DEPARTMENT OF LEATHER TECHNOLOGY

ANNA UNIVERSITY, CHENNAI

Vision:

To become a premier centre of learning and research in Leather and Allied Technology.

Mission:

MD 1: To provide quality education in the area of Leather Technology with high professional values.

MD 2: To share and disseminate expertise to provide solutions for the problems faced by the Leather industry.

MD 3: To build an expertise based capsule of delivering technology to leather and allied sectors.

MD 4: To provide a learning ambience for innovators, researchers and technologists.
1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

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<th>I.</th>
<th>To build an expertise base capsule of delivering technology based solution to leather and allied sectors.</th>
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<td>II.</td>
<td>To foster development of advanced human capacity for translational research for solutionscience.</td>
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<tr>
<td>III.</td>
<td>To equip learners with relevant knowledge and expertise system for professional consultation.</td>
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<tr>
<td>IV.</td>
<td>To enable learners in the areas of pedagogy and advanced research.</td>
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<tr>
<td>V.</td>
<td>To provide a learning ambience for innovators, researchers and professional technology authors.</td>
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2. PROGRAMME OUTCOMES (POs):
On successful completion of the programme,

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<tr>
<td>1.</td>
<td>Ability to independently carry out research/investigation and development work to solve practical problems</td>
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<td>2.</td>
<td>Ability to write and present a substantial technical report/document</td>
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<td>Able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery shall be at a level higher than the requirements in the appropriate bachelor programme.</td>
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<td>4.</td>
<td>Identify, formulate and solve engineering problems</td>
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<td>5.</td>
<td>Design a system or process to improve its performance, satisfying its constraints</td>
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<td>6.</td>
<td>Design the system with environment consciousness and social obligations</td>
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3. PROGRAM SPECIFIC OUTCOMES (PSOs):

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<td>Communication: People and social skills required for leadership,</td>
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<td>PSO3</td>
<td>Responsibility: Professionally ethical behavior and social responsibility of leather and allied sector.</td>
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<td>Design: Ability to comprehend, analyze, synthesize for design, develop and delivery of converging solutions for industrial problems</td>
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4. PEO/PO Mapping:

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#### MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

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## ANNA UNIVERSITY:: CHENNAI - 600 025
UNIVERSITY DEPARTMENTS
M.TECH. LEATHER TECHNOLOGY
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABI

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* Compulsory for non-leather graduates

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* Compulsory for non-leather graduates

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RESEARCH METHODOLOGY AND IPR COURSES (RMC)

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### SUMMARY

Name of the Programme: M.TECH – LEATHER TECHNOLOGY

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OBJECTIVE
- To provide knowledge on advanced physical and chemical concepts associated with the structure of collagen.
- To have a basic understanding on biosynthesis of collagen.
- To provide expertise on isolation and characterization of collagen.
- To provide knowledge on collagen degradation collagenases.
- To provide expertise on the application of collagen based biomaterials for various biomedical applications.

UNIT I BIOSYNTHESIS OF COLLAGEN
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.
Types of collagen - Collagen chains — nomenclature- common and distinctive features — Type I collagen pro and tropocollagen - carbohydrates.

UNIT II TYPE I COLLAGEN – STRUCTURE & SUPRAMOLECULAR ASSEMBLY

UNIT III ISOLATION AND CHARACTERISATION OF COLLAGEN
Extractability - selective precipitation behavior - chromatographic properties — Electrophoretic properties. 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.

UNIT IV COLLAGEN DEGRADATION

UNIT V BIOMATERIAL AND APPLICATION OF COLLAGEN
List of Experiments
1. Extraction of collagen from rat tail tendon/bovine hides
2. Estimation of hydroxyproline
3. Two dimensional gel electrophoresis -Collagen
4. Turbidity Assay-Collagen
5. FTIR-Collagen
6. Thermal stability studies
7. Circular Dichroism
8. Preparation of collagen scaffold

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, the students would be able"
CO1. Acquire a comprehensive knowledge on the biosynthesis of collagen
CO2. Explore the structure and supra-molecular association of Type I Collagen.
CO3. Acquire a conceptual framework on the extraction of collagen and different techniques used for the characterization of collagen.
CO4. Develop knowledge on overview about mammalian and bacterial collagenases; and their mechanism of action in degrading collagen.
CO5. Summarize on the versatility on the use of collagen for biomedical and food/pharma applications

REFERENCES:

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LE3102 QUALITY MANAGEMENT AND ASSURANCE

OBJECTIVE
- To provide comprehensive knowledge about the principles, practices, tools and techniques of quality assurance system in leather industries.
- To learn about the importance of quality assurance system and its policies.
- To learn and implement TQM principles in leather industries.
- To gain knowledge on the statistical techniques for quality improvement in leather industries.
- To provide expertise on the tools of statistical techniques to analyse complex data and to gather insights from customer and marker data.

UNIT I QUALITY ASSURANCE SYSTEM FOR LEATHER INDUSTRY
Introduction to QAS: Designing and developing quality assurance system for leather industry — Structure of QAS, understanding system requirements, Designing QAS for Leather industry, Implementing QAS, Verification of QAS.

UNIT II ISO 9001:2015 FOR LEATHER INDUSTRY

UNIT III TOTAL QUALITY MANAGEMENT FOR LEATHER INDUSTRY
TQM Principles — Leadership, Supplier teaming, Customer focus, Employee empowerment, continual improvement; Implementation of TQM principles in leather industry.

UNIT IV STATISTICAL TECHNIQUES FOR QUALITY MANAGEMENT IN LEATHER INDUSTRY
Statistical Process Control — chance and assignable causes, statistical basis of control charts, Various control charts, Application of control charts in process control for leather manufacturing.

UNIT V STATISTICAL TECHNIQUES AND TOOLS
(a) Capability Analysis — Process capability, Process capability analysis using control charts, Process capability using designated experiments, Process capability with attribute data; application of process capability for leather.
(b) DMAIC - Basic concept and techniques of DMAIC — application of DMAIC for leather.
List of Experiments
1. Binomial Distribution and its applications
2. $\bar{x}$ chart uses in the Leather sector
3. DMAIC and its applications for the leather sector.
4. Six sigma with appropriate examples related to leather sector.
5. Applications of control charts in process control for the manufacturing of leather
6. Types I Error and Type II errors with examples related to leather.
7. Process Capability analysis with relevant examples to the leather sector.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, students can
CO1. Describe key elements of effective quality control and improvement programs.
CO2. Apply structured problem-solving statistical techniques and tools to improve quality in the leather sector.
CO3. Identify current trends and benchmark organizations related to quality management.
CO4. Identify correct statistical tool for process design
CO5. Acquire an overview knowledge of quality guidelines in leather industries

REFERENCES:

Course Articulation Matrix:

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LE3151 PROJECT MANAGEMENT SYSTEM

OBJECTIVE
- The purpose of this subject is to identify; formulate; foresee or predict problems as possible
- To understand the concept of capital investments
- To learn about the various project appraisal techniques
- To understand the concept of project design and audit
• To develop the knowledge on the concepts of project scheduling and schedule compression techniques

UNIT I PROJECT IDENTIFICATION AND FORMULATION 10

UNIT II PROJECT BUDGETING AND FINANCING 9

UNIT III PROJECT APPRAISAL AND RISK ANALYSIS 8
Project Appraisal: Time Value of Money; Project Appraisal Techniques – Payback Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return, Benefit Cost Ratio; Social Cost Benefit Analysis; Effective Rate of Return. Risk Analysis: Measures of Risk; Sensitivity Analysis; Stimulation Analysis; Decision Tree Analysis.

