT III THERMAL AND RHEOLOGICAL PROPERTIES 9

Transition temperatures, Vicat softening temperature, heat distortion temperature, coefficient of expansion, specific heat, thermal conductivity, shrinkage, brittleness temperature, thermal stability, and flammability, melt flow index, Viscosity (Rotational viscometer, MDR, capillary rheometer, and torque rheometer)

UNIT IV ELECTRICAL, OPTICAL AND OTHER PROPERTIES 9

Volume and surface resistivity, dielectric constant and power factor, dielectric strength, arc resistance, tracking resistance, static charge Refractive index, light transmission, transparency, haze, gloss clarity, and birefringence. Environmental stress crack resistance (ESCR) - water absorption, weathering and chemical resistance, aging, ozone resistance, permeability-sorption, diffusion and permeation, adhesion.

UNIT V TESTING OF PRODUCTS 9

Plastic films, pipes, laminates, foams, containers, and Rubber hose, Microcellular sheet, wire and cables, foams, gloves, tyres and tubes.

Non-destructive testing: ultrasonic testing, study of acoustic properties, X-ray fluorescence and Imaging

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will have the knowledge of standard and specification for polymer testing.
- Will be able to demonstrate the test for various polymer properties.
- Will develop the skills in testing of polymer products.

TEXT BOOKS:

1. Vishu Shah, “Handbook of Plastics Testing Technology”, John Wiley, NY, 1998.
2. ASTM: 8.01 & 8.04; 9.01 & 9.02,2000

REFERENCES:

1. Testing of Polymers, interscience, New York, 1965.
2. G. C. Ives & J. A. Mead, and N. M. Riley “Handbook of Plastics Test Methods”, ILIFEE, London, 1971
3. Roger P. Brown, “Physical Testing of Rubber”, interscience, New York, 1966.
4. Nicholas P.Cheremisinoff, “Product Design and Testing of Polymeric Materials”, Marcel Dekker, inc, New York, 1990

PT6604 PROCESS CONTROL AND INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVE:

To enable the students to learn the basic concepts of instrumentation and control systems covering measurement of temperature, pressure, flow and level. To understand process control systems with related examples

UNIT I GENERAL CONCEPTS OF MEASUREMENTS 9

Variables and their measurements signals, the three stages of generalized measurement system, some common terms used in the measurement systems, mechanical loading, impedance matching, frequency response. Factors considered in selection of instruments - error analysis and classification, source of error. Transducer: classification, displacement & velocity transducers, potentiometer, LVDT, variable reluctance transducers, capacitive transducers, tachometer. Types of electric strain gauges - strain gauge bridges. Calibration of strain gauges

UNIT II TEMPERATURE MEASUREMENT 9

Platinum resistance thermometers, thermistors, thermocouple, total radiation pyrometers, optical pyrometer, temperature measuring problems in flowing fluids. Pressure measurement: Manometers, Elastic transducers, elastic diaphragm transducers, McLeod gauge, thermal conductivity gauges, calibration of pressure gauge using dead weight tester, dynamic characteristics of pressure measuring systems.

UNIT III FLOW & MISCELLANEOUS MEASUREMENTS 9

Venturi, Orifice & nozzle meters, Pitot tube, turbine type meters, hot wire anemometer, magnetic flow meters. Level measurement: float level meters & electrical conductivity meters.

UNIT IV CONTROL SYSTEMS 9

Open loop and closed loop controls, elements of closed loop control systems. Mathematical models for mechanical & electrical systems, transfer function, block diagram representation, signal flow graphs, control system components.

UNIT V PROCESS CONTROL 9

Instrumentation in Blow moulding, Extrusion and Injection moulding and control systems.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will acquire the knowledge in instruments for measurements
- Will familiarize about control systems.
- Will understand the role of process control in polymer machinery.

TEXT BOOKS:

1. T.G. Beckwith and N.L. Buck, Mechanical measurements, Addition Wesley Publishing company ltd. 1995
2. Ernest O Doebelin, Measurements systems Application & design, McGraw-Hill Publishing, 1990.

REFERENCES:

1. Rangan, Mani & Sharma, Instrumentation, Tata McGraw-Hill, New Delhi, 1997.
2. I.J. Nagarath and M. Gopal, Control systems engineering, 2nd Ed. New Age International Pvt. Ltd., 1982.
3. R. K. Jain, Mechanical & Industrial measurements, Khanna Publishing.
4. H.R.Simunds, “Encylaopedia of Plastic equipment”, Reinhold Publishing co., 1964.

PT6605 **PROCESSING TECHNOLOGY- II** **L T P C**
3 0 0 3

OBJECTIVE:

To enable the students to learn about different plastic processing techniques such as extrusion, compression moulding, transfer moulding, calendaring, rotational moulding, FRP processing etc.

UNIT I **9**

Extrusion - Principle - Types of Extruders - Single screw and twin-screw extruders -Metering - Screw design - process control variables - Die swell -Types of dies - . Extrusion of Pipes, profiles, cables – Blown films -Flat film- Cast film - sheet film - Filament - Fibre extrusion - Extrusion of elastomers.

UNIT II **9**

Compression moulding - types and procedure machinery and equipment moulding of thermoplastics - moulding of thermosets and rubber, Advantages & limitations, type of compression mould, Automatic compression molding- Transfer moulding – Types - advantages -Limitations.

UNIT III **9**

Rotational moulding - Basic process, materials and products parameters, temperature, speed, cooling, effect on product quality, control system, bubble formation of rotational molding, methods of bubble removal, effect of internal pressure in rotational molding, multilayer rotational moulding, rotational moulding of nylon, polyethylene etc., rotational moulding of liquid polymer. Rotational moulding equipments, drive, batch type and continuous type machines. Rotational moulding process analysis - mould temperature rise, heat and melt flow in rotational moulding, cycle time calculations.

UNIT IV **9**

Calendaring - Basic process, material and products, calendaring plant, types of calendars, roll construction, roll configurations, drives, heating system, film and sheet lines, laminating and embossing lines, various parameters, control and their effect on quality, defects, causes and remedy. Methodologies to take care of roll bending & deflection, sheet gauge thickness control.

UNIT V **9**

Special guidelines for machining of polymers LASER machining- printing techniques for plastics products- Decorating methods: surface preparation, electroplating, vacuum metallizing, texturising, special effects like rainbow effect, hot stamping, embossing.

Recycling of plastics: recycling - individual steps in the process and their purposes, standard of recycling and compounding- Equipments used for recycling, metal detection and separation, cutting mills, crammer feeder, screen changer energy balance, specific energy consumption.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize in advanced polymer processing method
- Will acquire skills in film processing methods
- Will have the knowledge in conversion process of polymeric materials into products.

TEXT BOOKS:

1. Edited by Michael L. Berlin “Plastics Engineering”, Handbook. Society of the plastic Industries Chapman & Hall NY 1991.
2. James L. Throne, “Technology of Thermoforming”, Hanser, Publisher Munmich 1996.

REFERENCES:

1. M.J. Stevens and J.A. Covas, “Extruder Principle and Operation”, Chapman & Hall UK, 2nd Edition 1995.
2. D.V. Rosato & D.V. Rosato, “Blow Moulding Hand Book”, Hanser Published 1998.

