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 professionalvalues.

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

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

MD 4: To provide a learning ambience for innovators, researchers and technologists.

ANNA UNIVERSITY: : CHENNAI - 600 025
UNIVERSITY DEPARTMENTS
M.TECH. LEATHER TECHNOLOGY
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM (CBCS)

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I.	To build an expertise base capsule of delivering technology based solution to leather and allied sectors.
II.	To foster development of advanced human capacity for translational research for solutionscience.
III.	To equip learners with relevant knowledge and expertise system for professionalconsultation.
IV.	To enable learners in the areas of pedagogy and advanced research.
V.	To provide a learning ambience for innovators, researchers and professional technology authors.

2. PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

PO	Programme Outcomes
1.	Ability to independently carry out research/investigation and development work to solve practical problems
2.	Ability to write and present a substantial technical report/document
3.	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.
4.	Identify, formulate and solve engineering problems
5.	Design a system or process to improve its performance, satisfying its constraints
6.	Design the system with environment consciousness and social obligations

3. PEO/PO Mapping:

PEO						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
I.	**2**	**3**	**3**	**2**	**2**	**3**
II.	**3**	**2**	**3**	**3**	**2**	**3**
III.	**3**	**2**	**3**	**3**	**1**	**2**
IV.	**3**	**2**	**3**	**2**	**2**	**3**
V.	**3**	**2**	**3**	**3**	**2**	**3**

PROGRAM ARTICULATION MATRIX

MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME									
Year	**Sem**	**Course Name**		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
YEAR 1	**Semester 1**	Collagen Science and Technology		3	-	2	-	3	2
		Quality Management and Assurance		2	2	1	2	2	1
		Project Management Systems		2	2	2	1	2	-
		Orientation to Leather Manufacture (Bridge Course forUG students from non-leather)		1	1	1.5	2	2	-
		Research Methodology and IPR		1	3	-	1.6	3	-
		Professional Elective I		-	-	-	-	-	-
		Practice on Quality Management		1	3	-	2	2	1
		Chemical and Physical Testing Laboratory		3	3	2	2	3	2
	Semester 2	Ecological Concepts in Leather Manufacturing		3	1	2	1	2	3
		Advanced Instrumental Methods		3	1	2	1	1	1
		Innovations and Green Concepts in Leather Process		2	1	2	1	2	3
		Professional Elective II							
		Professional Elective III							
		Leather Process DesignEngineering Laboratory		3	2	3	1	2	3
		Advanced Instrumental MethodsLaboratory		3	1	3	-	-	1
YEAR 2	**Semester 3**	Practice on Leather Chemicals		2	1	2	1	2	3
		Professional Elective IV							
		Professional Elective V							
		Internship/Training		-	2	3	1	3	1
		Project Work I		3	-	3	2	2	1
	Semester 4	Project Work II	Continuation of Project Work I (at Institution/Industry)	2	2	2	3	1	1
			Not the continuation of Project Work I (at Industry)	2	2	2.3	1.6	2.5	2

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

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	LE3101	Collagen Science and Technology	PCC	2	0	2	4	3
2	LE3102	Quality Management and Assurance	PCC	2	0	2	4	3
3	LE3151	Project Management System	PCC	2	0	2	4	3
4	LE3152	Orientation to Leather Manufacture (Bridge Course)*	PCC	2	0	2	4	0
5	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
6		Professional Elective I	PEC	3	0	0	3	3
PRACTICALS								
7	LE3111	Practice on Quality Management	PCC	0	0	6	6	3
8	LE3112	Chemical and Physical Testing Laboratory	PCC	0	0	6	6	3
			TOTAL	**13**	**1**	**20**	**34**	**21**

***** Compulsory for non-leather graduates

SEMESTER – II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	LE3201	Ecological Concepts in Leather Manufacturing	PCC	3	0	0	3	3
2	LE3202	Innovations and Green Concepts in Leather Process	PCC	3	0	0	3	3
3	LE3203	Advanced Instrumental Methods	PCC	3	0	0	3	3
4		Professional Elective II	PEC	3	0	0	3	3
5		Professional Elective III	PEC	3	0	0	3	3
PRACTICALS								
6	LE3211	Leather Process Design Engineering Laboratory	PCC	0	0	6	6	3
7	LE3212	Advanced Instrumental Methods Laboratory	PCC	0	0	6	6	3
			TOTAL	**15**	**0**	**12**	**27**	**21**