UNIT IV PROJECT DESIGN AND EVALUATION 7

UNIT V PROJECT SCHEDULING TOOLS AND TECHNIQUES 11
Critical Path Method (CPM); Critical Chain Method; Schedule Compression Techniques – Crashing – Fast Tracking; Resource Optimization Techniques – Leveling – Balancing; Modelling Techniques – What-if Analysis – Simulation; Leads and Lags; Scheduling tools; Schedule network Analysis.

List of Experiments
1. Payback Period
2. Accounting Rate of Return
3. Net Present Value
4. Internal Rate of Return
5. Benefit Cost Ratio
6. Social Cost Benefit Analysis
7. Effective Rate of Return
8. Decision Tree Analysis
9. Critical Path Method (CPM)
10. Program Evaluation Review Technique (PERT)
11. Schedule Compression Techniques
12. Resource Optimization Techniques

TOTAL : 60 PERIODS

COURSE OUTCOME
At the end of the course, the students are expected to
CO1 Successfully develop and implement all project’s procedures.
CO2 Achieve project’s main goal within the given constraints.
CO3 Develop techniques to manage and coordinate projects, subcontractors, customers, team members and vendors.
CO4 Identify various implementation techniques.
CO5 Describe ways to manage scope in a rapidly changing business environment.

REFERENCES:

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LE3152  ORIENTATION TO LEATHER MANUFACTURE        L  T  P  C
[Bridge Elective Course for Non-Leather UG Graduates]  2  0  2  0

OBJECTIVE
- This course objective is to orient the non-leather students on the fundamental science and technology of leather manufacture
- To understand the Principles and objectives of beam house processes
- To understand the concept of tanning
- To understand the concept of post tanning
- To gain knowledge of various finishing techniques available

UNIT I    HIDES, SKINS and PRESERVATION  7
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  8
Principles and objectives of beam house processes viz., soaking, liming, reliming, deliming, bating, pickling, depickling and degreasing; Various unit operations 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., neutralization, 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

Course Outcome
At the end of the course, the students are expected to
CO1 Understand the application and alternatives to leather in current global scenario.
CO2 Have knowledge on pre-tanning process.
CO3 Comprehend the process rational for making specific leather through tanning Process.
CO4 Develop Knowledge in post tanning processes.
CO5 Have knowledge in finishing techniques.

List of Experiments
1. Assortment and Grading of hides and skins
2. Preservation Techniques
3. Manufacture of chrome tanned leather from wet salted sheep skin
4. Manufacture of EI tanned leather from wet salted goat skin
5. Manufacture of upper leather

REFERENCES:
1. Sarkar, K.T., “Introduction to the Principles of Leather Manufacture”, Ajoy Sorcor,
Madras, 1981.

Course Articulation Matrix:

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RM3151 RESEARCH METHODOLOGY AND IPR

**OBJECTIVES:**
To impart knowledge on
- Formulation of research problems, design of experiment, collection of data, interpretation and presentation of result
- Intellectual property rights, patenting and licensing

**UNIT I** RESEARCH PROBLEM FORMULATION
Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

**UNIT II** RESEARCH DESIGN AND DATA COLLECTION
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

**UNIT III** DATA ANALYSIS, INTERPRETATION AND REPORTING
Sampling, sampling error, measures of central tendency and variation.; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research
UNIT IV INTELLECTUAL PROPERTY RIGHTS 9
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9
Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

COURSE OUTCOMES
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

REFERENCES:
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,

LE3111 PRACTICE ON QUALITY MANAGEMENT L T P C
0 0 6 3

OBJECTIVE
To provide practice on the principles of total quality management in leather and allied sector.
To provide practical exposure on quality control in leather manufacture.
To acquire the ability of quality check and assurance of the materials involved during manufacturing.

Students will be oriented on Quality control and Management practice requirements in leather manufacture for converting raw hides/skins into finished leather. To provide this practical orientation, any two types of leather (upper, garment etc.) will be used. The practice would involve preparation of charts used in tannery.

COURSE OUTCOMES:
At the end of the course students will be:
CO1. Apply quality management practice in leather manufacture
CO2. Analyses quality feature associated with leather manufacture

TOTAL: 90 PERIODS
CO3. Distinguish quality check and quality assurance involved during leather manufacture

**Course Articulation Matrix:**

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OBJECTIVE

- To provide a platform to attain practical knowledge on utilizing advanced instrumental techniques and machineries for leather physical strength analysis.
- To have hands on experience on characterizing leather chemicals and auxiliaries.
- To enhance the ability to analyze and interpret data obtained during characterization.

UNIT I LEATHER CHEMICALS LABORATORY 45
Analysis and characterization 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, and particle size - Analysis of chrome and formaldehyde in syntan and leather.

UNIT II PHYSICAL TESTING LABORATORY 45
Analysis of Strength Properties (Tensile Strength and Elongation at break, Tongue tear strength, Stitch tear and slit tear strengths) of leather - Water vapor permeability – perspiration resistance – Abrasion resistance — Grain crack resistance - Evaluation of fastness properties (Rub fastness, Light fatness, Color fastness) on wet and dry condition.

TOTAL: 90 PERIODS

OUTCOMES:
Students will
CO1. Acquire the practical skill in basic chemical analysis associated with leather science and technology
CO2. Develop analytical skills to characterize the leather chemicals
CO3. Acquire practical knowledge in physical testing of leather

Course Articulation Matrix:

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OBJECTIVE

- To provide knowledge on advanced physical, chemical and biological concepts associated with the leather manufacture.
- To provide a basic understanding of skin and leather in materials science aspect.
- To provide knowledge in designing eco-benign leather unit process.
- To provide knowledge on the role of process chemicals involved in tanning and mechanism of various tanning system.
- To give insight on various sustainability aspects in leather making.