PT6606 RUBBER TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

To enable the students to understand the chemistry and manufacturing technology of elastomers, compounding and vulcanization, properties and application

UNIT I FUNDAMENTALS OF RUBBER 9

Introduction to Rubbery materials, Type of rubbers- Diene and non-Diene rubber. Natural Rubber(NR)—Importance as Raw Material, uniqueness of NR, Plantation, Taping of NR latex, Factors affecting Tapping Efficiency, Stabilization and Coagulation of latex, Chemical nature of natural rubber hydrocarbon, Ageing of NR, Derivatives of NR, Various forms of natural rubber- crumb, sheet, crepe, SP rubber, DPNR, LNR, liquid rubber, classes of liquid elastomers, telechilic polymers, powdered rubber, Possibilities of Blending of NR with Synthetic Rubbers(SR)

UNIT II COMPOUNDING & VULCANIZATION 9

General recipe for product manufacturing, Different types of compounding ingredients & role of them in rubber compounding -activators, accelerators, promoters, antioxidants, antiozonants, processing aids, Blowing agents, Fillers and its effect. Vulcanisation, chemical and physical aspects, curing characteristics such as scorch time, Induction time, cure time, Mechanism of crosslinking by different crosslinking agents- EV, semi EV, conventional and sulphur less cure- Peroxide, metaloxide and other special curing methods. Vulcanisation techniques, batch and continuous vulcanization: press cure, autoclave, hot air, cold and hot water, fluidised bed, molten salt bath, drum curing, radiation, microwave curing

UNIT III PROCESSING OF RUBBER 9

Rubber processing – principles of mixing, dispersive and distributive mixing, mixing operations – composition, concentration, stabilization, coagulation, mastication, two-roll mill mixing, internal mixing- Banbury mixing, Brabender plasticorder, and continuous mixers – master batching forming operations –calendaring – extrusion –spreading and moulding operations.

UNIT IV SYNTHETIC ELASTOMERS 9

Manufacturing, structure, properties, compounding, curing and applications Polyisoprene, Polybutadiene, SBR, EPDM, Butyl rubber, Neoprene, Nitrile rubber, Basic structure, Thermoplastic Elastomers -Manufacture, Morphology, Commercial grades and Applications Thermoplastic styrene block copolymers, Polyester thermoplastic elastomers, polyamide thermoplastic elastomer, Polyurethane thermoplastic Elastomers, PP/EP copolymer blend

UNIT V QUALITY CONTROL AND PROCESSABILITY 9

Rubber latex and dry rubber - cup viscosity, total alkalinity, total solids, dry rubber content, volatile matter, KOH number, mechanical stability and heat stability, Processibility test - Plasticity, plasticity retention index (PRI), scorch time and cure characteristics -plastimeter, Mooney viscometer, Oscillating disc rheometer, Moving Die Rheometer - Mixing test.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will distinguish the application of natural rubber and synthetic rubber.
- Will demonstrate the vulcanization process
- Will attain the knowledge of compounding materials

TEXT BOOKS:

1. C.M.Blow and Hepburn, - Rubber Technology and Manufacture, 2nd edition, 1982.
2. Hoffman, Rubber Technology Handbook -, Hanser Pub. Munich - 1996

REFERENCES:

1. Anil .K. Bhowmic, Howard L. Stephens (Edt), Handbook of Elastomers New Developments & Technology, Marcel Decker Inc. New York 1988.
2. Maurice Morton, Rubber Technology

PT6611 RUBBER PROCESSING LABORATORY L T P C
0 0 3 2

OBJECTIVE:

To practice mastication, mixing and preparing rubber products.

LIST OF EXPERIMENTS

1. Mastication of NR on two roll mill
2. Mixing of rubber compounds
3. Compression moulding of rubber compounds
4. Autoclave curing of an extruder
5. Rubber to metal bonding
6. Preparation of dry rubber products
   (i) Play ball **(ii)** Hawaii sheet **(iii)** M. C sheet(iv)Bottle Caps
7. Preparation of dispersions for compounding of latex
8. Preparation of latex products
   (i) Hand Gloves **(ii)** Balloon **(iii)** Rubber band **(iv)** Thread
9. Extrusion of rubber
10. Compression moulding of fabric/rubber composite
11. Foam beating and curing
12. Preparation of rubber blends

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will distinguish the application of natural rubber and synthetic rubber.
- Will demonstrate the vulcanization process
- Will attain the knowledge of compounding materials

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Equipments for Rubber processing:

1.	Two roll mill for rubber mixing	1 No.
2.	Laboratory internal mixer	1 No.
3.	Vertical injection mould	1 No.
4.	Extrusion for compounding of rubber	1 No.

5.	Ball mill	1 No
6.	Compression moulding machine	1 No.
7.	Air compressor	1 No.
8.	Sheet cutter	1 No.
9.	Bench Wise	1 No.
10.	Autoclave	1 No

Moulds for rubber processing:

1.	Moulds for sheet moulding	1 No.
2.	Moulds for M/C sheet moulding	1 No.
3.	Moulds for play ball	1 No.
4.	Moulds for Hand gloves	1 No.
5.	Moulds for Ballon	1 No.
6.	Moulds for Rubber band	1 No.
7.	Moulds for play thread	1 No.
8.	Moulds for flex specimen moulding	1 No.
9.	Electronic balance	1 No.

PT6612 POLYMER TESTING LABORATORY L T P C
0 0 3 2

OBJECTIVES:

- To familiarize the students with standard and methodology in preparing various polymers specimen
- Testing raw materials and components for evaluating various properties
- Testing products for predicting product performance.

LIST OF EXPERIMENTS

- Specimen Preparation for testing of products

- **1. Testing of Latex**
- Determination of total solid content of NR latex, dry rubber content of NR latex., total alkalinity of NR latex, Mechanical stability of Latex, Magnesium in latex, KOH number, viscosity of latex by Brookfield Viscometer
-
- **2. Testing of Dry rubber**
- Estimation of P_0 and PRI (Plasticity Retention Index)- Ash, Dirt content

- **3. Testing of Mechanical Properties**
- Plastics – Tensile, Compression, Flexural, Impact, Hardness Rubber – Tensile, Abrasion, Rebound resilience, Flex resistance, Hardness, Heat Build up
-
- **4. Testing of Thermal properties**
- Vicat softening point, Heat Distortion Temperature, Flammability, Limiting Oxygen Index

- **5. Testing of Electrical & Optical properties**
- Volume & Surface resistivity, Dielectric strength, Arc resistance, Refractive Index

- **6. Testing of weathering properties**
- Chemical resistance, ESCR, Thermal ageing resistance, Salt spray

- **7. Product Testing**
- (Any fifteen from the above all experiments)

OUTCOMES:

Upon completion of this course, the students

- Will be able to prepare the test sample for various polymer test
- Will acquire skills in polymer product testing
- Will be able to measure the polymer properties

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Universal tensile testing machine (UTM) 1 No
2. Humidity Chamber 1 No
3. Shore - A hardness tester 1 No
4. Shore - D hardness tester 1 No
5. Rockwell hardness tester 1 No
6. Izod and charpy impact tester 1 No
7. Falling dart impact tester 1 No
8. Din Abrader 1 No
9. Rebound Resilience tester 1 No
10. De-Mattia Flex Resistance tester 1 No
11. Vicat softening point tester (VSP) 1 No
12. HDT Tester 1 No
13. Dial gauge 1 No
14. Volume and surface resitivity tester 1 No
15. Arc resistance tester 1 No
16. Dielectric Strength tester 1 No
17. Refractometer tester 1 No
18. Environmental stress crack resistance tester (ESCR) 1 No

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Vishu Shah, Hand Book of Plastics Technology, John Wiley Intersciencs Inc., New York.1998
2. G. C. Ives, J. A. Mead, and M. M. Riley, Hand Book of Plastics Test Methods, I4FFE Books London, 1971.

