UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY:: CHENNAI - 600 025.

REGULATION - 2013

M.TECH. LEATHER TECHNOLOGY

I TO IV SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER - I

COURSE CODE	COURSE TITLE	L	Т	Р	С
LE8101	Advanced Leather Chemistry	3	0	0	3
LE8102	Advanced Leather Process Technology	3	0	0	3
MA8162	Applied Mathematics	3	1	0	4
	Bridge Course Elective I	3	0	0	3
	Bridge Course Elective II	3	0	0	3
PRACTICAL					
LE8111	Advanced Techniques in Leather Processing – I	0	0	6	3
	TOTAL	15	1	6	19

SEMESTER - II

COURSE CODE	COURSE TITLE	L	Т	Р	С	
LE8201	Advanced Chemistry and Technology of Leather Chemicals	3	0	0	3	
LE8202	Instrumental Methods in Leather Science	3	0	0	3	
LE8203	Treatment and Disposal of Tannery Waste	3	0	0	3	
	Elective I	3	0	0	3	
	Elective II	3	0	0	3	
PRACTICAL						
LE8211	Advanced Instrumentation Laboratory	0	0	6	3	
	TOTAL	15	0	6	18	

SEMESTER - III

COURSE CODE	COURSE TITLE	L	T	Р	С
THEORY	HESS INNUUUN ANUULE				I
LE8301	Environmental Management System	3	0	0	3
	Elective III	3	0	0	3
	Elective IV	3	0	0	3
PRACTICAL					
LE8311	Project Work Phase – I	0	0	14	7
LE8312	Seminar	0	0	2	1
	TOTAL	9	0	16	17

SEMESTER - IV

COURSE CODE	COURSE TITLE	L	Т	Р	С
PRACTICAL					
LE8411	Project Work Phase – II	0	0	26	A3-
	TOTAL	0	0	26	13

BRIDGE COURSE ELECTIVES

COURSE CODE	COURSE TITLE	L	Т	Р	С
LE8002	Advanced Leather Biotechnology [For M.Sc (Chemical Sciences, Environmental Science), B.Tech (Leather)]	3	0	0	3
LE8003	Advanced Organic and Inorganic Chemistry (For B.Tech Leather Technology / M.Sc (Biotechnology) / B.Tech (Biotechnology) students)	3	0	0	3
LE8011	Orientation to Leather Science and Technology [For M.Sc (Chemical Sciences, Environmental Science, Biotechnology), B.Tech (Biotech)]	3	0	0	3

LIST OF ELECTIVES

COURSE CODE	COURSE TITLE	L	Т	Р	С
LE8001	Advanced Coordination Chemistry	3	0	0	3
LE8004	Chemistry and Physics of Collagen	3	0	0	3
LE8005	Colloid and Surface Chemistry	3	0	0	3
LE8006	Energy Management in Leather Industries	3	0	0	3
LE8007	Engineering Economics in Leather Production	3	0	0	3
LE8008	Industrial Safety and Occupational Health	3	0	0	3
LE8009	Marketing of Leather and Leather Chemicals	3	0	0	3
LE8010	Nanotechnology and its Applications in Leather	3	0	0	3
LE8012	Science and Technology of Leather Supplements and Synthetics	3	0	0	3

^{* -} Apart from the above listed electives students will be encouraged to choose electives offered by other departments from Faculty of Technology





UNIT I STRUCTURE OF SKIN AND COLLAGEN

9

Matrix structure of skin and molecular structure of collagen including functional groups and ultra as well as microstructural details - Collagen as a membrane and enzymatic hydrolysis of connective tissue proteins.

UNIT II CHEMICAL PRINCIPLES INVOLVED IN PRETANNING OPERATIONS 9 Salt less/less salt curing methods - Swelling mechanisms; porosity of hides and skins. Diffusion of lime and sharpening agents into skin; Osmotic and lyotropic opening of fibres. Nucleophillic displacement pathways in unhairing, mechanisms of unhairing based on chemical and enzymatic methods — concepts; changes in fibre structure during liming; mechanism of deliming, bating and degreasing - Role of mineral acids, neutral salts and non-swelling acids, in pickling, the chemistry of pickling and the fibre structure and the importance of pore size characteristics of pickled pelts.

UNIT III CHEMISTRY OF TANNING MATERIALS

9

Classification, isolation, characterization and structural elucidation of vegetable tannins; biogenesis and biosynthesis of hydrolysable and condensed tannins - Aqueous chemistry of Chromium (III), Aluminium (III), Iron (II) and (III), Titanium (IV), and Zirconium (IV) - coordinative interactions and hydrolytic behaviour of coordinated ligands, olation, oxolation and polymerisation and their relevance to mineral tanning.

UNIT IV MECHANISM OF TANNING

9

Transport of tanning materials into pelt, diffusion equilibria and mechanism of vegetable, mineral and combination tannages, role of crosslinking and fibre coating in matrix stability.

UNIT V POST TANNING AND FINISHING

9

Physicochemical interactions of syntans, fatliquors and dyes with collagen and leather - Role of surface charge and importance of electrostatic, H-bond, dipole-dipole and hydrophobic interactions. Importance of Iso Electric Point (IEP) during tanning/post tanning ,Theory of finishing with special emphasis to optical properties of pigments /hollow spheres and binders.Role of interfacial phenomena ,adhesion /cohesion and film formation mechanism in leather finishing.

TOTAL: 45 PERIODS

REFERENCES

- O. Flaherty, William T. Roddy and Robert M. Lollar, "The Chemistry and Technology of Leather, Vol. I, Preparation for tannages", E. Robert Krieger Publishing Company, New York, 1978.
- 2. O. Flaherty, William T. Roddy and Robert M. Lollar, "The Chemistry and Technology of Leather Vol. II, Type of tannages" E. Robert Krieger Publishing Corporation, New York, 1977.
- 3. Bienkiewicz, "Physical Chemistry of Leather Making", Krieger Publishing Co., Florida 1982.
- 4. D. Covington, Tanning Chemistry: The Science Of Leather, Royal Society of Chemistry, 2009.

LE8102 ADVANCED LEATHER PROCESS TECHNOLOGY

LTPC 3 0 0 3

UNIT I SPECIALITY LEATHERS

10

Different types of raw materials used, properties required, physical and chemical standards required and process details to achieve the specifications of different types of leathers such as upholstery, washable garment, water resistant leathers, chamois, glove and fashion leathers. Processing of exotic leathers such as reptiles, crocodiles, lizards, fish, ostrich etc.