UNIT I MATERIALS SCIENCE ASPECTS OF SKIN AND LEATHER

Pore size distribution, hydration and swelling phenomenon; Various transport processes into multiphasic systems; Steady and non-steady state diffusion; Leather as a composite material – bulk and surface properties, stiffness and damping/energy; Viscoelastic and dynamic mechanical properties; Ordering and long range order — concepts.

UNIT II PRINCIPLES INVOLVED IN PRETANNING OPERATIONS

Preservation towards salt less/less salt methods - Swelling mechanisms; Diffusion of lime and sharpening agents into skin; Osmotic and lyotropic opening of fibres. Mechanisms of unhairing based on chemical and enzymatic methods — concepts; Principles of deliming, bating and degreasing in designing eco-benign processes;

UNIT III PRINCIPLES INVOLVED IN TANNING OPERATIONS

Role of mineral acids, neutral salts and non-swelling acids in pickling; Changes in porosity of hides and skins during processing; Aqueous chemistry of Chromium (III), Aluminium (III), Iron (II) and (III), Titanium (IV), and Zirconium (IV) – Zeolites- coordinative interactions and hydrolytic behavior of coordinated ligands, their relevance to mineral tanning. Organic tanning- Tetrakis (hydroxymethyl) phosphonium sulphate, Triazine, Biomass derived aldehyde tanning. 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 IV PRINCIPLES INVOLVED IN POST TANNING AND FINISHING

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. Theory of finishing with special emphasis to optical properties of pigments and binders. Role of interfacial phenomena, adhesion /cohesion and film formation mechanism in leather finishing.

UNIT V SUSTAINABILITY OF LEATHER MAKING

Sustainability concepts; Triple bottom line approach; Do-Undo concepts in leather processing; Effect of pH alternations; Do-ecology concepts; Narrow pH and reverse leather processing concepts; Bio-catalytic concepts to replace chemicals; Process integration; Waterless and low-water leather processing; Input-output process audit for atom economy.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will be able to
CO1. Acquire knowledge about underpinning science in leather manufacture
CO2. Summarize the advanced concepts and principle involved in the leather manufacture
CO3. Apply knowledge on sustainable leather making
CO4. Understand the charge of the leather substrate to design auxiliaries
CO5. Acquire knowledge on the basic concepts to reduce the carbon footprints in leather process

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LE3202             INNOVATIONS AND GREEN CONCEPTS IN LEATHER PROCESS             L T P C
                                                                  3 0 0 3

OBJECTIVE
- To impart knowledge on the technology of making different types of leathers with cleaner and greener approach.
- To understand the processing of specialty leathers.
- To provide knowledge on eco-labelling certification and restricted chemicals usage guidelines in leather manufacturing.
- To provide knowledge on various finishing techniques.
- To gain knowledge on wastes reduction and management through various approaches.

UNIT I             SPECIALITY LEATHERS
9
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
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
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
Role of following finishing equipment; techniques for newer and novel finishing system viz., aqueous based patent finishing, cationic finishing, foam finishing. Shoe suede, garment suede, grain finished effect and specialty 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

TOTAL : 45 PERIODS

COURSE OUTCOMES
At the end of the course, the students will be in a position to CO1. Apply the conceptual design to make leather.
CO2. Acquire knowledge in cleaner leather processing.
CO3. Analyze newer concepts in leather manufacture.
CO4. Develop knowledge about eco-benign chemicals and restricted chemicals in leather process
CO5. Acquire advanced knowledge in waste management

REFERENCES :
**LE3203 ADVANCED INSTRUMENTAL METHODS**  
**L T P C**  
3 0 0 3

**OBJECTIVE**
- To have a thorough understanding of the theory and principles of analytical techniques with special reference to leather technology.
- To provide knowledge on spectroscopic and chromatographic methods in leather science.
- To provide knowledge and understand the chromatographic techniques for leather auxiliary synthesis.
- To have the ability to characterize leather chemicals and auxiliaries.
- To enhance the ability to analyze and interpret data obtained during characterization.

**UNIT I SPECTROSCOPIC TECHNIQUES**  
9  
Electromagnetic spectrum and spectroscopic techniques, principles of electronic, vibrational and rotational spectroscopic techniques, principle and instrumentation of atomic absorption spectroscopy (AAS) – various atomization techniques, Hydride generation technique, ICP-OES, Raman spectroscopy, principles of magnetic resonance and mass techniques, block diagram of the instruments involved, the fields of application of spectroscopic techniques including the study of solid surfaces.

**UNIT II CHROMATOGRAPHIC TECHNIQUES**  
9  
Principles and application of different chromatographic techniques such as paper, TLC, HPLC, ion-exchange, gel permeation, gel filtration, GLC and affinity chromatography.

**UNIT III APPLICATIONS OF SPECTROSCOPIC AND CHROMATOGRAPHIC METHODS IN LEATHER SCIENCE**  
9  
Application of spectroscopy for the analysis of mineral tanning salts, formaldehyde, dyes, pigments and effluents, NMR techniques in the characterization of synthetic tanning agents, fatliquors, and 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  9
Redox process, electrode and electrode potentials, electrochemical cells, Theory, principle and applications of –potentiometry, conductometry, Polarography, and cyclic voltammetry.

UNIT V  PRINCIPLES OF MICROSCOPIC AND OTHER TESTING METHODS IN LEATHER SCIENCE  9
Principles involved in the morphological investigation of 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). Thermo Gravimetric Analysis (TGA).

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students can
CO1. Gain Fundamental knowledge and understand the basic scientific principle behind various advanced instrumental techniques.
CO2. Handle/select appropriate instrumental methods for the analysis of various types of samples and sample preparation techniques.
CO3. To have deep understanding on strengths, limitations and creative use of techniques for analytical problem-solving.
CO4. To understand the basic instrumentation techniques used for leather chemicals testing
CO5. Acquire knowledge on microscopic and thermal degradation techniques for leather and auxiliaries

REFERENCES:

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LE3211  LEATHER PROCESS DESIGN ENGINEERING LABORATORY  L T P C  0 0 6 3

OBJECTIVE
To impart practical exposure in designing of different types of leathers using cleaner approaches.
To have the ability prepare chemical and energy audit based on process design.
To have the ability to manage water resources during process design.

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

COURSE OUTCOMES:
At the end of the course, the students will be in a position.
CO1. Make different types of leather using cleaner methods.
CO2. Analyze process efficiencies.
CO3. Construct process strategy for specialty leathers.

Course Articulation Matrix:

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LE3212  ADVANCED INSTRUMENTAL METHODS LABORATORY  L T P C  0 0 6 3

OBJECTIVE
To provide a platform to attain practical knowledge on utilizing advanced instrumental techniques.
To have hands on experience on characterizing leather chemicals and auxiliaries.
To enhance the ability to analyze and interpret data obtained during characterization.