REFERENCE:

1. ASTM - Vol. 8.01 - 8.04, Vol.

PT6701	POLYMER BLENDS AND ALLOYS	L	T	P	C
		3	0	0	3

OBJECTIVE:

To enable the students to understand the miscibility of polymers, characteristics of blends and mechanism of toughening

UNIT I **9**

Definition of polymer blends and alloys, compatibility - Classification - on the basis of miscibility –- Criteria for selection of polymer - Advantages of blends over conventional polymers- Thermodynamics of miscibility - multicomponent mixtures, crystallizable components, ideal polymeric mixtures, phase separation-spinodal decomposition, nucleation and growth, critical Point

UNIT II **9**

Mixing Thoery - Derivation of the Flory-Huggins entropy of mixing, Huggins correction, polymer thermodynamic models - Flory-Huggins models, Flory-Huggins χ interaction parameter- - equation-of-state models, specific interaction - hydrogen bonding interaction, dipole-dipole interaction, ion–dipole & ion-ion interaction and additional specific interaction.- Enhancement of polymer miscibility – utilization of miscible polymers.

UNIT III **9**

Principles and methods involved in preparation of Polymer blends and alloys – -Types of blends - Polyolefin blends –Crystalline – amorphous polymer blend, crystalline – crystalline polymer blend, Engineering Polymer Blends –Emulsion blends-Liquid Crystalline Polymer Blends-Ternary Polymer –- Elastomer Blends-Polymer blends containing block copolymers-Water soluble blends – Biodegradable polymer blends- Recycled polymer blends

UNIT IV **9**

Characterization of Blends– Glass Transition Temperature – DSC, DMA- Phase morphology – Optical Microscopy, Scanning Electron Microscopy (SEM)-Atomic Force Microcopy – Determination of Crystallinity of blends -X-ray –FTIR-- Introduction to Rheology of polymer Blends – Rheology of phase separated blends

UNIT V **12**

Interpenetrating Polymer Network (IPN)-Toughened polymers- Specific examples for toughened thermoplastics and thermosets- Impact modified blends- Properties of Blends – Mechanical, thermal and electrical properties – Application of Blends in Emerging technology - Photovoltaic, Light Emitting Diode Supercritical fluids, Lithium battery & Fuel cells Applications

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will acquire the knowledge in type and application of blends
- Will demonstrate the miscibility behavior based on thermodynamics.
- Will develop the concept of techniques involved in preparation of polymer blends.

TEXT BOOKS:

1. Lloyd M. Robeson - Polymer Blends: A Comprehensive Review, Hanser Publishers
2. D R Paul and S Newman, “Polymer Blends Vol. I & II”, Academic Press Inc, 1978.

REFERENCES:

1. Olabisis, I W Rubison and M T Shaw Polymer - Polymer Miscibility Academic Press - New York 1979.
2. Utracki, “Polymer Blends and Alloys”, Hanser Publisher.
3. G. Lubin, “Hand Book of Composites”, 2nd Ed., Van Nostrand Reinhold, NY, 1982.
4. S.M.Lee, “Dictionary of Composites Materials Technology”, Technomic Lancaster, Pa, 1989.
5. B.T. Astrom, “Manufacturing of Composites”, Chapman & Hall, 1997.

MG6851 PRINCIPLES OF MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:
To teach an outline sketch of managing, planning, organizing, directing and controlling.

UNIT I OVERVIEW OF MANAGEMENT 9
Organization - Management - Role of managers - Evolution of Management thought - Organization and the environmental factors - Managing globally - Strategies for International Business.

UNIT II PLANNING 9
Nature and purpose of planning - Planning process - Types of plans - Objectives -Managing by objective (MBO) Strategies - Types of strategies - Policies - Decision Making - Types of decision - Decision Making Process - Rational Decision Making Process - Decision Making under different conditions.

UNIT III ORGANIZING 9
Nature and purpose of organizing - Organization structure - Formal and informal groups I organization - Line and Staff authority - Departmentation - Span of control- Centralization and Decentralization - Delegation of authority - Staffing - Selection and Recruitment - Orientation - Career Development - Career stages - Training - Performance Appraisal.

UNIT IV DIRECTING 9
Creativity and Innovation - Motivation and Satisfaction - Motivation Theories Leadership - Leadership theories - Communication - Hurdles to effective communication- Organization Culture - Elements and types of culture - Managing cultural diversity.

UNIT V CONTROLLING 9
Process of controlling - Types of control - Budgetary and non-budgetary control techniques - Managing Productivity - Cost Control - Purchase Control - Maintenance Control - Quality Control - Planning operations.

TOTAL : 45 PERIODS

OUTCOMES:
Upon completing this course, the students
- Will have the importance of management planning
- Will understand the concept of structural organization
- Will able to apply the budgetary control techniques

TEXT BOOKS:
1. Stephen P. Robbins and Mary Coulter, 'Management', Prentice Hall of India, 8th edition.
2. Charles W L Hill, Steven L McShane, 'Principles of Management', Mcgraw Hill Education, Special Indian Edition, 2007.

REFERENCES:
1. Hellriegel, Slocum & Jackson, ' Management - A Competency Based Approach', Thomson South Western, 10th edition, 2007.
2. Harold Koontz, Heinz Weihrich and Mark V Cannice, 'Management - A global & Entrepreneurial Perspective', Tata Mcgraw Hill, 12th edition, 2007.
3. Andrew J. Dubrin, 'Essentials of Management', Thomson Southwestern, 7th edition, 2007.

PT6702 **POLYMER PRODUCT DESIGN** **L T P C**
3 0 0 3

OBJECTIVES:

To enable the students

- To learn physical properties of polymers required for product design
- To design plastic parts such as static and dynamic loaded parts for electrical, optical and mechanical applications (gears, bearings, pipes, seals, couplings and vibration dampers)

UNIT I **9**

Introduction to structure and physical properties of polymers, stress - strain behaviour of polymers, effect of fillers on properties of polymers, stress analysis of polymers, structural design of beams, plates and other structural members.

UNIT II **9**

Dynamic load response of polymers, effects of cyclic loading, other forms of stress applied to polymer parts, design for stiffness, processing limitations on polymers product design. Material and process interaction and the effects on the performance of plastic parts and the resulting design limitations, performance in service and environmental exposure.