UNIT II CLEANER PROCESSING - BEAMHOUSE

8

Eco-friendly process technologies: Salt free curing options, sulphide free unhairing systems, ammonia - free deliming, salt free pickling systems, solvent free degreasing systems. Paradigm shift from chemical processing of hides and skins to bio beam house processing.

UNIT III CLEANER PROCESSING: TANNING, POST TANNING AND FINISHING

8

Less chorme and chrome-free tanning systems. Avoidance of eco sensitive substances viz., Formaldehyde, APE, Cr(VI),; VOX, AOX free post tanning; solvent free finishing systems; Latest concepts and trends in leather processing. ECHA /REACh guidelines,Brand / Eco-labelling requirements and trend integrated strategies to achieve permissible BOD, COD and TDS standards of tannery effluents;

UNIT IV ADVANCED FINISHING TECHNIQUES

13

Role of following finishing equipments; techniques for newer and novel finishing system viz., aqueous based patent finishing, cationic finishing, foam finishing. Shoe suede, garment suede, grain finished effect and speciality finishes at split leather processing technologies and finishing techniques specially suited for the purpose. Upgradation of lower ends for better utilisation. New textures with enhanced properties; Transfer foil/coating, lamination techniques, etc in split finishing. Latest trends.

UNIT V NEWER CONCEPTS IN LEATHER MANUFACTURE

6

Process controls and automation – productivity – quality consistency – Water management and Zero Discharge approaches - energy audit - Environmental footprints

TOTAL: 45 PERIODS

REFERENCES

- 1. P.S.Briggs, "Gloving, Clothing and special leathers" products Institute, London 1981.
- 2. J.H.Sharphouse, "Leather Technicians Hand Book", Leather Producers Association, Northampton NN3 1JD, Reprinted 1995.

MA8162

APPLIED MATHEMATICS

L T P C 3 1 0 4

UNIT I TENSOR ANALYSIS

12

Tensor Algebra, Metric Tensor, Christoffel Symbols and covariant differentiation, Riemann-Christoffel Curvature Tensor, Cartesian Tensors

UNIT II FOURIER TRANSFORMS

12

Fourier Transforms, Complex, Sine and Cosine Transforms, Finite Fourier Transforms, Applications to heat conduction problems

UNIT III CALCULUS OF VARIATIONS

12

Simple variational problems with fixed boundaries, Euler's equations, conditional extrema, Isoperimetric problems, Approximate solutions, Direct methods, Euler's finite difference method, Ritz method

UNIT IV METHOD OF WEIGHTED RESIDUALS

12

Basics of variational principle, Applications to ordinary and partial differential equations, subdomain method, Collocation method, least square method, Galerkin method

UNIT V QUALITATIVE ANALYSIS OF ORDINARY DIFFERENTIAL EQUATION

12

Stability of nonlinear systems, Elements of control Theory

TOTAL: 60 PERIODS

REFERENCES

- 1. Ramanaiah, G. T., "Tensor Analysis", S. Viswanatthan Pvt. Ltd., 1990.
- 2. Narayanan S, Manicavachagom Pillai T K and Ramanaiah G, "Advanced Mathematics for Engineering Students," Vol.III, S.Viswana, B. than Pvt. Ltd., 1990.
- 3. Finalyson A., "The Method of Weighted Residuals and Variational Principles", Academic Press, 1972.
- Geo, S. G. and Raghavendra V, "Ordinary Differential Equations and Stability Theory", Tata McGraw Hill, 1980.
- 5. Pushpavanam S., "Mathematical Methods in Chemical Engineering", Prentice Hall of India.

LE8111 ADVANCED TECHNIQUES IN LEATHER PROCESSING - I L T P C 0 0 6 3

Advanced processing techniques with emphasis on eco friendly leather manufacture. Case studies for specific product mix (upper, garment, upholstery, glove) with details of chemical audit, energy audit, water consumption during processing.

TOTAL: 90 PERIODS

LE8201 ADVANCED CHEMISTRY AND TECHNOLOGY OF LEATHER L T P C CHEMICALS 3 0 0 3

General Classifications, Chemistry, Process Flow Sheets, Equipment needs, Quality criteria, Product Specifications and Pollution & Hazard Control in the manufacture of the following:

UNIT I SYNTANS 9

Chemistry and Technology for the manufacture of synthetic tanning agents based on phenol-formaldehyde, urea-formaldehyde, melamine-formaldehyde, sulphones, metal-complex, polymeric retans like acrylic, styrene- maleic and polymeric lubricating syntans. New trends with Hyper branched Polymers (A2B, AB2) / Dendrimers

UNIT II FATLIQUORS 9

Importance of HLB balance and Role of Surfactants in the manufacture of leather chemicals particularly fat liquors, acrylic binders and lacquer emulsions. General chemistry and technology for the manufacture of fat liquors based on natural and synthetic oils, AOX free i.e. Absorbable Organic Halogen free fat liquors, odour free fish oil/cod oil based fat liquors, sulfo succinate, chlorosulfonates /sulfonates /phosphated fat liquors, and silicone based water proof fat liquors. Microemulsion Windsor Phases and its importance for fatliquor preparation. Linker chemistry. Importance of emulsion particle size for stability. Additives role for enhanced softness / touch.

UNIT III BINDERS

Technology for the manufacture of casein binders, casein-wax binders and cationic protein binders. Emulsion binders based on acrylates (Batch /One shot/ Semi batch/Core Shell) and urethanes. Hybrid's Urethane acrylics / Organic-Inorganic Adhesives used in the fabrication leather products. Physical properties and performance levels of binders and adhesives.

UNIT IV (i)DYES

Chemical and application orientated classification of dyes used in leather manufacture and properties thereof. Arylamines and health hazards.

(ii) PIGMENT DISPERSIONS

Classification of pigments and their properties. Surfactant demand - Pigments Manufacture of pigments dispersions with and without casein. Use of ball mill, triple roll mill and bead mill in the manufacture of pigment dispersions. Cationic pigment dispersions and their role in leather finishing.

UNIT V TOP COATS

11

Manufacture of nitro based lacquers and lacquer emulsions; manufacture of nitro free lacquers and lacquer emulsions. Role of solvents in the manufacture of lacquers and lacquer emulsions and VOC (Volatile Organic Compounds) restrictions in the use of such products in leather finishing. Aqueous poly urethane top coats - use and importance. Manufacture of wax emulsions, type of waxes used, cationic wax emulsions, slip agents, feel modifiers, and pull-up oils. Manufacturing methods, properties and uses of waxes, shoe creams and finishes for leather goods.