INSTRUMENTAL LABORATORY
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. 13C 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, FTIR.

TOTAL: 90 PERIODS

COURSE OUTCOMES:
At the end of the course, the students would
CO1. Have practical knowledge on various instrumental methods.
CO2. Understand the underpinning science behind various instrumental techniques
CO3. Have knowledge on advanced analytical techniques.
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SEMESTER III

LE3301  PRACTICE ON LEATHER CHEMICALS  L T P C

3 0 0 3

OBJECTIVE
To provide knowledge on the functions of leather auxiliaries.
To provide knowledge on different types of syntans and their preparation methods.
To provide knowledge on composition of fatliquors, preparation and functionalization techniques.
To provide knowledge on types of dyes, and their preparation methods.
To provide knowledge on pigments and binders, and their role in formulation.

UNIT I  INTRODUCTION
Definition and function of leather auxiliaries, role of wetting agents, syntans, fatliquors, fatliquoring cum retanning agents, dyes, pigments, binder, top coats, feel modifiers and matting agents in leather processing. Surface tension and principles of wetting, importance of HLB, Chemical classification of wetting agents.

UNIT II  SYNTANS
Chemical classification of syntans, sulphonation of naphthalene, phenols, Napthols, Phenol formaldehyde condensation reactions, chemistry of light fast syntans, chemistry of amino resins and PU, preparation of multi-functional polymers, Unit operations in syntan manufacture.

UNIT III  FATLIQUOR AND DYEING
Composition of fatliquors; Functionalisation of oils for surface active function, chemical classification natural and synthetic oils, sulphation, sulphonation, sulphitation reactions of oils, role of double bonds and iodine value in functionalisation of oils, sulphochlorination, sulphaamidation, transesterification, phosphorylation reactions for fatliquor preparation. Stability of emulsions, grain and particle sizes of emulsions, factors controlling grain sizes of emulsions. Fatliquor manufacturing technology. Theory of colors, chromphoric groups, structural features of dyes; acid, basic and reactive dye classification. Chemistry and technology of dye manufacture.

UNIT IV  PIGMENTS AND BINDERS
Definition of pigments, groups of polymer bases for color. Classification, formulations of pigments, particle size, refractive index, density, opacity criteria for the choice of pigment bases, Different techniques in particle size reduction and importance of particle size on functional properties of pigment formulation. Functional definition of binders, chemical classification of binders, acrylic, protein, polyurethane, introduction to manufacturing of binder formulations, preparation of metal-
organic framework based pigments.

UNIT V FINISHING
Different types of top coat formulations, choice of polymers for surface protection, role of plasticizers, internal and external plasticizers. Principles of feel modification of polymer surfaces, types of feel modifiers and matting agents.

COURSE OUTCOMES
At the end of the course, students would
CO1. Understand the structure and properties of various leather auxiliaries
CO2. Have knowledge on the chemistry of finishing chemicals
CO3. Understand various finishing formulation and application strategy
CO4. Understand the role of polymers in leather finishing
CO5. Understand the functionalization and functional groups in polymer

REFERENCES:
5. Samir Dasgupta, Treatise on Fatliquors and Fatliquoring of Leather, Indian Leather Technologists Association Publications, Kolkatta

Course Articulation Matrix:

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OBJECTIVE
The industrial internship is expected to enhance the technical employability skills of the students.
To develop skills in handling industrial equipment.
To interact with industry and society in a professional and ethical manner.

Students are expected to undertake industrial internship programme during the summer vacation. Minimum duration of this should be 1 month. During their internship programme, the students are expected to resolve atleast one of the problems faced by the industry. Students pursuing R&D elective stream will be allowed to take up their internship at a research lab. As a part of this course students are expected to make presentations and report on the work they have carried out during their internship.

COURSE OUTCOMES:
CO1 At the end of this course the students will have confidence in handling practical aspects in leather and allied sector.
CO2 To become expertise in handling respective training sector.
CO3 To improve the presentation skills of the students.

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LE3312 PROJECT WORK I

OBJECTIVE
The objective of this course is to facilitate the students to identify innovative projects that promotes creativity
To identify the problems associated with their respective field of research
To enhance the communication and presentation skills

Under Project 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 Phase I is intended to facilitate the better completion of project extended through Project 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.

TOTALS:: 180 PERIODS
COURSE OUTCOMES:
At the end of the course, the students are expected to

**CO1**  At the end of the Project Phase I period, students should understand conceptual thinking in their field.

**CO2**  Able to apply the concepts to relevant research problems or practical applications.

**CO3**  Should be able to defend their phase I project successfully with some leads towards project phase II.

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**SEMESTER IV**

**LE3411**

**PROJECT WORK II**

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**OBJECTIVE**

The objective of the project is to make use of the knowledge gained by the student at various stages of the degree programme.

To judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the programme.

To gain knowledge and expertise in the area of research and development.

The students should continue their work proposed in Project Phase I and are expected to complete the proposed work. A report should be submitted based on the data determined in the laboratory/industry. 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.

**COURSE OUTCOMES:**
At the end of the course, the students are expected to

**CO1**  The project work is expected to shape the student to think originally, plan/execute work properly.

**CO2**  Helps in developing the analytical abilities and problem solving.

**CO3**  Improves documenting, reporting and communication skills.

**TOTAL: 360 PERIODS**
LE3001 ADVANCED COORDINATION CHEMISTRY

OBJECTIVE
- To provide knowledge on the advanced concepts associated with coordinate covalent complexes.
- To provide knowledge on various theories of coordination.
- To provide knowledge on the aqueous chemistry and various chemical reaction with transition metal complexes.
- To understand the concepts of metal-protein interactions.
- To have the ability to characterize inorganic compounds using spectroscopic techniques.

UNIT I CONCEPTS IN CHEMICAL BONDING
Concepts and types of chemical bonding, group theoretical approach molecular symmetry elements, symmetry operation, point groups, application. Pi back bonding, organic metallic compounds, synthesis bonding and structure.

UNIT II THEORIES OF CO-ORDINATION
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
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 behavior.

UNIT IV REACTIVITIES OF TRANSITION METAL COMPLEXES
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. Bio inorganic chemistry, characterization of inorganic compounds by IR, NMR, UV-Vis and Mass spectroscopy

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students would be in a position to
CO1. Acquire knowledge on chemical bonding and coordination chemistry of transitions metals
CO2. To have deep Understanding in the synthesis, structure and reactivity of transition metal
complexes
CO3. Explore metal-protein interactions
CO4. To gain knowledge on synthesis of new ligands
CO5. To understand the mechanism of metal-protein interactions through spectroscopic techniques

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LE3002 ADVANCED LEATHER BIOTECHNOLOGY L T P C 3 0 0 3

OBJECTIVE
- To understand the advanced biotechnology concepts in various unit processes and operations in leather manufacture.
- To provide knowledge on fermentation methods and process involved.
- To give an overview on molecular biology.
- To have basic understanding on biochemical engineering, unit process involved in fermentation and down streaming process.
- To give insight on animal waste utilization.