UNIT III **9**

Design procedure for plastic parts- Basic Principles-Shrinkage-Flash lines-Undercuts-suggested Wall thickness-Draft-Tolerance-Moulded holes-threads-radius- moulded hinges-integral hinge-snap fits - product design thumb rules - case studies and product design. design of plastic structural parts for static loads, design of dynamically loaded plastic parts, design of plastic parts for electrical applications, design of plastic parts for optical applications.

UNIT IV **9**

Gear Design materials strength and durability, moulded V/s cut plastic gearing inspection assembly and operation. Bearings: Self lubricated plastic materials rubber bearing, type of bearings, designers check list. PVC piping: Raw materials, pipe design, specification and test procedure, manufacturing process-Reverse engineering, rapid proto typing

UNIT V **9**

Elastomeric ring seals Basic configurations, design method, design consideration static and dynamic seals. Vibration dampers: Basic vibration damping relations, Octave rule for damped systems, Estimating damping in structures, controlling resonant peaks with damping, response of damped structures to shock. Flexible Coupling - Vibration of two mass system, specification and selection of couplings, types of couplings.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will demonstrate the response of polymers for various load.
- Will be able to apply the knowledge to develop plastic products.
- Will develop the design for polymer product in engineering applications.

TEXT BOOKS:

1. S.Levy & J.H.Dubois, “Plastic Product Design Engineering Hand Book”, Van Nostrand Reinhold Co., New York, 1977.
2. Edward Miller, “Plastics Products Design Hand Book”, Marcel Dekker,

REFERENCES:

1. Robert A. Malloy, "Plastic Part Design for Injection Moulding", Hanser Pub., Munich Vienna NY, 1994.
2. H. Belofsky, "Plastics Product Design and Process Engineering", SPE, Hanser Publication, Munich Vienna NY, 1995.
3. P.K.Freekly & A. R. Payne, "Theory and Practice of Engineering with Rubber". B. Hepburn and R.J.W. Raynolds, Elastomers, "Criteria for Engineering Design".
4. R.D.Beck, "Plastic Product Design", Van Nostrand Reinhold Co.

PT6703 RUBBER PRODUCT MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

To enable the students to learn the manufacturing technique for different rubber products.

UNIT I **9**

Tyre- Introduction- functions and requirements– Composition - Various Types – Bias – Belted – Radial – Tubeless Tyre – Tyre Building- Manufacturing methods - moulding & vulcanization, and testing- Tube manufacture – Compounding for tyre and tube.

UNIT II **9**

Belting and Hoses- Conveyor belting, passenger conveyor belting, - Components and Functions – Power transmission Belts – Types- V & F belting,- Building & Manufacturing- Hose- Types- moulded, machine, handmade, bursting, pressure considerations- Compounding aspects

UNIT III **9**

Footwear and Sports Goods– Components- sole and heel units – Various manufacturing process- Safety and antistatic footwear – Micro and macrocellular rubbers- Blowing Agents - Sports Goods - Tennis Balls – Golf Balls-Tennikoit rings

UNIT IV **9**

Manufacturing, curing of Cables, Oil Seals, Gaskets, Engine Mounts, Bridge and railway pads- Rubber-Metal bonding-. Good manufacturing practices - Effluent- Control and Treatment- Safety in rubber industry

UNIT V **9**

Latex Products –Dipped goods- rubber band, Gloves, balloon, nipples, Manufacturing of Latex Foam -Rubber thread, use of latex in cement, adhesives, road rubberisation –Rubber Recycling products.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will have the knowledge of rubber product manufacturing technique.
- Will understand about processing of rubbers
- Will familiarize in latex product manufacturing process

TEXTBOOKS:

1. A.K.Bhowmick, M.M. Hall and H.A. Benaney, Rubber Products Manufacturing technology, Marcel Dekker Inc, New York, 1994.

2. A.S. Craig, Rubber Technology, Oliver and Boyd, Edinburgh, 1982.
3. C.W. Evans, Hose Technology, Elsevier Applied Science Publishers, 1979.

REFERENCE:

1. D.C. Blackley, High Polymer Latices, Vol I & II, Applied Science Publishers, London, 1966.

PT6704 SPECIALTY POLYMERS AND APPICATIONS L T P C
3 0 0 3

OBJECTIVE:

To enable the students to learn properties and applications of special polymers such as high performance flame resistance, conducting and high temperature resistant polymers

UNIT I **9**

High temperature and fire resistant polymers –Requirement for heat resistance- polymers, for low fire hazards - polymers for high temperature Resistance - applications of heat resistant polymers like polyamides, polyimides, polyquinolines, polyquinoxalines, PBO, PBI, PPS, PPO, PEEK

UNIT II **9**

Conducting polymers, conducting mechanisms, requirements for polymer to work as conductor, types of conducting polymers - doping of polymeric systems, polyaniline, polyacetylene, polyparaphenylene, polypyrrole, organometallic polymers, Photosensitive polymers - synthesis, curing reactions, applications in various fields

UNIT III **9**

Polymers with electrical and electronic properties, polymers in non-linear optics, polymers with piezoelectric, pyroelectric and ferroelectric properties, photoresists for semi conductor fabrication - Polymers in telecommunications and power transmission - liquid crystalline polymers

UNIT IV **9**

Ionic Polymers, synthesis, physical properties and applications, Ion-exchange, Hydrophilicity, Ionomers based on polyethylene, elastomeric ionomers. Ionomers based on polystyrene, Ionomers based on PTFE, ionomers with polyaromatic backbones, polyelectrolytes for ion exchange, polyelectrolytes based on carboxylates, polymers with integral ions, polyelectrolyte complexes. Biological and inorganic ionic polymers

UNIT V **9**

Polymer concrete, polymer impregnated concrete ultra high modulus fibres, natural biopolymers and synthetic biopolymers and their biomedical applications polymeric binders for rocket propellants, polymer supported reagents.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will have the knowledge of polymers applied in special application
- Will correlate the polymer properties for special purpose
- Will acquire skills in selection of polymer to suitable application

TEXTBOOKS:

1. Manas Chanda, Salil.K.Roy, “Plastics Technology Hand book”, 2nd edition, Marcel Dekker, New York, 1993.
2. Matrin.T.Goosey, “Plastics for Electronics”, Elsevier, Applied Science, 1985.
3. R.W. Dyson, “Specialty Polymers”, Chapman & Hall, 2nd edition, 1998.

REFERENCE:

1. H.F.Mark, (Ed), “Encyclopedia of polymer Science & Engineering”, John Wiley & Sons, New York, 1989.

PT6711 POLYMER PRODUCT DESIGN USING CAD L T P C
0 0 3 2

OBJECTIVE:

To teach the students to design and analyse moulds and dies for polymer products.

UNIT I INJECTION MOULD 7

Design calculations: No. of cavities, Selection of injection moulding machine, shot capacity, plasticizing rate, Clamping force, Injection pressure.

UNIT II SEMI - AUTOMATIC COMPRESSION MOULD 7

Design calculations: Economic determination of no. of cavities, flash thickness allowances, design of mould cavity, design of loading chamber, bulk factor, loading chamber depth

UNIT III TRANSFER MOULD 7

Design calculations: Pot calculation, runner & gate dimensions, bulk factor & shrinkage allowances for thermo set plastics & Minimum moulding pressure

UNIT IV BLOW MOULD DESIGN 7

Design calculations: Clamping force, pinch-off, head die design and parison diameter calculations.

