

**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	T	P	C
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
<b>PRACTICAL</b>					
LE8111	Advanced Techniques in Leather Processing – I	0	0	6	3
	<b>TOTAL</b>	<b>15</b>	<b>1</b>	<b>6</b>	<b>19</b>

**SEMESTER - II**

COURSE CODE	COURSE TITLE	L	T	P	C
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
<b>PRACTICAL</b>					
LE8211	Advanced Instrumentation Laboratory	0	0	6	3
	<b>TOTAL</b>	<b>15</b>	<b>0</b>	<b>6</b>	<b>18</b>

**SEMESTER - III**

COURSE CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
LE8301	Environmental Management System	3	0	0	3
	Elective III	3	0	0	3
	Elective IV	3	0	0	3
<b>PRACTICAL</b>					
LE8311	Project Work Phase – I	0	0	14	7
LE8312	Seminar	0	0	2	1
	<b>TOTAL</b>	<b>9</b>	<b>0</b>	<b>16</b>	<b>17</b>

**SEMESTER - IV**

COURSE CODE	COURSE TITLE	L	T	P	C
<b>PRACTICAL</b>					
LE8411	Project Work Phase – II	0	0	26	13
	<b>TOTAL</b>	<b>0</b>	<b>0</b>	<b>26</b>	<b>13</b>

## BRIDGE COURSE ELECTIVES

COURSE CODE	COURSE TITLE	L	T	P	C
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	T	P	C
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

PROGRESS THROUGH KNOWLEDGE

Attested

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**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 chrome 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, sub-domain 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**

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## **(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 Fatliquors and Fatliquoring of Leathers, Indian Leather Technologists Publication, Kolkatta

**LE8202**

### **INSTRUMENTAL METHODS IN LEATHER SCIENCE**

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

#### **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 chromatographic 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**

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**

**10**

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).

## 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 Craddock, 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.
5. Frank A. Bovey, "High Resolution NMR of macromolecules", Academic Press, New York, 1972.
6. 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**

**UNIT I PHYSICO-CHEMICAL TREATMENT OF WASTEWATER 8**

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 8**

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 Compounds 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 – Bacterial composting – Vermi composting – Bioremediation-RO reject management.

TOTAL : 45 PERIODS

## 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, 3<sup>rd</sup> edn. Tata-McGraw Hill Publishing, New Delhi 1991.
3. Bessellievie, B.E. and Schwartz, M. "The Treatment of Industrial wastes", 2<sup>nd</sup> 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.

Attested

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**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. <sup>13</sup>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 Dichroism etc.

**TOTAL : 90 PERIODS****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 (SO<sub>2</sub>, SPM, NH<sub>3</sub>, H<sub>2</sub>S 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.

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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 14 7**

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.

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**SEMINAR**

**L T P C**  
**0 0 2 1**

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.

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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**

1. 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.
8. F.Cotton and G.Wilkinson, "Advanced inorganic chemistry", John Wiley, New York, V Edition, 1988.
9. James Huheey, Inorganic Chemistry IV Edition, 1993.
10. Kettle, "Co-ordination compounds", ELBS, 1975.

**LE8011 ORIENTATION TO LEATHER SCIENCE AND TECHNOLOGY LT PC**  
 (Bridge Elective Course for M.Sc (Chemical Sciences, 3 0 0 3  
 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 10**  
 Principles and objectives of beamhouse processes viz., soaking, liming, reliming, delimiting, bating, pickling, depickling and degreasing; Various unit operations in pretanning.

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- 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.
- Dutta, S.S., "Introduction to the Principles of Leather Manufacture", Indian Leather Technologists Association, Calcutta, 1980.
- Thorstenson, T.C., "Practical Leather Technology", Robert E. Krieger Publishing Co., Malabar, Florida, 1985.
- 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.
- Tchobanoglous, G., Burton, F.L. and Stensel, H.D. (Eds), "Waste water Engineering, treatment, disposal and reuse: Metcalf and Eddy", 3<sup>rd</sup> 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** **5**  
 Metal - protein interactions and their role in structural stability of protein.

**TOTAL : 45 PERIODS**

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## REFERENCES

1. F.Cotton and G.Wilkinson, "Advanced inorganic chemistry", John Wiley, New York, V Edition, 1988.
2. James Huheey, Inorganic Chemistry IV Edition, 1993.
3. Kettle, "Co-ordination compounds", ELBS, 1975.
4. M.L.Tobe, "Inorganic reaction mechanism", Nelson, 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**  
Collagen triple helix; helix stabilization—synthetic collagen like polypeptides -denaturation-  
renaturation. Native collagen fibrils- 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 - lathyrisms 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

1. 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.

3. 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. Nimni M.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, E.J. 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**

**9**

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. Bienkiewicz, "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.

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**UNIT I ENERGY SCENARIO 9**

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 INDUSTRY 9**

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

**TOTAL : 45 PERIODS****REFERENCES**

1. Jernold H. Krentz, "Energy conservation and Utilisation", Allyn and Bacon 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 P C  
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.

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**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.
2. 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 L T P C**  
**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 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.
2. 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 Jersey, 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**

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

**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 Kotler, "Marketing Management", 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.

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**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, cellulose.

**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., Shreve'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.

PROGRESS THROUGH KNOWLEDGE

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