TOTAL: 45 PERIODS

REFERENCES

- 1. K.M. Shah, Handbook of Synthetic Dyes and Pigments, Vol. I Synthetic Dyes, Vol. II Pigments, Multi-tech Publishing Company, 1994.
- 2. Journal of the American Leather Chemists Association
- 3. Journal of the Oil and Colour Chemists Association.
- 4. Colour Index Directory of Dyes and Pigments published by Society of Dyers and Colourists.
- 5. Groggins, "Unit processes in Organic Synthesis", McGraw-Hill Book Company, New York, 1958.
- 6. Samir Das Gupta, Treatise on Fatliuors and Fatliquoring of Leathers, Indian Leather Technologists Publication, Kolkatta

LE8202 INSTRUMENTAL METHODS IN LEATHER SCIENCE

LTPC 3003

UNIT I ANALYSIS OF VARIOUS SPECTROSCOPIC TECHNIQUES

10

Electromagnetic spectrum and spectroscopic techniques, principles of magnetic resonance, mass and microwave spectroscopic techniques, block diagram of the instruments involved, the fields of application of spectroscopic techniques including study of solid surfaces.

UNIT II CHROMATOGRAPHIC TECHNIQUES

8

Theory and application of different chromatographic techniques such as paper, TLC, HPLC, ion-exchange, gel permeation, gel filtration, GLC and affinity.

UNIT III APPLICATIONS OF SPECTROSCOPIC AND CHROMATOGRAPHIC METHODS IN LEATHER SCIENCE

12

Application of spectroscopy to the analysis of mineral tanning salts, formaldehyde, dyes, pigments and effluents, NMR techniques in the characterization of synthetic tanning agents, fatliquors, finishing agents - Application of chromotographic techniques in separation, analysis and characterization of mixtures containing compounds such as biocides, peptides, proteins, mineral tanning salts, vegetable tannins, dyes and finishing agents with special emphasis on the characterization of polymers.

UNIT IV ELECTROANALYTICAL METHODS

5

10

Theory and applications of electroanalytical techniques like - Polarography, coulometry, cyclic voltammetry and chrono-potentiometry.

UNIT V PRINCIPLES OF MICROSCOPIC AND OTHER TESTING METHODS IN LEATHER SCIENCE

Principles involved in the morphological investigation on leather and polymers (conventional, core-shell morphologies), various microscopic techniques including electron microscopy, mechanical testing devices and criteria for the measurement of mechanical properties -Imaging techniques for surface applications. Differential Scanning Calorimetry(DSC) / Hyper DSC. Thermo Gravimetric Analysis (TGA).

TOTAL: 45 PERIODS

REFERENCES

- 1. Hobart H. Willard, Lye L. Merritt, Jr. John A. Dean and Frank A. Settle, Jr., "Instrumental Methods of Analysis", Sixth edition", CBS Publishers & Distributors, Delhi, 1986.
- 2. E.A.V. Ebsworth, David W.H. Rankin, Stephen Cradock, Structural Methods in Inorganic Chemistry, ELBS, 1988.
- 3. Vogel's Textbook of Quantitative Chemical Analysis, ELBS, V Edition, 1994.
- 4. H. Engelhardt, "Practice of High Performance liquid Chromatography", Springer Verlag, Berlin, 1986.
- Frank A. Bovey, "High Resolution NMR of macromolecules", Academic Press, New York, 1972.
- P.O. Samuelson, "Ion Exchange Separation in Analytical Chemistry", John Wiley, New York, 1963.

LE8203 TREATMENT AND DISPOSAL OF TANNERY WASTE

L T P C 3 0 0 3

TOTAL: 45 PERIODS

UNIT I PHYSICO-CHEMICAL TREATMENT OF WASTEWATER
 Screening – Flow Equilisation – Theory on Coagulation & Flocculation – Sedimentation – Filtration – Detail study and design aspects with reference to tannery wastewater.

UNIT II INTRODUCTION TO BIOLOGICAL TREATMENT OF WASTEWATER 7
Introduction to microbial metabolism – Bacterial growth – Kinetics of Biological Growth

UNIT III BIOLOGICAL TREATMENT OF WASTEWATER

Aerobic suspended growth system - Aerobic attached growth system - Anaerobic suspended growth system - Anaerobic attached growth system - Advanced Biological System - UASB - EGSB

UNIT IV ADVANCED WASTEWATER TREATMENT FOR THE REMOVAL OF REFRACTORY ORGANIC COMPOUNDS 12

Theories on Advanced Oxidation Process viz., Photocatalytic treatment, Membrane Separation, Homogenous catalysis system using hydrogen peroxide, ozone etc - Heterocatalytic systems using metal oxides, activated carbon – Removal of Inorganic Componds through electro dialysis, reverse osmosis, multiple effect evaporator, ion-exchange.

UNIT V SOLID WASTE DISPOSAL 10

Secured land fill: leachability studies and management of leachates – Biomethanisation of Solid waste: with reference to energy recovery – Thermal incineration – Bacterical compositing – Vermi composting – Bioremidiation-RO reject management.

REFERENCES

- 1. Arceivala S.J. "Waste water treatment and disposal" Marcel Dekkar Inc., New York, 1981.
- 2. Metcalf and Eddy,H `Tchobanoglous, G. and Burton, F.L. (Ed), Waste water Engineering, treatment, disposal and reuse, 3rd edn. Tata-McGraw Hill Publishing, New Delhi 1991.
- 3. Besselievie, B.E. and Schwartz, M. "The Treatment of Industrial wastes", 2nd edn., McGraw Hill
- 4. McCarty, P., Parkin, G.F. and Sawyer, C.N., "Chemistry for Environmental Engineering 4th Edition", McGraw Hill, 1994.
- 5. Hans-Joachim Jordening and Josef Winter, "Environmental Biotechnology", Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004.
- 6. M.C.Carre, A Vulliermet and B.Vulliermet, "Environment and Tannery", Centre Technique du Cuir, Lyon, France, 1983.
- 7. UNEP/IEO & UNIDO Tanneries and the Environment A Technical guide, UNEP/IEO, Paris, 1991.
- 8. R.E. Hester and R.M. Harrison, Waste treatment and disposal, The Royal Society of Chemistry Cambridge CB4 4WF, 1995.

UNIT I LEATHER CHEMICALS LABORATORY

35

Analysis and characterisation of natural and synthetic fatliquors in terms of charge, fat content, stability to acids and electrolytes - Evaluation of dyes and pigments in terms of hue, brilliance, particle size determination - Analysis of tannery effluents for their B.O.D., C.O.D., total solids, chrome, sulphide, and leathers for biocides & formaldehyde.