UNIT I MICROBIAL BIOTECHNOLOGY 9
Microbial fermentation methods. Types of fermentations. Fermentation equipment, preparation of media, preparation of inoculum, sterilization, separation and purification of products. Examples of microbial biotechnology in industry.

UNIT II PROTEIN AND ENZYME CHEMISTRY 9
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.

UNIT III  MOLECULAR BIOLOGY  9

UNIT IV  BIOCHEMICAL ENGINEERING  9
Basic principles, kinetics of growth, 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, Design of fermentor and other fermentation vessels - instrumentation and control - downstream processes - application of various systems.

UNIT V  BY-PRODUCT UTILISATION  9
Animal based raw materials for Industries with particular reference to India; Role of enzymes and microorganisms in animal wastes utilization. Biological treatment of waste water.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students are expected to
CO1. Acquire knowledge on the role of biotechnological approaches in leather manufacture.
CO2. Understand the concepts of molecular biology.
CO3. Aware of by product utilization technology.
CO4. Understand the design and down streaming process for enzyme production.
CO5. Gain knowledge on genetic engineering.

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OBJECTIVE

- To provide knowledge on inorganic and organic chemistry essential for leather technologists.
- To give an overview on atomic structure and bonding models.
- To provide knowledge on mechanism involved in organic reactions.
- To provide knowledge on chemistry of transition metals.
- To have a basic understanding on the mechanism of metal complexes

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
- Lewis structures: (1) resonance, (2) formal charges VSEPR theory; Valence Bond Theory, hybridization 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  ORGANIC REACTION TYPES ENCOUNTERED IN LEATHER SCIENCE

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

UNIT III  MECHANISM OF ORGANIC REACTIONS USED IN THE MANUFACTURE OF LEATHER CHEMICALS

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

UNIT IV  CHEMISTRY OF TRANSITION METALS


UNIT V  REACTION MECHANISMS OF METAL COMPLEXES

Ligands in a metal ion complex; ligand substitution mechanisms; oxidative addition” or “reductive elimination” of ligands, election transfer reactions, redox reaction.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1. Gain knowledge on some of the advanced aspects of organic and inorganic chemistry.
CO2. Understand the mechanism of organic reaction
CO3. Understand the chemistry of transition metals
CO4. Understand the synthesis mechanism of leather chemicals
CO5. Understand the metal-ligand complex formation

REFERENCES:
Wiley Eastern, New Delhi, 2015.

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OBJECTIVE

- To provide knowledge on the advanced concepts of colloids and surface chemistry associated with leather processing.
- To have a basic understanding on surface and interfacial tension.
- To provide knowledge on the bulk properties of surfactants.
- To give insight on soft condensed matter and solids.
- To understand the various properties and preparation of emulsions.

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

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 behavior and industrial application. Lyophobic sols, Lyophilic systems and stability, HLB number and tuning them to designed surface and interfacial properties – leather applications

Wetting, cohesion & adhesion, contact angle- tuning surface and interface properties of materials

UNIT III  SOFT CONDENSED MATTER AND COLLOIDS

Functional and adaptive surfactants, polymers, gels and bio colloids Types of colloids and their characterization, Phase behavior and aggregated structures in self-assembling colloids- Applications in leather processing Stability of colloids- Sources of surface charge, short range forces, zeta potential, DLVO theory Aggregation, flocculation and precipitation, Schulze-Hardy rule, inorganic coagulants, polymeric floculants, wastewater treatment; Surface Active Agents & Association Structures of Amphiphilic Molecules Transport and fate of colloids in porous media- pores sizes and their distributions and adsorption of emulsions/colloids in such porous materials

UNIT IV  EMULSIONS

Emulsion and pseudo emulsion films Phase diagrams Foams and foam breaking Antifoaming agents & mechanisms FlotationPurification of surface-active agents using foams Designed responsive and functional interfaces- Pickering emulsions – In processes in Leather, food and textile Designing Pickering emulsions for – surface and interface properties of leather

UNIT V  ADSORPTION BY SOLIDS

Solid-liquid interfaces (changing of surfaces, Electrical Double Layer, adsorption) Particle-particle interactions: Electrostatic forces; Analysis of surface change and surface chemistry (electro kinetics electrophoresis, streaming potential, electro-osmosis, sedimentation potential, electroacoustic, surface spectroscopy, ESR) Particle-particle Interactions: steric forces & polymer-mediated forces; Particle-particle interactions: hydrophobic forces; Analysis of particle interactions (rheometry, AFM, CFM, MASSIF, SFA)

COURSE OUTCOMES:

At the end of this course, the students are expected to
CO1. Understand the role of colloid and surface chemistry in leather applications.
CO2. Gain knowledge on bulk properties of surfactant solutions and monolayers
CO3. Understand the adsorption phenomena of solids.
CO4. Understand the significance of HLB ratio in fat liquor preparation
CO5. Understand the advanced preparation methods for surfactants

REFERENCES:
1. Encyclopedia of Colloid and Interface Science" by Tharwat Tadros
2. Advances in Measurement and Control of Colloidal Processes" by R A F Williams and N C de Jaeger
3. Physical Chemistry of Surfaces" by A W Adamson and A P Gast
4. Interfacial Transport Processes and Rheology" by D A Edwards
7. Surface and Interfacial Forces - From Fundamentals To Applications" by Doris Vollmer

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LE3005 CORPORATE SOCIAL RESPONSIBILITY L T P C 3 0 0 3

OBJECTIVES
To equip individuals with knowledge and skills undertaking Corporate Social Responsibility.
To develop competencies for effective field interventions, research and management of CSR interventions.
To develop an insight into present CSR strategies of model business organization.
To give a global insight into the requirements of the leather and footwear industry.
To enable students with conceptual clarity on need, purpose and relevance of research applicability in CSR practice.

UNIT I INTRODUCTION
Introduction to CSR - Meaning & Definition of CSR, History & evolution of CSR. Concept of Charity, Corporate philanthropy, Corporate Citizenship, CSR-an overlapping concept. Concept of sustainability & Stakeholder Management.
CSR through triple bottom line and Sustainable Business; relation between CSR and
Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India; models of CSR in India, Carroll’s model; drivers of CSR; major codes on CSR; Initiatives in India.