UNIT V EXTRUSION DIE DESIGN 8

1. For pipes.
2. For profiles.

UNIT VI PART DESIGNS FOR AN INJECTION MOULDED COMPONENT USING MOULDFLOW 9

TOTAL: 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will be able to design mould for polymer products
- Will be able to develop new polymer products

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Computers with LAN - 8 Nos.
2. Software packages
   - Auto cad - 1 No
   - Pro-E - 1 No
3. Printer - 1 No.

TEXT BOOKS:

1. R.G.W.Pye, Injection Mould Design, SPE Publication.
2. P.S.Cracknell and R.W.Dyson, Hand Book of thermoplastics injection mould design, Chapman & Hall, 1993.

REFERENCES:

1. Herbert Rees, Mould Engineering, Hanser publishers, Munich, Vienna N.Y. 1994.
2. Technical Directory on Design and Tooling for plastics, CIPET, Guindy, Chennai.
3. Design calculations for Compression moulds, Machinery publications, Yellow series, U.K.
4. Mould Flow Manual & Part - Adviser Manual - MOULD FLOW
5. Laszco Sors and Imre Blazs, Design of Plastic Moulds and Dies, Elsevier, Amsterdam - Oxford - Tokyo - NY, 1989.

PT6712 PLASTIC PROCESSING LABORATORY L T P C
0 0 3 2

OBJECTIVE:

To train the students on different plastic processing Techniques such as extrusion, compression moulding, calendaring, FRP processing etc.

LIST OF EXPERIMENTS

1. Preparation of Blow moulded products
2. Compression moulding of phenolic resin and SMC& BMC
3. Injection moulding of thermoplastics – Hand, semiautomatic and Fully automatic
4. Extrusion of thermoplastics
5. Compounding of plastics
6. Preparation of FRP laminates
7. Post processing techniques
8. Preparation of Thermoformed products
9. Recycling of plastic – Scrap grinder
10. Casting of polymer films
11. Manufacturing practices

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will attain the basic knowledge about processing technique.
- Will have knowledge of post processing techniques.
- Will acquire skills in handling processing equipments.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Hand injection moulding machine	3 No
Semi Automatic injection moulding machine	1 No
Fully automatic injection moulding machine	1 No
Extruder for compounding of thermoplastics	1 No
Hand blow moulding machine	1 No.
Fully automatic blow moulding machine	1 No
Air compressor	1 No
Scrap grinder	1 No
Crane for mould handling	1 No
Bench grinding and buffing machine	1 No

Bench wise	1 No
Sheet cutter	1 No
Moulds for hand injection moulding	3 No
Mould for automatic injection moulding	1 No
Mould for semiautomatic injection moulding	1 No
Mould for hand blow moulding	1 No
Mould for fully automatic blow moulding	1 No
Thermo Forming Unit	1 No
Electronic balance	1 No

PT6007 ADHESIVES AND SURFACE COATINGS L T P C
3 0 0 3

OBJECTIVES:

To enable the students to understand the following

- Adhesives - concepts of terminology, theories of adhesion
- Types of specialty adhesives and their application
- Adherend surfaces and joint design
- Surface coatings - constituents and classification
- Evaluation of properties of surface coatings

UNIT I **9**

Adhesives - concepts and terminology, functions of adhesives, advantages and disadvantages of adhesive bonding, theories of adhesion-mechanical theory, adsorption theory, electrostatic theory, diffusion theory, weak-boundary layer theory, Requirements for a good bond, criteria for selection of adhesives.

UNIT II **9**

Types of adhesives, structural adhesives, Urethane structured adhesives, Modified acrylic structural adhesives, phenolic adhesives and modifiers, anaerobic adhesives, cyanoacrylate adhesives, Hot melt adhesives, pressure sensitive adhesives, RTV Silicone adhesives, sealants, water based adhesives. Specialty adhesives, adhesives in aerospace, adhesive in automobile industry, conductive adhesives, adhesives in building construction, adhesive in electrical industry.

UNIT III **9**

Joint design, stress, types of joints, selection of joint detail, joint criteria, surface preparation of adherends-metals, plastics and rubbers. Adhesive bonding processmethods for adhesives application and bonding equipment, adhesives for specific substrates, testing of adhesives, adhesive specifications and quality control.

UNIT IV **9**

Introduction to surface coatings -Components of paints. Pigments, pigment properties, different types, extenders, solvents, oils, driers, diluents, lacquers, varnishes, paint preparation, formulation, factors affecting pigment dispersion, preparation of pigment dispersion. Different types of paints- classification based on polymeric resin, emulsion, oil and alkyd paints, acrylic paints, epoxy coatings, polyurethane, silicones, formaldehyde based resins, chlorinated rubbers, hydrocarbon resins. Classification based on application, fluropolymers, vinyl resins, appliance furnishes, automotive finishes, coil coatings, can coatings, marine coatings, aircraft coatings.

UNIT V **9**

Surface preparation and paint application. Paint properties and their evaluation -mechanism of film formation, factors affecting coating properties, methods used for film preparation - barrier properties, optical properties, ageing properties, rheological properties and adhesion properties of coatings.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will attain the knowledge in mechanism of adhesion
- Will familiarize about the compounding of paints
- Will demonstrate the adhesive types and application

TEXT BOOKS:

1. Gerald L. Schreberger, "Adhesive in Manufacturing", Marcel Dekker Inc., New York, 1983
2. W.C. Wake, "Adhesion and the Formulation of Adhesives", Applied Science Publishers, London, 1976.

REFERENCES:

1. Swaraj Paul, "Surface Coatings", John Wiley & Sons, NY, 1985.
2. George Mathews, "Polymer Mixing Technology", Applied Science Publishers. Shields, "Hand Book of Adhesives", Butterworths,1984

PL6003 BIODEGREDABLE POLYMERS L T P C
3 0 0 3

OBJECTIVE:

To enable the students to understand the method of development of biodegradable polymers; the need of biodegradable and testing methods used for analyzing the biodegradability

UNIT I CHEMISTRY AND BIOCHEMISTRY OF POLYMER DEGRADATION 9

Introduction, enzymes - enzyme nomenclature - enzyme specificity - physical factors affecting the activity of enzymes - enzyme mechanism, Chemical degradation initiates biodegradation, Hydrolysis of synthetic biodegradable polymers.

UNIT II PARTICULATE STARCH BASED PRODUCTS 9

Development of Technology, Current objectives, relative starch technology, Manufacture of master batch, Conversion technology - processing precautions - moisture and temperature - rheological considerations, cyclic conversion process, physical properties of products - sample preparation - physical testing methods - test results, Quality control testing of degradation - auto oxidation measurement - biodegradation assessment - soil burial test.

UNIT III BIOPOLYESTERS 9

Introduction, History, biosynthesis, Isolation - solvent extraction - sodium hypo chloride digestion, enzymatic digestion, Properties - crystal structure - nascent morphology, degradation- Intracellular biodegradation - extra cellular biodegradation - thermal degradation - hydrolytic degradation - environmental degradation - effects of recycling, applications, economics, future prospects.