UNIT II INSTRUMENTAL LABORATORY

55

UV and visible spectrophotometric techniques and their applications in the determination of chromium, iron, formaldehyde, dyes, NMR methods for fatliquors - Functional group identification in polymers using IR and NMR techniques. 13 C spectra of polymeric syntans. GPC for molecular weight determination of polymeric syntans - Leather surface examination by electron microscope.

Protein Purification techniques - Characterization of proteins viz., SDS-Page, Circular Dichroismetc.

TOTAL: 90 PERIODS

LE8301

ENVIRONMENTAL MANAGEMENT SYSTEM

L T P C 3 0 0 3

UNIT I LEGISLATIONS ON ENVIRONMENTAL POLLUTION CONTROL AND MANAGEMENT

9

Environmental legislations. Water (Prevention and Control of Pollution) Act 1974, Air ((Prevention and Control of Pollution) Act 1986, Hazardous waste management rules. Standards for discharge of treated liquid effluent into land and water bodies including sea environment. Standards for disposal of gaseous emissions (SO₂, SPM, NH₃, H₂S and HC) into atmosphere. Environment regulations such as REACH.

UNIT II CLEAN DEVELOPMENT MECHANISM (CDM)

9

Overview on sustainable development. Green house gasses reduction mechanism. Project cycle for the CDM. CDM for small scale projects. Risks and opportunities for industries. Financing of CDM projects. Case studies.

UNIT III OCCUPATIONAL HEALTH HAZARDS AND INDUSTRIES

7

Factory Act 1987 of India, Occupational health and safety requirements, Compliance of rules and guidelines of Factory Act applicable to industries.

UNIT IV ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

11

Principles of environmental impact assessment. Guidelines and legislature requirements for siting of industrial units/complexes. Preparatory procedures for EIA study, Evaluation of impact on air, water and land environment. Monitoring of ambient environment, including air, water and land, noise. Liquid and solid waste management.

UNIT V ENVIRONMENTAL AUDIT (EA)

9

Principles of environmental auditing, cleaner technologies in industrial processes and evaluation of processes. Auditing techniques in preparation of EA.

TOTAL: 45 PERIODS

REFERENCES

1. Canter, W.L., Environmental Impact Assessment, McGraw-Hill Inc., 1992.

2. Rau, J.G. and Wooten, D.C., Environmental Impact Analysis Handbook, McGraw-Hill, 1980.

3. UNEP/IED Technical Report Series No.2., Environmental Auditing, 1990.

- 4. Jain, R.K., Urban, L.V., Stacey, G.S. and Balbach, H.E., Environmental Assessment, McGraw-Hill. 1993.
- 5. Woolsten, H., Environmental Auditing An Introduction and Practical Guide.
- 6. Hillary, R., The Eco-management and Auditscheme: A practical guide. Technical Communications (Publishing) Ltd. UK.

LE8311

PROJECT WORK PHASE I

L T P C 0 0 147

Under Project Work Phase I the students are expected to pursue preliminary work on a project undertaken by and assigned to him/her by the Department. A report should be submitted based on the information available in the literature or data determined in the laboratory/industry. The objective of the project work is to make use of the knowledge gained by the student at various stages of the degree programme. Project Work Phase I is intended to facilitate the better completion of project extended through Project Work Phase II in Semester IV.

VIVA VOCE

The object of the viva-voce examination is to determine whether the objectives of the Project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the Project Work.

LE8312

SEMINAR

L T P C

Students are expected to pursue one month industrial/laboratory training during the summer vacation. Seminar presentations need to be made based on their comprehension of their exposure.

LE8411

PROJECT WORK PHASE II

L T P C 0 0 26 13

The students should continue their work proposed in Project Work Phase I and are expected to complete the proposed work. A report should be submitted based on the data determined in the laboratory/industry. The objective of the project work is to make use of the knowledge gained by the student at various stages of the degree programme. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the programme.

VIVA VOCE

The object of the viva-voce examination is to determine whether the objectives of the Project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the Project Work.

LE8002

ADVANCED LEATHER BIOTECHNOLOGY

(Bridge Elective Course for M.Sc (Chemical Sciences, Environmental Science), B.Tech (Leather))

L T P C 3 0 0 3

UNIT I MICROBIAL BIOTECHNOLOGY

R

Microbial fermentation methods. Types of fermentations. Fermentation equipments, preparation of media, preparation of inoculum, separation and purification of products. Application of microbial biotechnology in the industry processes

UNIT II PROTEIN AND ENZYME CHEMISTRY

10

Protein classification, separation, chromatographic and electrophoretic techniques, criteria of homogeneity. Enzyme classification, methods of estimation, sources of enzymes, purification and properties, specificity, activation, inhibition. Immobilization of enzymes and microbial cells for industrial applications- microbial genetics.

UNIT III MOLECULAR BIOLOGY

8

DNA; genetic role, structure and replication - Structure of RNA and transcription - gentic Code - protein synthesis - control of gene expression - genetic engineering - principles and methods - recombinant DNA technology and its potentials. Artificial culturing of Skin.

UNIT IV BIOCHEMICAL ENGINEERING

12

Basic principles, chemical reactions - mechanisms, kinetics, rates of reactions. Analysis of chemical reactions - types of reactions, batch, fed-batch, continuous, well-mixed, plug flow tubular, mass and enthalpy balances, choice of reactor - Transport phenomena in biosystems - mass transfer in gas-liquid systems, application to effluent treatment diffusion, transport through living membranes - Design of fermentor and other fermentation vessels - instrumentation and control - downstream processes - recovery of particulates - application of various systems.

UNIT V BY-PRODUCT UTILISATION

7

Animal based raw materials and their possible uses - Industries based on animal based raw materials with particular references to India; Role of enzymes and micro organisms in animal wastes utilization. Biological treatment of waste water.