UNIT II PRINCIPLES OF CSR
International framework for Corporate Social Responsibility, Millennium Development goals, Sustainable development goals, Relationship between CSR and MDGs. United Nations (UN) Global Compact 2011. UN guiding principles on business and human rights. OECD CSR policy tool, ILO tri-partite declaration of principles on multinational enterprises and social policy.

UNIT III LEGISLATION AND ACTS
CSR-Legislation In India & the world. Section 135 of Companies Act 2013. Scope for CSR Activities under Schedule VII, Appointment of Independent Directors on the Board, and Computation of Net Profit’s Implementing Process in India.

UNIT IV REGULATORY REFORMS
The Drivers of CSR in India, Market based pressure and incentives civil society pressure, the regulatory environment in India Counter trends. Performance in major business and programs. Voluntarism Judicial activism.

UNIT V GUIDELINES OF CSR, REVIEW AND INITIATIVES

COURSE OUTCOMES:
At the end of the course, the students are expected to
CO1. Gain comprehensive knowledge on the relate and describe the multidisciplinary, strategic, and evolving nature of corporate social responsibility.
CO2. Able to apply ethical decision making principles in a professional or business context.
CO3. Aware of guidelines of CSR.
CO4. Understand the regulatory reforms
CO5. Understand the role of CSR for sustainable development

REFERENCES:
3. Innovative CSR by Lelouche, Idowu and Filho
5. Handbook on Corporate Social Responsibility in India, CII.
Oxford University Press, 2011
10. Blowfield, Michael, and Alan Murray, Corporate Responsibility, Oxford University Press, 2014

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LE3006 ENERG Y MANAGEMENT IN INDUSTRIES

OBJECTIVE
To orient the students to assess the energy requirement and management in leather manufacture.
To acquire knowledge on various forms of energy.
To provide knowledge on energy generation and conservation.
To have the ability to calculate energy requirements for accessories used during leather manufacturing.
To have the ability to do energy audit in leather industry.

UNIT I ENERGY SCENARIO

UNIT II ENERGY FORMS
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.
Different types of energy forms — SI units, Basics of heat, Power and Pressure, AC & DC motors, Basic of Pump and its types, Refrigeration and Air conditioning, Compressor and Boiler used in leather units and treatment system.

UNIT III ENERGY MANAGEMENT
UNIT IV  ENERGY AUDIT
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
Performance evaluation of Motor, Pump and Air compressor used in leather production and treatment units

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1. Understand the energy requirements in leather manufacture.
CO2. Gain knowledge in energy controls in leather manufacture.
CO3. Make case studies for real systems.
CO4. Understand various approaches of energy management.
CO5. Understand the significance of energy audit for leather industry.

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OBJECTIVE

- The objective of this course is to present students on project identification and preparations
- To understand the principles of Investment appraisal and financial analysis
- To understand the risk and uncertainty of the implementation and management
- To develop knowledge in handling finances
- To gain knowledge in the budget and its various methods

UNIT I PROJECT IDENTIFICATION AND PREPARATION 10
General considerations - choice of project between alternative propositions - engineering aspects - cost estimates and demand forecasting for footwear 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 payback period - cash flows accounting profit - intangible returns - Inflation and project appraisal.

UNIT III IMPLEMENTATION AND MANAGEMENT 9
Methodological and organizational aspects of implementation - pert and other methods - risk and uncertainty - probability theory.

UNIT IV SOURCES OF FINANCE AND BUDGETING 9

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

COURSE OUTCOME
At the end of the course, the students are expected to

CO1 Understand the project identification and preparation in the footwear industry.
CO2 Understand the principles of project analysis in footwear sector.
CO3 Have knowledge in organizational aspects of implementation.
CO4 Understand finances and ownerships.
CO5 Develop knowledge in budgeting.

REFERENCES:
3. Little M.D. and MirrleesJ.A., Project Appraisal and Planning for Developing

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**LE3007 SUSTAINABLE CHEMISTRY APPROACHES FOR LEATHER MANUFACTURE**  

**OBJECTIVE**
- To give an overview on the concepts of green chemistry and life cycle assessment
- To have a basic understanding the on the principles of sustainable chemistry in leather processing,
- To provide knowledge on the greener practices in pretanning process of leather manufacturing.
- To provide knowledge on the sustainable tanning technologies.
- To provide knowledge on the sustainable post tanning and finishing technologies.

**UNIT I INTRODUCTION TO SUSTAINABLE CHEMISTRY**  
Principles and Concepts of Green Chemistry-Atom Economy-Life Cycle Assessment-Use of Renewable Resources

**UNIT II PRINCIPLES OF SUSTAINABLE CHEMISTRY IN LEATHER PROCESSING**  
Prevent waste-Maximize atom economy-Design less hazardous chemical syntheses-Design safer chemicals and products-Use safer solvents and reaction conditions-Increase energy efficiency-Use renewable feedstocks-Avoid chemical derivatives-Use catalysts, not stoichiometric reagents-Design chemicals and products to degrade after use- Analyze in real time to prevent pollution-Minimize the potential for accidents

**UNIT III GREENER APPROACHES IN PRETANNING PROCESSES**  
Saltless curing technology - Enzymes in leather processing - Role of ionic liquids in unhairing and fibre opening, Role of Supercritical Carbon dioxide in fibre opening and deliming

**UNIT IV SUSTAINABLE TECHNOLOGIES IN TANNING**  
Role of water in tanning - Alternative solvent system for cleaner leather processing - Waterless chrome tanning - Metal free tanning system - Strategy for high exhaustion Chrome Tanning - Mass balance, diffusion and reactivity of Tanning agent — Pickle free chrome tanning - Zero liquid
discharge tanning system

UNIT V SUSTAINABLE TECHNOLOGIES FOR POST TANNING AND FINISHING

Formaldehyde, Phenol, AOX free post tanning systems – Biopolymers based retanning agent - Role of finishing equipments such as HVLP spray, foam finishing, etc in cleaner perspective. Aqueous finishing concepts and formulation; other novel finishing techniques to reduce VOC emission - Nano technology in post tanning and finishing

COURSE OUTCOMES:
At the end of the course, the students are expected to
CO1. Gain knowledge on the various concepts of greener chemistry involving in the leather process (viz., pre-tanning, tanning, post-tanning and finishing systems).
CO2. Understand the various cleaner options for leather manufacturing.
CO3. Aware of recent greener technological options.
CO4. Understand the principles and concepts of sustainable chemistry
CO5. Understand the cleaner tanning process for waste management

REFERENCES:

BOOKS

JOURNALS
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LE3052 INDUSTRIAL SAFETY AND OCCUPATIONAL HEALTH L T P C
3 0 0 3

OBJECTIVE
- This course will make the students to understand the regulations and practices associated with safety and occupational health
- To gain knowledge about the accident occurrence theories and its prevention
- To gain knowledge about productive machine safety in footwear industry
- To acquire deeper insights about fire hazards and control
- To learn about the occupational health

UNIT I SAFETY PHILOSOPHY
Place of industry in society Industrial management role – supervisor’s 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 AND SAFETY TRAINING
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- In plant& External courses - training of new workers - role of supervision - need for re-training.