SEMESTER – III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	LE3301	Practice on Leather Chemicals	PCC	3	0	0	3	3
2		Professional Elective IV	PEC	3	0	0	3	3
3		Professional Elective V	PEC	3	0	0	3	3
PRACTICALS								
4	LE3311	Internship/Training	EEC	0	0	4	4	2
5	LE3312	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**16**	**25**	**17**

SEMESTER – IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1	LE3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS: 71

LIST OF PROFESSIONAL CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	LE3101	Collagen Science and Technology	2	0	2	3
2.	LE3102	Quality Management and Assurance	2	0	2	3
3.	LE3151	Project Management Systems	2	0	2	3
4.	LE3111	Practice on Quality Management	0	0	6	3
5.	LE3112	Chemical and Physical Testing Laboratory	0	0	6	3
6.	LE3201	Ecological Concepts in Leather Manufacturing	3	0	0	3
7.	LE3202	Innovations and Green Concepts in Leather Process	3	0	0	3
8.	LE3203	Advanced Instrumental Methods	3	0	0	3
9.	LE3211	Leather Process Design Engineering Laboratory	0	0	6	3
10.	LE3212	Advanced Instrumental Methods Laboratory	0	0	6	3
11.	LE3301	Practice on Leather Chemicals	3	0	0	3
TOTAL CREDITS						**33**

BRIDGE COURSE

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	LE3152	Orientation to Leather Manufacture (For B.E Mechanical, Production, Industrial Engg. Students)	PCC	3	2	0	2	0

***** Compulsory for non-leather graduates

LIST OF PROFESSIONAL ELECTIVES COURSES (PEC)

S. No.	CODENO	COURSE TITLE	CATEGORY	L	T	P	C	CONTACT PERIODS
1.	LE3001	Advanced Coordination Chemistry	PEC	3	0	0	3	3
2.	LE3002	Advanced Leather Biotechnology	PEC	3	0	0	3	3
3.	LE3003	Advanced Organic and Inorganic Chemistry	PEC	3	0	0	3	3
4.	LE3004	Colloids and Surface Chemistry	PEC	3	0	0	3	3
5.	LE3005	Corporate Social Responsibility	PEC	3	0	0	3	3
6.	LE3006	Energy Management in Industries	PEC	3	0	0	3	3
7.	LE3051	Engineering Economics in Production	PEC	3	0	0	3	3
8.	LE3007	Sustainable Chemistry Approaches for Leather Manufacture	PEC	3	0	0	3	3
9.	LE3052	Industrial Safety and Occupational Health	PEC	3	0	0	3	3
10.	LE3008	Marketing of Leather and Leather Chemicals	PEC	3	0	0	3	3
11.	LE3009	Nanotechnology and its Applicationin Leather	PEC	3	0	0	3	3
12.	LE3010	Science and Technology of Leather Supplements and Synthetics	PEC	3	0	0	3	3
13.	LE3053	Self-Management and Entrepreneurship	PEC	3	0	0	3	3
14.	LE3011	Sustainability Engineering	PEC	3	0	0	3	3
15.	LE3012	Tannery Waste Management and Engineering	PEC	3	0	0	3	3
16.	LE3013	Design of experiments and Statistical Tools	PEC	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO.	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1	RM3151	Research Methodology and IPR	2	1	0	3

LIST OF EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1	LE3312	Project Work I	0	0	12	6
2	LE3311	Industrial Internship	0	0	4	2
3	LE3411	Project Work II	0	0	24	12
					TOTAL CREDITS	**24**

SUMMARY

Name of the Programme: M.TECH –LEATHER TECHNOLOGY						
S. No.	**Subject Area**	**Credits per Semester**				**Credits Total**
		I	**II**	**III**	**IV**	
1.	Professional Core Courses (PCC)	15	15	3	0	33
2.	Professional Electives Courses (PEC)	3	6	6	0	15
3.	Employability Enhancement Courses (EEC)	0	0	8	12	20
4.	Research Methodology And IPR Course (RMC)	3	0	0	0	3
	Total Credit	**21**	**21**	**17**	**12**	**71**

SEMESTER I

LE3101 COLLAGEN SCIENCE AND TECHNOLOGY L T P C
2 0 2 3

OBJECTIVE

- To provide knowledge on advanced physical and chemical concepts associated with the structure of collagen.
- To provide 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 9

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 9

Collagen triple helix; Amino acid composition and primary structure; helix stabilization– synthetic collagen like polypeptides –denaturation, renaturation. Native collagen fibrils- axial structure - 3 Dimensional structure — stabilization -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.