TOTAL: 45 PERIODS

REFERENCES

- P.F.Stanbury and A.Whitaker, "Principles of Fermentation Technology", Pergamon Press, 1984
- 2. Lehninger "Biochemistry: the molecular basis of cell structure and function, 2nd Edition, "Kalyani Publishers, Ludhiana, 1978.
- 3. G.S.Stent and C.Calendar, "Molecular Genetics: an introductory narrative, 2nd Edition," Freeman, San Francisco, 1978.
- 4. A.Wiseman, "Topics in Enzyme and Fermentation Biotechnology" (Several volumes). Vol.2.
- 5. T. A. Brown, "Gene Cloning and DNA Analysis: An Introduction", Blackwell Publishing, Fifth edition, 2005,

LE8003 ADVANCED ORGANIC AND INORGANIC CHEMISTRY

L T P C 3 0 0 3

(Bridge Elective Course for B.Tech Leather Technology / M.Sc (Biotechnology) / B.Tech (Biotechnology) Students)

UNIT I Bonding Models

Ionic compounds

Crystal systems, Structures of crystal lattices, Lattice energy and the Born-Haber Cycle, Atomic size revisited - ionic radii

Covalent compounds

Valence bond theory

Lewis structures: (1) resonance, (2) formal charges

Hybridization VSEPR theory

Molecular orbital theory

Linear combination of atomic orbitals: (1) delocalization, (2) antibonding orbitals

Symmetry and overlap

Homonuclear diatomic molecules
Heteronuclear diatomic molecules
Bond order and bond strength

Polyatomic molecules

UNIT II REACTION MECHANISMS OF ORGANIC COMPOUNDS

11

Methods of determining reaction mechanism, factors influencing SN1 and SN2, E1, E2 reactions. Electron displacements, inductive effect, inductometric effect, mesomeric effect, electrometric effect, hyperconjugation, steric inhibition of resonance. Aromatic electrophilic and nucleophilic substitution reactions.

UNIT III DIFFERENT ORGANIC REACTION TYPES

10

Free radical reactions, addition to carbon- carbon, carbon – oxygen multiple bonds, elimination reactions, molecular rearrangements, oxidation and reduction reactions.

UNIT IV CHEMISTRY OF TRANSITION METALS

9

D-block element with special emphasis on Chromium, Titanium, Iron, Aluminium and Zirconium including their redox behaviour.

UNIT V REACTION MECHANISMS OF METAL COMPLEXES

6

Ligands in a metal ion complex; ligand substitution mechanisms; oxidative addition" or "reductive elimination" of ligands,

TOTAL: 45 PERIODS

REFERENCES

- Jerry March, "Advanced organic chemistry, Reactions, mechanisms and structure, 3rd Ed. Reprinted" Wiley Eastern, New Delhi, 1991.
- 2. I.L.Finar, "Organic Chemistry", Vol.I and II, Fifth Edition, Reprinted ELBS Ed., New Delhi, 1991.
- 3. T.W.G.Solomons, "Organic Chemistry", 3rd Ed., Wiley, New York, 1984.
- 4. R.O.C.Norman, "Principles of Organic Synthesis", 2nd Ed., Chapman and Hall, London, 1978.
- 5. D.G.Torgeson, "Fungicides An advanced treatise, agricultural and industrial applications, environmental interactions", Vol I and II, Academic Press, New York, 1967.
- 6. "Reagent for Organic Synthesis" L.F. Fieser & Mary Fieser, 1968.
- 7. "The Flavonoids" J.B. Harborne T.J. Mabry and Helga Mabry, 1975.
- F.Cotton and G.Wilkinson, "Advanced inorganic chemistry", John Wiley, New York, V Edition, 1988.
- 9. James Huheey, Inorganic Cemistry IV Edition, 1993.
- 10. Kettle, "Co-ordination compounds", ELBS, 1975.

LE8011 ORIENTATION TO LEATHER SCIENCE AND TECHNOLOGY

LT PC 3 0 0 3

(Bridge Elective Course for M.Sc (Chemical Sciences, Environmental Science, Biotechnology), B.Tech (Biotech))

UNIT I HIDES, SKINS AND PRESERVATION

9

Origin and characteristics of hides and skins; Categories of livestock; Grading systems; Defects in hides and skins; Various preservation techniques and their principles.

UNIT II PRETANNING PROCESSES AND OPERATIONS

A 1105

Principles and objectives of beamhouse processes viz., soaking, liming, reliming, deliming bating, pickling, depickling and degreasing; Various unit opeartions in pretanning.

UNIT III TANNING

10

Definition and objectives of tanning; Types and basic chemistry of vegetable tannins; Basic chemistry of basic chromium sulfate; Principles involved in vegetable and chrome tanning and their mechanism in brief; Combination tannages.

UNIT IV POST TANNING PROCESSES AND OPERATIONS

10

Principles and objectives of post tanning processes viz., neutralisation, retanning, dyeing and fatliquoring; Various unit operations involved.

UNIT V FINISHING TECHNIQUES

10

Types of binders; Basic chemistry of protein, resin and PU binders; Types of pigments; Basic characteristics of pigments; Basic theory of coating; Principles and objectives of finishing; Classification of finishing; Types of auxiliaries and finishes.

TOTAL: 45 PERIODS

REFERENCES

- Sarkar, K.T., "Introduction to the Principles of Leather Manufacture", Ajoy Sorcor, Madras, 1981
- 2. Dutta, S.S.," Introduction to the Principles of Leather Manufacture", Indian Leather Technologists Association, Calcutta, 1980.
- 3. Thorstenson, T.C.," Practical Leather Technology", Robert E. Krieger Publishing Co., Malabar, Florida, 1985.
- 4. Fred O Flaherty, Roddy, T.W. and Lollar, R.M., "The Chemistry and Technology of Leather", Vol.I & II, Type of tannages, Rober E. Krieger Publishing Co., New York, 1977.
- 5. Tchobanoglous, G., Burton, F.L. and Stensel, H.D. (Eds), "Waste water Engineering, treatment, disposal and reuse: Metcalf and Eddy", 3rd edn. Tata-McGraw Hill Publishing, New Delhi, 1991.

LE8001

ADVANCED COORDINATION CHEMISTRY

L T P C 3 0 0 3

UNIT I CONCEPTS IN CHEMICAL BONDING

5

Concepts and types of chemical bonding, group theoretical approach to structure and reactivity.

UNIT II THEORIES OF CO-ORDINATION

10

Valance bond theory, ligand field theory, molecular orbital theory, importance of ligand field stabilization energy, coordination geometrics and various oxidation states of metal ions.

UNIT III SYNTHESIS, STRUCTURE AND SPECTROCOPY OF TRANSITION METAL COMPLEXES 15

Synthetic strategies to transition metal complexes, spectroscopy of co-ordination compounds, structure and property relations in 'd' block elements. Aqueous chemistry of chromium, titanium, iron, aluminium and zirconium including their redox behaviour.

UNIT IV REACTIVITIES OF TRANSITION METAL COMPLEXES

10

Ligand substitution process and their kinetics and mechanisms. Electron transfer reactions of metal complexes. Stability constant and equilibrium constants.

UNIT V METAL PROTEIN INTERACTIONS

Metal - protein interactions and their role in structural stability of protein.