UNIT III SAFE GUARDING OF MACHINERY AND MATERIAL HANDLING
UNIT IV  
FIRE HAZARDS AND CONTROL  
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 management Toxicity.

UNIT V  
OCCUPATIONAL HEALTH  
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. safe handling of microorganisms (mycobacterium tuberculosis, anthrax).

TOTAL : 45 PERIODS

COURSE OUTCOME
At the end of the course, the students are expected to
CO1  Legal framework of safety and health in India and international conventions.
CO2  Hazard identification and assessment for accident prevention and safety training.
CO3  Productive machine safety in the footwear industry.
CO4  Emergency prevention and preparedness safety for fire hazards.
CO5  Obtain knowledge of physical hazards, chemical hazards as well as its prevention and control measures for occupational health.

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OBJECTIVE

- To understand the basic management and marketing concepts.
- To provide knowledge on the raw materials availability, conversion ratio and marketing channels.
- To have the ability to forecast market needs based on trends.
- To understand the concepts of foreign trade policies and international trading of leather.
- To have the ability to promote leather export growth.

UNIT I  MARKETING CONCEPTS
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
Indian livestock population over two decades - hides and skins availability, their sizes, marketing centers, channels, prices over two decades - leather production centers - channels, prices -leather products - centers and marketing channels.

UNIT III  MARKETING FUNCTION
Market classification and segmentation - consumer market and buying behavior — 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 organizations - techniques of marketing research for consumer products.

UNIT IV  INTERNATIONAL TRADE
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
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

COURSE OUTCOMES:

On the completion of the course students are expected to
CO1. Understand the international trade, government policies in export aspects of world trade related to leather sector, custom tariff and international marketing.
CO2. Gain knowledge on concepts of international marketing.
CO3. Aware of India’s share in the global level.
CO4. Aware of advanced marketing strategies
CO5. Aware of international market standards for trading
REFERENCES:
4. World Statistical compendium for Raw Hides and Skins, Leathers and Leather
5. Footwear (FAO of UN).
6. Employment and working conditions and competitiveness in Leather and Footwear
7. Industry (ILO of UN).
11. CLRI, Report of nationwide survey on leather product units in India, CLRI, Chennai, 1997

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OBJECTIVE

- To provide the knowledge on basic principles of nanotechnology.
- To provide knowledge on nanomaterial synthesis.
- To provide expertise on the characterization of nano materials.
- To provide knowledge on the application of nano technology in leather processing.
- To provide a platform to design and synthesis nano leather chemicals.

UNIT I  NANO TECHNOLOGY


UNIT II  NANO MATERIALS SYNTHESIS

Introduction to synthesis of nanostructure materials, bottom-up approach and top-down approach – equipment for mechanical alloying, process variables in milling, Bottom-up vs. top-down. Chemical approaches: sol gel method, solvo thermal and hydrothermal routes, precipitation, Spray pyrolysis, Electro spraying and spin coating routes, Electro chemical deposition, Electrophoretic deposition. Physical Approaches: Inert gas condensation technique – arc plasma and laser ablation, Vapor deposition, epitaxial growth techniques, pulsed laser deposition, Sputtering, Lithography, Dry and Wet etching, Epitaxial growth.

UNIT III  NANO MATERIALS: CHARACTERIZATION


UNIT IV  APPLICATION OF NANO TECHNOLOGY IN LEATHER PROCESSING

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

UNIT V  NANO LEATHER CHEMICALS

Manufacture of Nano based leather auxiliaries: Enzyme immobilized nano particles, tanning agents, syntans, fat liquors, binders, metal oxides nanoparticles for transparent and surface coating.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to
CO1. Acquire knowledge about the various methods for nanomaterials synthesis
CO2. Gain knowledge on nanomaterial and its characterization.
CO3. Aware of environmental aspects of nanotechnology.
CO4. Understand the advancements in nano technology for leather chemicals preparation
CO5. Understand the nanotechnological interventions in leather processing
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OBJECTIVE
- To provide an overview on polymers in leather industry.
- To provide knowledge on the concepts polymerization techniques.
- To have the ability to characterize the polymers using analytical techniques.
- To give an overview on the polymers for industrial applications.
- To understand the concepts of various fabrication techniques of polymeric materials.

UNIT I POLYMERS
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
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 III ANALYSIS AND TESTING OF POLYMERS
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 POLYMERS FOR INDUSTRIAL APPLICATIONS
Manufacture of industrially important polymers for plastics, fibres and elastomer - Polyethylene, polypropylene, polyvinyl chloride, polyvinyl acetate, copolymers, formaldehyde resins, polyvinyl alcohol, polycrylonitrile, polystyrene, polyurethane, fluoro-carbon polymers, epoxy resins, polyamides, polyesters, alkyd resins, silicone polymers, cellulosics.

UNIT V FABRICATION
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.

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1. Have knowledge on the chemistry of most common polymeric materials used in leather industry as supplements.
CO2. Understand the importance of polymers for industrial application.
CO3. Understand the various polymerization techniques
CO4. Understand the principles and characterization techniques of polymers
CO5. Understand the fabrication process of polymer

TOTAL: 45 PERIODS
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LE3053  SELF- MANAGEMENT AND ENTREPRENEURSHIP  L T P C  3 0 0 3

OBJECTIVE:
- To provide understanding on the need to self-manage and other management competency for a successful entrepreneurship
- To focus on business development and entrepreneurial skills necessary for success in self-management
- To understand the financial management and documentations
- To learn basic time management concepts to assessing health of business
- To concentrate on marketing aspects of footwear products

UNIT I  SELF-MANAGEMENT  12
Defining self-management - Writing a mission statement - Self-discipline - Self-evaluation - Self-analysis by personal SWOT; Planning & Goal setting; Developing a career plan

UNIT II  BUSINESS DEVELOPMENT  9
Intellectual property and copyright; Trademarks and patents; Types of businesses – Pvt, Public, Partner; Business development report - Institutions & organization for business development

UNIT III  FINANCE MANAGEMENT  9
Pricing your work & budgeting; Building an online portfolio; Branding; Networking and Partnership building; The elevator pitch Fundraising; Establishing a value network

UNIT IV  TIME MANAGEMENT  6
Time management; Project management; Time map and project management plan; Reflection on perfectionism

UNIT V  MARKETING MANAGEMENT  9
Publicity and advertising; Press releases; Digital and social media marketing

TOTAL : 45 PERIODS

COURSE OUTCOME
At the end of the course, the students are expected to
CO1  Understanding the concept of self-management
CO2  Recognize the various roles of managers and types of business management
CO3  Understanding of basic finance management concepts
CO4  Identify the fundamentals of managing the time and finance
CO5  Have knowledge on marketing and advertising the footwear products

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LE3011  SUSTAINABILITY ENGINEERING  L  T  P  C
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OBJECTIVE
To give an overview on the concepts sustainability and its tools.
To give insight on environmental sustainability practices.
To give insight on the strategies to attain economic sustainability in leather industries.
To give insight on the social sustainability practices to attain social impact and benefits.
To provide knowledge on sustainable industrial practices.