UNIT IV RECYCLING TECHNOLOGY FOR BIODEGRADABLE PLASTICS 9

Introduction, conventional recycling - economic incentive - recycling problems, degradable complicate recycling - polyethylene/starch film, reprocessing polyethylene/corn

starch film scrap - learning to reprocess PE/S - Calcium oxide moisture scavenger - temperature control - accounting for pro-oxidant - handling PE/S repro - economics of in-plant recycling, Using PE/S repro - comparative study of PE/S repro on film properties, recycling other degradables.

UNIT V TEST METHODS & STANDARDS FOR BIODEGRADABLE PLASTICS 9

Introduction, defining biodegradability, criteria used in the evaluation of biodegradable polymers, tiered systems for evaluating biodegradability, choice of environment, choosing the most appropriate methodology, description of current test methods -screening test for ready biodegradability, tests for inherent biodegradability, tests for simulation studies, other methods for assessing biodegradability - petri dish screen -environmental chamber method - soil burial tests, Test method developments for the future.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize about polymer degradation method
- Will develop the knowledge in mechanism of degradation
- Will acquire the skill in assessing bio-degradability of polymers

TEXT BOOKS:

1. G.J.L Griffin Blackie(ed.), Chemistry & Technology of Biodegradable Polymers Academic & Professional London 1994.
2. Yoshiharu Doi, Kazuhiko Fukuda (ed.) Biodegradable Plastics & Polymers Elsevier 1994.

REFERENCES:

1. Abraham J.Donb & Others (ed.) Handbook of Biodegradable polymers.
2. Harvard Academic Publishers Australia 1997.

GE6075 PROFESSIONAL ETHICS IN ENGINEERING LT P C
3 0 0 3

OBJECTIVE:

To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

UNIT V GLOBAL ISSUES 8

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

TOTAL : 45 PERIODS

OUTCOME :

- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society

TEXTBOOKS:

1. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, “Fundametals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.\
6. World Community Service Centre, ‘ Value Education’, Vethathiri publications, Erode, 2011

Web sources:

1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

PL6005 POLYURETHANE TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE:

To enable the students to understand the basic variation between the raw materials used for polyurethane production, methods of polyurethane production and analysis of the raw materials products.

UNIT I **9**

Introduction to polyurethane- chemistry and materials of polyurethane manufacture: basic reaction, cross linking in polyurethane, important building blocks for polyurethane (isocynates, polyols, amines and additives) - The manufacturer of polyurethanes (the process, parameters and controls).

UNIT II **9**

Polyurethane processing-basic design principles of polyurethane processing equipment steps in the polyurethane processing Flexible foams-(production, properties and application slab stock foam, carpet backing, flexible molded foams & semi rigid molded foams. Reinforced RIM - trends in the use of RIM and RRIM.

UNIT III **9**

Rigid polyurethane foams-chemistry of raw materials, manufacturing of rigid polyurethane (manufacturing of buns, panels, foaming of applications, molded rigid foams), properties, relationship between production methods and properties- application of rigid polyurethane Polyurethane skin integral foam- production, properties and applications

UNIT IV **9**

Solid polyurethane materials- polyurethane casting systems (cast elastomers and casting resins)- thermoplastic polyurethane elastomers: productions / processing, properties and applications, polyurethane, pains, technique and coatings, adhesives builders, elastomers fibers, manufacture / processing and applications.

UNIT V **9**

Determination of composition and testing of polyurethane-chemical compositions, detection methods, identification of functional groups, determinations of properties materials and products (Characterization, physics/mechanical, temp dependence, chemical performance, combustibility) polyurethane and environment health and safety: making and using polyurethane safety.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will understand the importance of poly urethane in engineering application
- Will familarize about manufacturing techniques for poly urethane
- Will attain the knowledge of qualitative and quantitative analysis of poly urethane

TEXT BOOK:

1. Dr. Gumter Oertal (ed.), Polyurethane Hand Book, Hanser Publication Munich.

REFERENCE

1. George woods, The ICI Polyurethane book -published journls by ICI, John Wiley and sons, New York.

GE6757 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- To facilitate the understanding of Quality Management principles and process.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

UNIT II TQM PRINCIPLES 9

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors..

TOTAL: 45 PERIODS

OUTCOME:

- The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXTBOOK:

1. Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

PT6001 **SPECIALITY ELASTOMERS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand special properties of elastomers with respect to structure.
- To study the manufacturing, compounding and processing of specialty elastomers such as silicone rubber, fluoro elastomers, acrylic rubber, EPDM etc.

UNIT I **9**

Introduction of speciality Rubbers - Silicones (Q) - Introduction, Manufacture - Structure and its influence on properties - Compounding - Fabrication - Curing - General properties - Applications - Copolymers - PMQ, PVLQ, FMQ, FVMQ - Silicones Rubber for medical use.

UNIT II **9**

Chlorosulphonated polyethylene - Introduction - Manufacture- Structure and its influence on properties - Compounding - Curing - Properties - Applications Epichlorohydrin - (CO, ECO, ETIR) - Introduction - Manufacture - Structure and its influence on properties - Compounding and Curing Properties and application Fluoro Elastomers (FKM) - Introduction - Manufacture - Structure and its influence on properties - Compounding - Curing - Properties and applications.

UNIT III **9**

Polysulphides (TM) - Introduction, Manufacture - Cross linked Polyethylene (XLPE) - Polyurethane Rubbers - Introduction Manufacture - Structure and its influence on properties - Compounding - Curing - Properties and applications. Thermoplastic Polyurethanes - Introduction - Manufacture - Structure and its influence on Properties - Compounding - Curing - Properties and applications

UNIT IV **9**

Acrylic Rubber (ACM), Ethylene acrylic copolymers, Introduction, Manufacture- Structure and its influence on Properties - Compounding - Curing - Properties and applications Ethylene Vinyl Acetate - Copolymer - Introduction, Manufacture - Structure and its influence on Properties - Compounding - Curing - Properties and applications

UNIT V **9**

Chlorinated Polyethylene - Introduction - Manufacture - Structure and its influence on Properties - Compounding - Curing - Properties and applications. EPM, EDPM - Introduction, Manufacture - Structure and its influence on Properties -Compounding - Curing - Properties and applications.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize the elastomer used in small special application
- Will demonstrate the manufacturing and properties of speciality polymer
- Will attain the knowledge of compounding and curing characteristics for speciality rubbers

TEXT BOOKS:

1. Hoffmann, “Rubber Technology Hand Book”, Hanser Publishers Munich- 1989.
2. Anil. K., Bhowmick, Howard L. Stephens (ed.) Hand Book of Elastomers, New Development & Technology, Marcel Decker Inc., New York, 1988.

PT6071 **FIBRE TECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

To enable the students to learn

- Production technologies of synthetic fibres such as nylon6, PET, PP and acrylic fibres
- Melt spinning, wet spinning, dry spinning, texturing and stretching methods; colouration techniques of fibres.
- Modification for low filling, flame retardant and hollow fibres

UNIT I **9**

Development of synthetic - commercial synthetic fibres, Raw materials manufacture. DMT, TPA, MEG, caprolactum, adipic acid, hexamethylene diamine, acrylonitrile, polymerisation - types of polymers - criteria for fibre forming polymers - production of polyethylene terephthalate polymer - polyamides - production of nylon 66 polymer -nylon 6 polymer.