Intramolecular and intermolecular crosslinks –difunctional and multifunctional crosslinks - lathyrism and (functional significance of) crosslinks.

UNIT III ISOLATION AND CHARACTERISATION OF COLLAGEN 9

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 9

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 V BIOMATERIAL AND APPLICATION OF COLLAGEN 9

Biomaterials – Processing of collagen – preparation of different forms sponge/sheet/ gels – biomedical applications of collagen – wound Healing – Burns – Drug carrier – other bio-products from 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 :

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. NimniM.E.(ed) Collagen: Vol.3, Boca Raton CRC, 1988.
8. Olsen B.R. and Nimni M.E.(ed) Collagen:Vol.4 Molecular Biology, Boca Raton CRC,1989.
9. Miller, EJ. Rhodes, R.K. Structural and Contractile Proteins Extracellular matrix: MethodsEnzymol vol.82, 1982.
10. Elizabeth D.Hay, `Cell Biology of Extracellular Matrix' Second Edition, Plenum Press, NewYork, 1991.
11. Kucharz, EJ; `The Collagens: Biochemistry and Pathophysiology', Berlin Springer, Verlag,(1992).
12. Fratzl, P; 'Collagen: Structure and Mechanics', Springer, 2008.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	2	–	–	–
CO2	3	–	3	2	2	–
CO3	3	–	2	–	3	2

CO4	3	-	1	–	–	–
CO5	2	–	3	–	3	–
Average	2.8	–	2.2	–	1.6	2

LE3102 QUALITY MANAGEMENT AND ASSURANCE L T P C
2 0 2 3

OBJECTIVE

- To provide comprehensive knowledge about the principles, practices, tools and techniques of quality assurance system in leather industries
- To provide knowledge on the importance of quality assurance system and its policies.
- To provide knowledge on implementing TQM principles in leather industries
- To provide 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 9

ntroduction 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 9

Guidelines and classes of ISO 9001:2015; Designing of Quality Management System in accordance to ISO 9001:2015 for leather industry — Setting the Quality policy and Objectives; Preparation of system procedures for leather industry; Implementing ISO 9001:2015 in leather industry - training and implementation of ISO 9001:2015 in leather industry; Continual improvement– audit, management review and continual improvement in leather industry.

UNIT III TOTAL QUALITY MANAGEMENT FOR LEATHER INDUSTRY 9

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 9

Statistical methods for quality management - Process quality — Describing variation, Discrete distribution, Continuous distribution, Probability Plots, Sampling distribution, Point estimation, Statistical inference; Application of process quality for leather.
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 9

(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, the students will be able to

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 :

1. Poornima M. Charantimath, Total Quality Management, Pearson Education, 2011.
2. Dale H. Besterfield, Carol Besterfield-Michna, Glen Besterfield, Mary Besterfield-Sacre, Total quality management, Pearson publication, 3rd edition, 2011
3. James R. Evans, Six Sigma and Process Improvement, Cengage se Learning India private limited, 2009.
4. Foster T. S. Managing quality: An Integrative Approach. New Jersey: Prentice Hall, 2002. 476 pp.
5. Goetsch D. L., Davis S. B. Quality management. Introduction to TQM for production, processing and services. New Jersey: Prentice Hall, 2003.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	2	1
CO2	2	2	2	3	2	1
CO3	2	2	1	2	3	1
CO4	2	2	2	2	2	1
CO5	3	2	1	1	2	3
Average	2.2	2.2	1.8	2.16	2.2	1.4

LE3151 PROJECT MANAGEMENT SYSTEM L T P C
2 0 2 3

OBJECTIVE

The purpose of this subject is to enable the students

- To identify; formulate; foresee or predict problems as possible
- To provide the concept of capital investments

- To learn about the various project appraisal techniques
- To provide the concept of project design and audit
- To provide knowledge on the concepts of project scheduling and schedule compression techniques

UNIT I PROJECT IDENTIFICATION AND FORMULATION 10

Project Identification Analysis: Concept of Project, Search for Business Idea, Project Identification, Project Planning Formulation and Analysis, Project Screening and Presentation of Projects for Decision Making; Socio -economic Consideration in Project Formulation; Social Infrastructure Projects for Sustainable Development; Investment Opportunities. Project Life Cycle, Feasibilities of Projects-Different forms of Project Contracting.