UNIT I  INTRODUCTION TO SUSTAINABILITY  9
Definition, Concept and challenges of Sustainability, Pillars of sustainability — Environment, Economic and Social, Values and principles of sustainability, Integrated sustainability into business System Thinking, value chain perspective and sustainability strategy & planning and stakeholder engagement, Integrated sustainability management - Sustainable performance management, Continuous improvement and integrated sustainability management systems, Sustainability measurement and tools — ISO standards and Life cycle Assessment.

UNIT II  ENVIRONMENTAL SUSTAINABILITY  9

UNIT III  ECONOMIC SUSTAINABILITY  9
Economic sustainability – Strategy, Technology Innovation, current and future economic prospects and market position; Types of economic contribution impact to the industry (Direct, Indirect and Induced impact.

UNIT IV  SOCIAL SUSTAINABILITY  9
Social sustainability — Safety, health, community involvement, tax issues and corruption; Social sustainable management; Organizational behavior and sustainable Human Resources (HR); Measuring social impacts and benefits.
UNIT V  SUSTAINABLE INDUSTRIAL DEVELOPMENT


COURSE OUTCOMES:
Upon successful completion of this course, students are expected to
CO1. Gain a fundamental knowledge of issues, principles, concepts, processes related to sustainability, describe how core technologies in the industry relate to sustainability.
CO2. Understand the sustainability in environment, economic and social.
CO3. Aware of strategy for sustainable leather industry development
CO4. Understand the concepts of ISO standards and life cycle assessment
CO5. Understand the strategies to reduce waste emission

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OBJECTIVE
- To give an overview on the leather industry wastewater generation and characterization.
- To have the ability to design layout for effluent treatment plant.
- To provide knowledge on chemical and biological wastewater treatment
- To provide knowledge on removal of refractory organic compounds from wastewater.
- To understand the various concepts of waste management.

UNIT I  WASTE GENERATION AND ENVIRONMENTAL LEGISLATION  9
Sources of waste water generation, Characteristics of effluent and pollution load from tanneries, significant pollutants in tanneries, Design Layout for Common Effluent Treatment Plant (CETP) and Effluent Treatment Plant (ETP), Environmental discharge norms.

UNIT II  INTRODUCTION TO TREATMENT OF WASTEWATER-CHEMICAL AND BIOLOGICAL  9
Screening – Flow Equalization – Theory on Coagulation & Floculation – Sedimentation – Filtration- Detail study and design of these primary treatment unit, Introduction to microbial metabolism – Bacterial growth – Kinetics of Biological Growth, Aerobic suspended growth system - Anaerobic suspended growth system - Anaerobic attached growth system – Advanced Biological System – UASB – EGSB; Field visits to ETP/CETP

UNIT III  ADVANCED WASTE WATER TREATMENT FOR THE REMOVAL OF REFRACTORY ORGANIC COMPOUNDS  9

UNIT IV  SOLID WASTE MANAGEMENT  9
Source of solid waste generation and its Characteristics, Various treatment options for tannery solid wastes, Design of Secured land fill: Biomethanisation system with energy recovery option – Thermal incineration – Bacterial composting – Vermi composting, Emerging Technologies in Waste Management – RO reject management, Field visit

UNIT V  ADVANCED CONCEPTS IN WASTE MANAGEMENT  9
Various in-plant control measures for waste minimization at source; Carbon footprint (CF) – CF reduction options in tannery sector; introduction to circular economy for sustainable development in tanneries; Entrepreneurship in waste management – case studies.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be in a position to
CO1. Understand the methods and means to manage tannery wastes.
CO3. Aware of various treatment option for waste water management.
CO4. Gain knowledge on solid and liquid waste discharge norms
CO5. Understand the basic concepts of carbon footprints and circular economy approaches

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LE3013  DESIGN OF EXPERIMENTS AND STATISTICAL TOOLS  L T P C
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OBJECTIVE

- To understand the basic principles of design of experiments.
- To provide expertise on the application of response surface methodology.
- To understand and have expertise on correlation and regression.
- To understand the concepts of sampling, identifying the errors through hypothesis evaluation for attain best fitting.
- To understand the basic principles of experimentation and analyzing the variance.

UNIT I  INTRODUCTION AND OVERVIEW OF DOE  9
Principles of Design of Experiment: Randomization, Replication and Local Control, Choice of size and type of a plot using uniformity trials. Completely Randomized Design (CRD)

UNIT II  RESPONSE SURFACE METHODOLOGY  9
First and second order experiments, analysis of second order response surfaces, central composite designs, Plackett-Burman designs, process optimization & reliability improving experiments

UNIT III  CORRELATION AND REGRESSION  9
Correlation coefficient - Properties - Problems - Rank correlation - Regression equations - Problems - Curve fitting by the method of least squares - Fitting curves of the form ax+b , ax²+bx+c , abx and axb - Bivariate correlation application to biological problems

UNIT IV  SAMPLING AND TESTING OF HYPOTHESIS  9
Concept of sampling - Methods of sampling - Sampling distributions and standard error – Small samples and large samples - Test of hypothesis - Type I & Type II Errors - Critical region - Large sample tests for proportion, mean - Exact test based on normal , t , F and Chi – square distribution problems - Test of goodness of fit

UNIT V  ANALYSIS OF VARIANCE  9
Basic principles of experimentation - Analysis of variance - One - way, Two - way classifications - Randomized block design - Latin square design - Problems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students would be able”

CO1. To have knowledge on the concept of Design of experiment and its basic principles
CO2. To have knowledge on the concept of factorial experiments and their practical applications.
CO3. To compute and interpret simple linear regression and least square methods between two variables.
CO4. To understand the methods of sampling and application of various statistical tests in testing hypotheses on data
CO5. To understand one-way and two-way classifications of analysis of variance, properties and assumptions, randomized block design and Latin square design problems
REFERENCES:

Course Articulation Matrix:

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