Attested

TOTAL: 45 PERIODS

REFERENCES

- F.Cotton and G.Wilkinson, "Advanced inorganic chemistry", John Wiley, New York, V Edition, 1988.
- 2. James Huheey, Inorganic Cemistry IV Edition, 1993.
- 3. Kettle, "Co-ordination compounds", ELBS, 1975.
- 4. M.L.Tobe, "Inorganic reaction mechanism", Nelkson, London, 1972.
- 5. C.K.Jorgenson, "Modern ligand field theory", North Holland, London, 1971.
- 6. A.B.P.Leaver, "Inorganic electronic spectroscopy", Elsevier, Amsterdam, 1968.
- 7. R.S.Drago, "Physical methods in inorganic chemistry", East West, New Delhi, 1975.

LE8004 CHEMISTRY AND PHYSICS OF COLLAGEN

L T P C 3 0 0 3

UNIT I MOLECULAR STRUCTURE OF COLLAGEN

12

Collagentriple helix; helixstabilization—syntheticcollagenlike polypeptides -denaturation-renaturation. Native collagenfibrils- axial structure - 3 Dimensional structure - stabilisation -assembly-fibril organisation. X-ray Diffraction studies of collagen. Electron microscopic appearance of collagen. Polymorphic ordered aggregates - Segment long spacing crystallites - Fibrous long spacing crystallites.

UNIT II CHEMISTRY OF COLLAGEN AND ITS DISTRIBUTION

5

Collagen chains - molecules of nomenclature - common and distinctive chemical features - pro and chains - carbohydrates - structure and functions of pro collagens.

UNIT III COLLAGEN CROSSLINKS

5

Chemistry and properties of crosslinks - intramolecular and intermolecular crosslinks - difunctional and multifunctional crosslinks - lathyrism and (functional significance of) crosslinks - analysis of collagen crosslinks.

UNIT IV ISOLATION AND CHARACTERISATION OF COLLAGEN

5

Extractability - selective precipitation behaviour - chromatographic properties - Electrophoretic properties. Amino acid composition and primary structure.

UNIT V BIOSYNTHESIS OF COLLAGEN

7

Transcription and translation - collagen genes and mRNA - synthesis of pro chains - intracellular processing of collagen - extracellular modifications. Steps in collagen biosynthesis and their significance - specific enzymes and their reaction.

UNIT VI COLLAGEN DEGRADATION

4

Mammalian collagenases - pathway of collagen degradation - sources of collagenases - methodology, assay and purification - biological properties - mechanism of action. Action of collagenases on collagen fibres - molecular weights of collagenases - latent collagenases. Inhibitors of collagenases.

UNIT VII PHYSICO-CHEMICAL TECHNIQUES FOR COLLAGENOUS MATRICES 7
Microscopy and spectroscopy techniques for collagen morphology. Non-invasive methods of

liquid and solid imaging of biological specimen and their relevance to location of defects in hides/skins.

TOTAL: 45 PERIODS

REFERENCES

 G.N.Ramachandran (Ed) "Chemistry of Collagen, Treatise on collagen Vol.1, Academic Press, 1967.

2. B.S.Gould (Ed) 'Biology of Collagen', Treatise on collagen, Vol.2, Academic Press, 1968.

- G.N.Ramachandran and A.H.Reddy (Eds) "Biochemistry of collagen", Plenum, New York, 1976.
- 4. K.A.Pieze and A.H.Reddy, (Eds), "Extracellular Matrix Biochemistry", Elsevier, New York, 1984.
- 5. N.Ramanathan (Ed), "Collagen:, Interscience Publishers, New York and London, 1962.
- 6. Eyre D.R., Paz M.A., Gallop P.M., Annu. Rev. Biochem. 53, 717-748, 1984.
- 7. NimniM.E.(ed) Collagen: Vol.3, Boca Raton CRC, 1988.
- 8. Olsen B.R. and Nimni M.E.(ed) Collagen: Vol.4 Molecular Biology, Boca Raton CRC, 1989.
- 9. Miller, EJ. Rhodes, R.K. Structural and Contractile Proteins Extracellular matrix: Methods Enzymol vol.82, 1982.
- 10. Elizabeth D.Hay, `Cell Biology of Extracellular Matrix' Second Edition, Plenum Press, New York, 1991.
- 11. Kucharz, EJ; `The Collagens: Biochemistry and Pathophysiology', Berlin Springer, Verlag, (1992).
- 12. Fratzl, P; 'Collagen: Structure and Mechanics', Springer, 2008.

LE8005

COLLOID AND SURFACE CHEMISTRY

L T P C 3 0 0 3

UNIT I SURFACE TENSION, INTERFACIAL TENSION AND SURFACE ACTIVITY

Definition, effect of temperature, spreading, wetting etc. - Young Laplace and Kelvin equations -Gibbs Law and its application - Critical evaluation of methods of surface tension determination.

UNIT II BULK PROPERTIES OF SURFACTANT SOLUTIONS AND MONOLAYERS 9 Critical micelle concentration (CMC) - Shape, Size, Aggregation, Hydration, Correlation times, Weight of micelles, etc. Different models and thermodynamics of micelle formation. Factors affecting CMC, Monolayers, types, their behaviour and industrial application. Lyophobic sols, Lyophilic systems and stability.

UNIT III ADSORPTION BY SOLIDS

9

Gibbs adsorption equation, Langmuir, Freundlich and BET isotherms. Double layer and Electrical aspects and industrial application. Compositions and structure of solid surface.

UNIT IV SURFACTANTS

9

Chemical and physico-chemical types, properties; Rheology: Viscosity, Non-Newtonian flow and Viscoelasticity - Birefringence: electrical and streaming; X-ray and Neutron scattering. Various diffusional aspects and applications.

UNIT V APPLICATION TO LEATHER TECHNOLOGY

9

Wetting, cohesion & adhesion, contact angle, foams, detergency, emulsions, stability, surface properties and membrane technology.

TOTAL: 45 PERIODS

REFERENCES

- 1. H.E.Garret, "Surface Active Chemicals", Pergamon Press, London, 1972.
- 2. A.W.Adamson, "Physical Chemistry of Surfaces, 3rd Edn.", Wiley Inter-Science, New York, 1990.
- 3. Bienkienwicz, "Physical chemistry of leather making", Krieger Publishing Co., Florida, 1983.
- 4. Ayao Kitahara and Akira Watanabe, Electrical Phenomena at interfaces, Pub:- Marcel Dekker Inc., New York, 1984.
- 5. Arved Datyner, Surfactants in Textile Processing, Pub:- Marcel Dekker Inc., New York, 1983.
- 6. D. J. Shaw, B. Hewemann, Introduction to Colloid and Surface Chemistry, 1992.
- 7. Surfactant Science Series, John-Wiley Interscience Publications, New York.