UNIT II **9**

Polymer production for acrylic fibres - polypropylene - production of other fibres - PVC fibres - PVA fibres - Aramid fibres - Melt spinning - Polymer feed - melt spinning equipment - high speed spinning - spin draw processes - crystallization method - melt spinning of PET & PP stable fibres - wet and dry spinning comparison. Spin finishes - functions of spin finish - methods of application of spin finish - spin finish for polyester staple fibres - spin finish for texturing process - effect of spin finish on dyeing.

UNIT III **9**

Stretching or drawing - conditions of drawing - machines for draw warping - texturing -false twist process - draw texturing- staple fibre production, melt spinning - drawing, heat setting - crimping in fibre line - production of melt spin staple fibre - polyester tops for wool blending - Mass coloration and tow dyeing of polyester, nylon, acrylic -polypropylene - dyeing in loose fibre and yarn forms of polyester, nylon, acrylic, PP, other synthetic fibres - loose fibre dyeing.

UNIT IV **9**

Modified synthetic fibres - modified polyester, Nylon, PP, acrylics - Hydrophilic -Hollow - Low pilling - flame retardant- bicomponent fibres - Dyeability of synthetic fibres

UNIT V **9**

Quality control - testing raw material - testing polymers - testing yarns & fibres - waste utilisation of polyester - nylon 6 - 66 - acrylics - PP- Energy conservation - pollution control.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will have knowledge of polymer used in fiber formation.
- Will demonstrate the processing techniques for fiber formation.
- Will attain the knowledge of testing of fiber.

TEXT BOOK:

1. A.A. Vaidya, Production of synthetic fibres, Prentice Hall of India Pvt. Ltd., New Delhi, 1988.

REFERENCES:

1. Fourne, Franz, “Synthetic Fibres, Machines and Equipment, Manufacture, Properties”, Hanser Publishes, 1999.
2. Corbman Bernard P., “Textiles: fibre to fabric”, Sixth Edition, McGraw Hill, 1983.

PT6002 **TYRE TECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

To enable the students

- To understand various components used and their function of tyres.
- To design and suitable compounding formulation for various tyre components
- To know the building & curing of tyres.

UNIT I **9**

A historical introduction on the design and development of tyres of various kinds and types. The current status of tyre industry in India and its future prospectus. Tyre sizing and marking on the tyres. Different types of tyres - bias, bias belted radial, tube type abd tubeless tyres their basic features and performance comparison. Different components of a tyre, its geometry, basic functions. Functions of a pneumatic tyre - load carrying, vibration and noise reduction, the tyre function as a spring, contribution to driving control and road adhesion, the tyre friction contribution to driving control, steering control and self aligning torque.

UNIT II **9**

Cord- rubber composites and its properties and failure mechanism of cord reinforced rubber. Mechanics of tyre pavement interaction. Tyre forces on dry and wet road surface. Traction forces on dry, wet, ice, snow and irregular pavements, Breaking and traction of tyres.

UNIT III **9**

Tyre wear, rubber friction and sliding mechanism, various factors affecting friction and sliding. Tyre stresses and deformation, tyre noise, mechanism of noise generation, effect of tread pattern, vehicle speed etc., on noise level, Tyre in plane dynamics. High frequency properties, basic yaw and camber analysis.

UNIT IV **9**

Manufacturing techniques of various tyres like two wheeler and car tyres, truck tyres, OTR, Farm tyres, aircraft tyres. Principles of designing, formulations for various rubber components. Tyre reinforcement materials (Textile, steel, glass etc.). Criteria of selection, different styles and construction, textile treatment. Tyre mould design, green tyre design principles, methods of building green tyres for bias, bias belted, radial and tube-less tyres, green tyre treatments. Tyre curing methods, post cure inflation, quality control tests, Tyre related products, their design and manufacturing techniques, tubes, valves, flaps and bladders. Different types, their feature and operation of tyre building machines, bead winding machine, wire/glass processing machines, bias cutters, curing presses.

UNIT V **9**

Measurement of tyre properties, dimension and size-static and loaded, Tyre construction analysis, Endurance test wheel and plunger tests, traction, noise measurements. Force and moment characteristics, cornering coefficient aligning torque coefficient, load sensitivity and load transfer sensitivity, Rolling resistance, non uniformity dimensional variations, force variations- radial force variation, lateral force variation concentricity and ply steer. Type balance, mileage, evaluations, tyre flaws and separations, X-ray holography etc., Foot print pressure distribution.BIS standards for tyres, tubes and flaps

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize about the components of the tyre
- Will attain the knowledge of manufacturing technique of various tyres
- Will acquire the skill in testing of tyre

TEXT BOOKS:

1. Samuel K. Clark, “Mechanics of pneumatic Tires”, National Bureau of standards, Monograph, US Govt. printing office, 1971.
2. Tom French, “Tyre Technology”, Adam Hilger, New York, 1989.

REFERENCES:

1. F.J. Kovac, “Tire Technology”, 4th edition, Good year Tire and Rubber Company, Akron, 1978.
2. E. Robecchi, L.Amiki, “Mechanics of Tire”, 2 Vols, Pirelli, Milano, 1970.

PT6003 PLASTICS PACKAGING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

To enable the students to understand the concepts of materials used in packaging, machinery in packaging and testing of packaging material.

UNIT I **9**

Introduction to plastics packaging: functions of packaging, advantages of plastic packaging, distribution hazards, special requirements of food and medical packaging, packaging legislation and regulation. Packaging as a system: Elements, approach, package, design, relation criteria for packaging materials, packaging equipment checklist, case histories Major packaging plastics Introduction - PE, PP, PS, PVC, polyesters, PVA, EVA, PA, PC, ionomers & fluoro polymers.

UNIT II **9**

Conversion process - Compression & transfer for moulding, Injection moulding, Blow moulding, Extrusion, roto moulding, thermoforming, Lamination, metallizing, decoration process, Shrink wrapping, Pallet & stretch wrapping, sealing methods, Plasma barrier coatings. Energy requirement for conversion

UNIT III **9**

Extrusion, film and flexible packaging - extrusion, cast film & sheet, Blown film, Multi layer film & sheet coatings, laminations & coextrusions, stretch and shrink wrap, pouching, sealing, evaluation of seals in flexible packages, advantages of flexible packaging - flexible packaging products. Specialized packaging for food products.

UNIT IV **9**

Thermoformed, moulded and rigid packages, Thermoforming packages: Position & thermoforming & wrap forming, variations in thermoforming and solid phase pressure forming, scrabbles, twin sheet & melt - to- mold thermoforming, skin packaging, thermoforming moulds, thermoforming fill- real, Aseptic thermoforming, advantages & disadvantages of moulding foams, other cushioning materials & distribution packaging -Polystyrene & other foams systems cushioning, Design of molded cushioning systems, plastic pallets, drums & other shipping containers.