UNIT II PROJECT BUDGETING AND FINANCING 9

Capital Investments and Difficulties, Types of Capital Investment, Phase of Capital Budgeting, Facets of Project Analysis, Financial Estimates and Deductions, Estimation of Project Cash Flows. Social Cost Benefit Analysis – Rational for SCBA, UNIDO Approach, Multiple Project and Constraints – Linear Programming Model, Financing of Projects – Different Kind of Project Finance.

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

Project Design — Logic Model — Creating Work Break Down Structure (WBS) — Project Roll– up, Process Break down Structure, Responsibility Matrix, Cost of Capital, Project Control Process, Performance Measurement, Evaluation, Planning Audit, Post Completion Audit.

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:

1. Projects – Planning, Analysis Selection, Finance, Implementation and Review by Dr. Prasanna Chandra, Tata McGraw Hill Education (2009)7th Edition.
2. Project Management – Clifford F. Gray & Erik Larson, McGraw Hill Higher Education;3rd Edition (2005)
3. Project Management: A Managerial Approach by Jack R. Meredith, Samuel J. Mantel Jr, Wiley; 8th edition (2011)
4. The Practice and Theory of Project Management: Creating Value Through ChangeRichardNewton Basingstoke, Hampshire: Palgrave Macmillan, 2009.
5. Effective Project Management - James P. Clements, Jack Gido , South-Western CengageLearning, 2012

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	1	2	-
CO2	-	-	1	3	3	-
CO3	-	-	-	1	2	3
CO4	1	-	-	-	-	-
CO5	-	-	-	1	2	-
Average	2	2	1	1.8	2.3	3

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 theirmechanism 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.

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

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	-	2	-
CO2	1	1	-	2	-	-
CO3	-	-	1	-	-	-
CO4	1	-	-	-	-	-
CO5	-	-	-	-	2	-
Average	1	1	1.5	2	2	-

RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

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 9

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 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

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.

TOTAL: 45 PERIODS

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:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

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 enable the students 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.

TOTAL: 90 PERIODS

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
CO3. Distinguish quality check and quality assurance involved during leather manufacture

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	−	2	2	-
CO2	−	3	−	2	2	2
CO3	1	3	−	2	3	3
Average	1.5	3	−	2	2.3	1.8

LE3112 CHEMICAL AND PHYSICAL TESTING LABORATORY LT P C
0 0 6 3

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:

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	2	3	2
CO2	3	3	2	2	3	3
CO3	3	3	2	2	3	2
Average	3	3	2	2	3	2.33

LE3201 ECOLOGICAL COCEPTS IN LEATHER MANUFACTURING L T P C
3 0 0 3

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 provide knowledge on the various sustainability aspects in leather making

UNIT I MATERIALS SCIENCE ASPECTS OF SKIN AND LEATHER 9

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 9

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 9
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 9

Physicochemical interactions of syntans, fatliquors and dyes with collagen and leather — Role of surface charge and importance of electrostatic, H-bond, dipole-dipole and hydrophobic interactions. 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 9

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. Apply knowledge on 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. Explain the charge of the leather substrate to design auxiliaries.
CO5. Acquire knowledge on the basic concepts to reduce the carbon footprints in leather process.

REFERENCES :

1. O. Flaherty, William T. Roddy and Robert M. Lollar, "The Chemistry and Technology of Leather,Vol. I, Preparation for tannages", E. Robert Krieger Publishing Company, New York,1978.
2. O. Flaherty, William T. Roddy and Robert M. Lollar, "The Chemistry and Technology of LeatherVol. II, Type of tannages" E. Robert Krieger Publishing Corporation, New York, 1977.
3. Bienkiewicz, "Physical Chemistry of Leather Making", Krieger Publishing Co., Florida 1982.
4. D. Covington, Tanning Chemistry: The Science of Leather, Royal Society of Chemistry, 2011.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	–	3	1	2	3
CO2	3	1	3	1	2	2
CO3	3	1	3	1	2	3
CO4	3	1	2	1	2	2
CO5	2	2	2	1	2	3
Average	2.8	1.5	2.5	1	2	2.5

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

OBJECTIVE

- To provide knowledge on the technology of making different types of leathers with cleaner and greener approach
- To provide knowledge on 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 provide 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 9

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

UNIT III CLEANER PROCESSING: TANNING, POST TANNING AND FINISHING 9

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 9

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 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES

At the end of the course, the students will be able to

CO1. Apply the conceptual design to make leather.
CO2. Explain the concepts 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. Describe advanced knowledge in waste management

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.
3. Exploration of GSK'S solvent selection guide in leather industry: A CSIR-CLRI tool for sustainable leather manufacturing. (2016) Green Chemistry.
4. Alternative carrier medium for sustainable leather manufacturing–A review and perspective. (2016) Journal of Cleaner Production, 112(1)*, 49-58*
5. Buljan, J., and I. Kral. "The framework for sustainable leather manufacture." United Nations Industrial Development Organization 12 (2015): 145-147.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	–	1	3	2	2	3
CO2	3	–	2	1	2	3
CO3	2	1	2	1	3	3
CO4	2	–	1	–	3	3
CO5	3	2	1	2	2	3
Average	2.5	1.3	1.8	1.2	2.5	3

LE3203 ADVANCED INSTRUMENTAL METHODS L T P C
3 0 0 3

OBJECTIVE

- To provide knowledge on the theory and principles of analytical techniques with special reference to leather technology
- To provide knowledge on the spectroscopic and chromatographic methods in leather science
- To provide knowledge and understand the chromatographic techniques for leather auxiliary synthesis
- To provide the ability to characterize leather chemicals and auxiliaries
- To provide 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. Discuss the strengths, limitations and creative use of techniques for analytical problem solving.

CO4. Classify the basic instrumentation techniques used for leather chemicals testing.

CO5. Acquire knowledge on microscopic and thermal degradation techniques for leather and auxiliaries.

REFERENCES :

1. Hobart H. Willard, Lye L. Merritt, Jr. John A. Dean and Frank A. Settle, Jr., "InstrumentalMethods of Analysis", Sixth edition", CBS Publishers & Distributors, Delhi, 1986.
2. E.A.V. Ebsworth, David W.H. Rankin, Stephen Cradock, Structural Methods inInorganicChemistry, 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, NewYork,1963.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2	–	2
CO2	3	2	2	–	–	–
CO3	3	2	3	1	1	1
CO4	2	–	2	–	2	2
CO5	2	–	3	–	1	1
Average	2.6	1.6	2.4	1.5	1.3	1.2

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

OBJECTIVE

- To provide practical exposure in designing of different types of leathers using cleaner approaches
- To provide the ability prepare chemical and energy audit based on process design
- To provide the ability to manage water resources during process design
- To provide knowledge on advanced processing techniques with emphasis on eco-friendly leather manufacture.
- To provide the ability to prepare and analyze case studies for specific product mix (upper, garment, upholstery, glove) with details of chemical audit, energy audit, water consumption during processing

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:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	2
CO2	3	2	3	2	2	–
CO3	3	2	3	–	2	1
Average	3	2	3	2	2	2

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. ^{13}C spectra of polymeric syntans. GPC for molecular weight determination of polymeric syntans - Leather surface examination by electron microscope. Protein Purification techniques - Characterization of proteins viz., SDS-Page, Circular Dichroism, FTIR.

TOTAL: 90 PERIODS

COURSE OUTCOMES:

At the end of the course, the students can

CO1. Have practical knowledge on various instrumental methods.
CO2. Understand the underpinning science behind various instrumental techniques.
CO3. Have knowledge on advanced analytical techniques.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	–	–	–
CO2	3	2	3	–	–	2
CO3	3	2	3	–	–	2
Average	3	1.6	3	_	–	2

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 9

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 9

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 9

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, sulphoamidation, 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 9

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 9

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.

TOTAL: 45 PERIODS

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 :

1. Fred O Flaherty, Roddy, T.W. and Lollar, R.M. `The Chemistry and Technology of Leather', Vol.II, Type of tannages, Rober E. Krieger Publishing Co., New York, 1977.
2. Gustavson, K.H. `Chemistry of Tanning Processes' Academic Press, New York, 1956.