Attested

Anna University, Chennai-600 025

UNIT I ENERGY SCENARIO

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Energy Scenario, Energy Analysis of Fuels, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment: Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Energy Conservation.

UNIT II ENERGY FORMS

9

Energy forms: (a) thermal (b) Electricity (c) Non-Conventional Sources Thermal: Different Fuels & its Energy Contents, Temperature & Pressure, Heat Capacity. Steam and Moist Air. Electricity: AC & DC, Load Management, Maximum Demand Control, Aggregated Technical & Commercial Losses (ATC);

Non-Conventional: Various Forms; Some Applications related to Non- Conventional Energy Sources.

UNIT III ENERGY MANAGEMENT

9

Need for Energy Management, Various Approaches, Cost Effectiveness, Bench Marking, Optimization of Energy Requirements and Maximization of System Efficiencies. Fuel and Energy Substitution...A Few Case Studies of Real Systems.

UNIT IV ENERGY AUDIT

9

Requirements for Energy Audit, Different Approaches viz, Preliminary and Detailed Energy Audit, Case Studies for Real Systems.

UNIT V ENERGY MANAGEMENT AND AUDITING IN LEATHER IDUSTRY 9 Energy requirement – management – auditing in Leather and Leather Products Manufacturing

Energy requirement – management – auditing in Leather and Leather Products Manufacturing Industry.

TOTAL: 45 PERIODS

REFERENCES

- 1. Jernold H. Krentz, "Energy conservation and Utilisation", Allyu and Bacun Inc, 1976.
- 2. Gemand M. Gramlay, "Energy" Macmillan Publishing Co., New York, 1975.
- 3. Rused, C.K. "Elements of Energy Conservation", McGraw Hill Book Co., 1985.

LE8007 ENGINEERING ECONOMICS IN LEATHER PRODUCTION

L T PC 3 0 0 3

UNIT I PROJECT IDENTIFICATION AND PREPARATION

10

General considerations - choice of project between alternative propositions - engineering aspects - cost estimates and demand forecasting for leather tanning industry.

UNIT II PRINCIPLES OF PROJECT APPRAISAL

10

Investment appraisal and financial analysis through the measurement of project return - by discounted cash flow method - net present value of a project - internal rate of return - project pay back period - cash flows accounting profit - intangible returns - Inflation and project appraisal.

UNIT III IMPLEMENTATION AND MANAGEMENT

9

Methodological and organisational aspects of implementation - pert and other methods - risk and uncertainty - probability theory.

UNIT IV SOURCES OF FINANCE AND BUDGETING

9

Different sources of finance - ownership finance - ordinary share, short, medium and long term loan - budget preparation - annual cost, variable costs - allocation of costs.

UNIT V METHODS OF BUDGETING

7

Marketability method - benefit method - use of facilities method - special cost method, alternative single purpose expenditure method.

TOTAL: 45 PERIODS

REFERENCES

- 1. An Introduction to Engineering Economics", The institutions of civil engineer,1972.
- DasGupta A.K. and Pearle D.W. Cost Benefit analysis Theory and Practice, MacMillan, 1972.
- 3. Little M.D. and Mirrlees J.A., Project Appraisal and Planning for Developing countries, H.E.B, London.
- 4. Economic Analysis of agricultural projects. Price Githinger 1.B.R.D.

LE8008 INDUSTRIAL SAFETY AND OCCUPATIONAL HEALTH

LTPC 3 0 0 3

UNIT I SAFETY PHILOSOPHY

9

Place of industry in society Industrial management role - supervisors role - role of workers - role of trade unions - role of govt. and various other agencies - Factory Act 1948 and the rules. Hazardous Industry - need for safety, legal humanitarian, economic safety and productivity. Factors impeding safety.

UNIT II ACCIDENT PREVENTION & SAFETY TRAINING

9

Definition of accident, injury, dangerous occurrence, unsafe act, unsafe condition. Theories of accident occurrence - principles of accident - prevention - accident inventive methods - industrial accidents - frequencies of industrial accidents in India and foreign countries - classification of accidents - industry wise and causation wise.

PREVENTION - ACCIDENT INVESTIGATION

Methods - developing safety training programme - training of supervisors - training of workers -Inplant & External courses - training of new workers - role of supervision - need for re-training.

UNIT III SAFE GUARDING OF MACHINERY AND MATERIAL HANDLING

9

Principle of machine guarding. Ergonomics of machine guarding. Type of guards - guarding of different types of machinery. Material & construction of guards. Maintenance & repair of guards, lifts & lifting tables, chairs, rope slings, rings, hooks, shackle, eyebolts power tracks and tractors, safety features.

UNIT IV FIRE HAZARDS AND CONTROL

9

Chemistry of fire, classification of fire, portable fire extinguishers and their operation - Industrial fire. Types of all fire protection equipment. Hazard Identification : Fire, explosions, indices consequence analysis, HAZOP, likelihood analysis, risk concepts and criteria, risk mangement Toxicity.

UNIT V OCCUPATIONAL HEALTH

9

Physical hazard, noise vibration, x-rays - ultra violet radiation - permissible exposure limits - effects of exposure - preventive & control measures. Chemical Hazards: toxic chemicals, dirt gases, furies, mists, vapours. Noise pollution, exposures evaluation, common occupational diseases, etc.

TOTAL: 45 PERIODS

REFERENCES

- 1. William Handley, Industrial Safety Hand Book, 2nd Edition, McGraw Hill Book Company, 1969.
- H.W.Heinrich, P.E. Dan Peterson and Nester, Road Industrial Accident Prevention, McGraw Hill Book Co., 1980.

- 3. R.P.Blake, Industrial Safety, II Edn., Prentice Hall Inc., New Jersy, 1963.
- 4. Frank P. Lees, Loss Prevention in the process industries, Butterworth Heinemann, 1996, Vol. 1 to 3.
- 5. V.C. Marshall, Major Chemical hazards, John Wiley & Sons, New York, 1987.
- 6. Guidelines for Chemical Process Quantitative Risk Analysis prepared for centre for Chemical Process Safety of the American Institute of Chemical Engineering, 1989.

LE8009 MARKETING OF LEATHER AND LEATHER CHEMICALS

LTPC 3003

UNIT I MARKETING CONCEPTS

8

Definition of basic management and marketing concepts - role of marketing in the production function - marketing concepts relevant to consumer durable like leather and leather chemicals.