UNIT V **9**

Testing of plastic packages, Barrier, Migration & compatibility, Printing, labeling & pigmenting, Sterilization systems and health care products. Packaging hazards and their controls. Environmental considerations.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will demonstrate the plastic packaging process.
- Will familiarize in testing of plastic packaging
- Will attain the knowledge of thermoforming packaging

TEXT BOOKS:

1. Susan E.M. Seleke, "Understanding Plastic Packaging Technology", Hanser publications - Munich
2. A.S. Altalye, "Plastics in Packaging", Tata McGraw-Hill publishing Co. Ltd., New Delhi.

REFERENCES:

1. Walter Soroka, 'Fundamentals of Packing Technology' Institute of Plastics Packaging, 1999.
2. Neil Farmer (Ed.) Trends in Packaging of Food, Beverages and Other Fast-Moving Consumer Goods, Wood Head Publishing India Pvt Ltd. 2013.

PT6004 CONDUCTING POLYMERS L T P C
3 0 0 3

OBJECTIVE:

To enable the students to understand the basic concepts on conducting polymers, conduction mechanism, various methods of synthesis and characterization of conducting polymers and their applications

UNIT I **9**

Introduction to conducting polymers - discovery of polyacetylene - concept of doing and n-type - polarons and bipolarons - conduction mechanism - redox type polymers (electro - active polymers)

UNIT II **9**

Synthesis of conducting polymers - Chemical synthesis - electrochemical synthesis -template synthesis - precursor synthesis - soluble polymers (colloids and dispersions) -advantages and disadvantages of various synthesis methods.

UNIT III **9**

Characterization methods - elemental analysis for dopants - IR - UV (electro chemical) scanning electro microscopy (SEM) - electro chemical characterization - cyclic voltometry- electrochemical quartz crystal microbalance (EQCM) - probe beam deflection (PBD) - Langmuir - blodgett technique.

UNIT IV **9**

Applications tested - rechargeable batteries, lights emitting diodes - gas sensors - bio sensors - photo voltaic energy devices - micro electronics (PCB fabrications) electro catalysis - applications - proposed - antistatic coatings - electro chem. Mechanical devices - super capacitors

UNIT V **9**

Recent trends in conducting polymers - functionalised conducting polymers (second generation polymers) - super conductors (inorganic - organic hybrid structures) - conducting polymers based on nano composites.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will understand the mechanism of conduction in polymers
- Will able to characterize the conduction in polymers
- Will understand the application of conductivity polymer in various devices

TEXT BOOKS:

1. R. G. Linford, Electro Chemical Science and Technology of Polymers - 1&2, ed., elsevier applied sciences, London, 1987 and 1990.
2. M. Schlvxinger and M. Paunovic, (eds.) Modern Electro Plating, john Wiley and sons Inc., New York, 2000.

REFERENCES:

1. Hari Singh Nalwa (ed.), Hand Book of Organic conductive molecules and polymers, 4 - volume set, John wiley & sons, England, 1997.
2. T.Asaka, S. Komabe and T. Momma, Conductive Polymers.

PT6005 FIBRE REINFORCED PLASTICS L T P C
3 0 0 3

OBJECTIVE:

To enable the students to understand the basic materials in FRP system covering series of matrix resins and reinforcements, various processing methods of composites, post processing operations, various applications of composites and testing of FRP materials

UNIT I MATRIX SYSTEM AND REINFORCEMENT MATERIALS 9

Basic Materials -Polymeric Matrix System- Polyester And Vinyl Ester Resins - Epoxy Resins- High Temperature Resins- Bismaleimides- Cyanide Esters- Benzyl Cyclo Butene- Acetylene Terminated- Bisnodimide- Aryethynyl Resins- Thermoplastic Resins. Fibre Reinforcements - Glass, carbon, aramide, natural fibres, Boron, Ceramic Fibers-Particulate Fillers.

UNIT II PROCESSING METHODS OF COMPOSITES 9

Prepregs, SMC, DMC etc. - Hand Lay-Up; Spray- Up; Bag Molding; Compression Molding, Injection molding, Resin Transfer Molding (RTM); Filament Winding; Pultrusion Auto Clave Molding; Processing of Thermoplastic Composites. Polymer nanocomposites - Definitions, classification of nanoparticles- preparation steps - intercalation, exfoliation & functionalized polymer nanocomposites

UNIT III POST PROCESSING METHODS & APPLICATIONS 9

Cutting, Trimming, Machining, Water Jet Cutting, Abrasive Jet Cutting, Laser Cutting, Joining, Mechanical Fastening and Adhesive Bonding, Painting And Coating.

Applications of Composites in Land Transportation, Marine, Air Craft -Aero Space in Sports Goods- -Composites In Scientific, Industrial And Commercial Applications. Composites in Construction, Composite Bio Materials

UNIT IV MECHANICS OF COMPOSITES 9

Macromechanical Behavior of a Lamina- Stress-strain relations for anisotropic Materials- invariant properties of an orthotropic lamina- Biaxial strength criteria for an orthotropic lamina: Micromechanical Behavior of a Lamina Halpin-Tsai equations, elasticity approach -materials -

approach to strength, tensile and compressive strength in fiber direction-Macromechanical Behavior of a Laminate

UNIT V TESTING OF COMPOSITES 9

Non- Destructive Evaluation Methods For Composites Visual, Tap Test, Ultrasonic Methods, X-Ray Imaging, Thermography, Neutron Radiography, Infrared Thermal Testing, Laser Shear - O- Graphy, Holography And Micro Wave Testing. Mechanical Tests: Tension And Compression Testing, Shear, Torsion, Bending- A Mention About Special Test Methods.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize about the fibers used in reinforcement
- Will attain the knowledge of reinforcement mechanism
- Will develop the knowledge in testing of composites

TEXT BOOKS:

1. G Lubin, “Hand Book of Composites”, 2nd Ed, Van Nostrand Reinhold, New York,1982.
2. L.Holloway “Hand Book of Composites for Engineers”, Technomic, Lancaster, Pa, 1994.

REFERENCES:

1. S.M. Lee, “Dictionary of Composites Materials Technology”, Technomic Lancaster,Pa, 1989.
2. G.Shook, “Reinforced Plastic for Commercial Composites”, Source Book, Asm, 1986.
3. Kevin Potter, “An Introduction to Composites Products”, Chapman and Hall Madras India 1997.
4. S.T.Peter, “Hand Book of Composites”, Chapman and Hall Chennai 1998.
5. Lin / Pearce, “High Performance Thermosets”, Hanser Publishers, Munich, New York, 1993.
6. Harold Belofsky, “Plastics: Product Design And Process Engineering”, Hansen Publisher Munich, New York, 1995,

GE6081 FUNDAMENTALS OF NANOSCIENCE L T P C
3 0 0 3

OBJECTIVE:

To make the students learn about basis of nanomaterial science, preparation method, types and application

UNIT I INTRODUCTION 8

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS 12

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube,

Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays-functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications

UNIT IV CHARACTERIZATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

UNIT V APPLICATIONS 7

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Will develop knowledge in characteristic nanomaterial

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, “Nanoscale charecterisation of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCES:

1. G Timp (Editor), “Nanotechnology”, AIP press/Springer, 1999.
2. Akhlesh Lakhtakia (Editor),“The Hand Book of Nano Technology,Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.