UNIT II HIDES AND SKINS - LEATHERS

8

Indian livestock population over two decades - hides and skins availability, their sizes, marketing centres, channels, prices over two decades - leather production centres - channels, prices - leather products - centres and marketing channels.

UNIT III MARKETING FUNCTION

9

Market classification and segmentation - consumer market and buying behaviour - market management and forecasting - market planning and control - competition marketing strategy - product life cycle strategy - product and price strategy - sales promotion, publicity, advertising, packaging- marketing organisations- techniques of marketing research for consumer products.

UNIT IV INTERNATIONAL TRADE

10

General concepts of international marketing, principles relevant to leather and leather chemicals - global market for leather and leather chemicals - important production and consumption centres, product wise in the world - major world suppliers of leather chemicals.

UNIT V EXPORT TRADE INDIA

10

India's export trade in leather. India's share in the global level - India's competitors and their strength. International prices. Indian Government policies in the export promotion. Role of Indian and overseas promotional institutions for export growth - strategies for export promotion. Market constraints - quality, image, brand name, merchandising methods.

TOTAL: 45 PERIODS

REFERENCES

- 1. Philip Kolter, "Marketing Mangement", Fifth Edition, Prentice Hall, New Delhi, 1984.
- 2. CLRI, Report of All India Survey on Raw Hides and Skins, CLRI, Madras 1987.
- 3. CLRI, Report on Capacity Utilisation and Scope for Modernisation in Indian Tannery Industry, CLRI, Chennai 1990.
- 4. World Statistical compendium for Raw Hides and Skins, Leathers and Leather Footwear (FAO of UN).
- 5. Employment and working conditions and competitiveness in Leather and Footwear Industry (ILO of UN).
- 6. Thyagarajan, G., Srinivasan, A.V. and Amudeswari, A, "Indian Leather 2010, A technology, Industry and Trade Forecast", CLRI, Madras, 1994.
- 7. Sadulla, S.,The Leather Industry Kothari's Deskbook Series, H.C. Kothari Group (Publications Division), Madras 1995.
- 8. ILO Tanning of hides and skins, Third Impression 1989, Geneva.
- 9. CLRI, Report of nationwide survey on leather product units in India, CLRI, Chennai, 1997.

LE8010 NANO TECHNOLOGY AND ITS APPLICATIONS IN LEATHER

LTPC 3 0 0 3

UNIT I INTRODUCTION TO NANOTECHNOLOGY

3

The nanoscale. What is nanotechnology? Consequences of the nanoscale for technology and society. Beyond Moore's Law.

UNIT II NANOMATERIALS: FABRICATION

9

- Structure and bonding
- Electronic band structure
- Electron statistics
- Bottom-up vs. top-down
- Epitaxial growth
- Self-assembly
- Chemical Synthesis
- Green Synthesis

UNIT III NANOMATERIALS: CHARACTERIZATION

10

- Structural
 - XRD, TEM, SEM, STM, AFM, TGA, DSC, N₂ adsorption, FTIR spectroscopy, Raman spectroscopy
- Chemical
- Optical

UNIT IV APPLICATION OF NANO TECHNOLOGY IN TANNING, POST TANNING AND FINISHING

Collagen – Skin Matrix – Association of nano materials with collagen matrix at various stages of processing – Pre tanning. Tanning. Post Tanning and Finishing.

UNIT V NANO LEATHER CHEMICALS

9

Manufacture of Nano based materials for leather manufacture: syntans, fatliquor, coloring and finishing chemicals

UNIT VI ENVIRONMENTAL ASPECTS OF NANOTECHNOLOGY

5

Synthesis, Water purification, Beneficial and adverse affect of nanomaterials

TOTAL: 45 PERIODS

REFERENCES

- 1. C. P. Poole, F. J. Owens, "Introduction to Nanotechnology", Wiley-Interscience, 2003.
- 2. B. Bhushan, "Sringer Handbook of Nano-Technology", Springer, 2004.

LE8012 SCIENCE AND TECHNOLOGY OF LEATHER SUPPLEMENTS AND LTPC SYNTHETICS 3 0 0 3

UNIT I POLYMERS

5

Polymer and rubber industries in India. Chemistry and Technology of the most common polymeric materials used in leather industry as supplements.

UNIT II POLYMERIZATION TECHNIQUES

15

Concept of a macromolecule, natural and synthetic polymers, modes of polymerization, radical, condensation, stereo-regular polymerization, polymerization kinetics, mechanism, anionic and cationic polymerization. Polymers with linear, branched and cross linked structure, thermoplastic and thermosetting polymers, bulk, solution, suspension and emulsion polymerization.

UNIT II ANALYSES AND TESTING OF POLYMERS

10

Molecular weight and distributions of polymers, different methods of molecular weight determinations, colligative properties, viscometry, light scattering techniques, thermal analysis of polymers, crystallinity, glass transitions and other mechanical properties, spectral analysis such as IR, UV and NMR of polymers.

UNIT IV INDUSTRIAL POLYMERS

10

Manufacture of industrially important polymers for plastics, fibres and elastomer - Polyethylene, polypropylene, polyvinyl chloride, polyvinyl acetate, copolymers, formaldehyde resins, polyvinyl alcohol, polyacrylonitrile, polystyrene, polyurethane, fluoro-carbon polymers, epoxy resins, polyamides, polyesters, alkyd resins, silicone polymers, cellulosics.

UNIT V FABRICATION

5

Fabrication of polymeric materials, compounding and mixing, casting, extrusion, fibre spinning, moulding, coating foam fabrication. Manufacture of rubber and elastomers, Natural rubber, processing, vulcanizing synthetic elastomers, butadiene copolymer, nitrile rubber, polyisoprene, polybutadiene.

TOTAL: 45 PERIODS

REFERENCES

- 1. Williams, D.J., 'Polymer Science and Engineering', Prentice Hall, New York, 1971.
- 2. Austin, G.T., Shrere's 'Chemical Process Industries',5th ed., McGraw Hill International Book Co., Singapore, 1984.
- 3. Elrich, F.R., 'Science and Technology of Rubber', Academic Press, New York, 1978.
- 4. G.Lubin, S.T.Peters, 'Handbook of composites', Van Nostrand Reinhold Co., New York, 1997
- 5. F. Rodriguez, 'Principles of Polymer System', Temple Press, London, 1965.
- 6. D.C. Miles & J.H. Briston, 'Polymer Technology', Temple Press, London, 1965.
- 7. R.W. Moncrieff, `Man-made Fibres', 5th Edn., Heywood Books, London, 1970.
- 8. F. W. Billmeyer, Jr., Textbook of Polymer Science, 2nd Ed., Wiley. Interscience, New York, 1971.