3. Venkataraman, K. `Chemistry of Synthetic Dyes', Academic Press, New York and Lond,1971.
4. Myers, R.R., and Lond, J.S. `Treatise on Coatings', Marcel Dekker, New York, 1975.
5. Samir Dasgupta, Treatise on Fatliquors and Fatliquoring of Leather, Indian Leather Technologists Association Publications, Kolkatta

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	–	2	–	3	3
CO2	3	1	2	–	3	3
CO3	3	1	3	2	2	2
CO4	3	–	3	1	2	2
CO5	2	–	3	–	3	3
Average	2.6	1	2.6	1	2.6	2.6

LE3311 **INTERNSHIP / TRAINING** **L T P C**
0 0 4 2

OBJECTIVE

- 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:

At the end of this course, the students will be able to

CO1. Handle practical aspects in leather and allied sector with confidence.
CO2. Expertise in handling respective sector.
CO3. Improve the presentation skills.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	3	1	-	-
CO2	-	2	3	-	-	-
CO3	-	3	3	-	-	-
Average	-	2	3	1	-	-

LE3312 **PROJECT WORK I** **L T P C**
0 0 12 6

OBJECTIVES:
The course aims to enable the students to identify the research problem relevant to their field of interest, search databases to define the problem, design experiment, conduct preliminary study and report the findings.

COURSE CONTENT
Individual students will identify a research problem relevant to his/her field of study with the approval of project review committee. The student will collect, and analyze the literature and design the experiment. The student will carry out preliminary study, collect data, interpret the result, prepare the project report and present before the committee.

TOTAL: 180 PERIODS

OUTCOMES:
At the end of the course the students will be able to
CO1: Identify the research problem
CO2: Collect, analyze the relevant literature and finalize the research problem
CO3: Design the experiment, conduct preliminary experiment, analyse the data and conclude
CO4: Prepare project report and present

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	2	2
CO2	1	1	3	2	-	-
CO3	2	2	2	1	3	2
CO4	-	3	2	-	-	-
Average	2	2	2.3	1.6	2.5	2

SEMESTER IV

LE3411	**PROJECT WORK II**	**L T P C** **0 0 24 12**

I. Continuation of Project Work I (at Institution/Industry)

OBJECTIVES:
The course aims to enable the students to conduct experiment as per the plan submitted in Project work I to find solution for the research problem identified.

COURSE CONTENT
The student shall continue Project work I as per the formulated methodology and findings of preliminary study. The student shall conduct experiment, collect data, interpret the result and provide solution for the identified research problem. The student shall prepare the project report and present before the committee.

TOTAL: 360 PERIODS

OUTCOMES:
At the end of the course the students will be able to
CO1: Conduct the experiment and collect data
CO2: Analyze the data, interpret the results and conclude
CO3: Prepare project report and present

Course articulation Matrix

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	3	1	1
CO2	3	3	2	-	-	-
CO3	-	3	2	-	-	-
Average	2	2	2	3	1	1

II. Not the continuation of Project Work I (at Industry)

OBJECTIVES:
The course aims to enable the students to identify the research problem at the company, search databases to define the problem, design experiment, and conduct experiment to find the solution.

COURSE CONTENT
Individual students will identify a research problem relevant to his/her field of study at the company and get approval of project review committee. The student will collect, and analyze the literature and design the experiment. The student will carry out the experiment, collect data, interpret the result, prepare the project report and present before the committee.

TOTAL: 360 PERIODS

OUTCOMES:
At the end of the course the students will be able to
CO1: Identify the research problem
CO2: Collect, analyze the relevant literature and finalize the research problem

CO3: Design and conduct the experiment, analyse the data and conclude
CO4: Prepare project report and present

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	2	2
CO2	1	1	3	2	-	-
CO3	2	2	2	1	3	2
CO4	-	3	2	-	-	-
Average	2	2	2.3	1.6	2.5	2

LE3001 ADVANCED COORDINATION CHEMISTRY L T P C
3 0 0 3

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 provide knowledge on the concepts of metal-protein interactions
- To provide the ability to characterize inorganic compounds using spectroscopic techniques

UNIT I CONCEPTS IN CHEMICAL BONDING 9

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 9

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 METALCOMPLEXES 9

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 9

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

UNIT V METAL PROTEIN INTERACTIONS 9

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 will be in a position to

CO1. Acquire knowledge on chemical bonding and coordination chemistry of transitions metals.
CO2. Understand the synthesis, structure and reactivity of transition metal complexes.
CO3. Explore metal-protein interactions.
CO4. Acquire knowledge on the synthesis of new ligands.
CO5. Elucidate the mechanism of metal-protein interactions through spectroscopic techniques.

REFERENCES :

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

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	-	1	2
CO2	2	-	3	-	2	2
CO3	3	-	3	-	2	2
CO4	3	-	3	-	2	3
CO5	2	1	3	-	2	3
Average	2.6	1	3		1.8	2.4

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

OBJECTIVE

- To provide knowledge on the advanced biotechnology concepts in various unit processes and operations in leather manufacture
- To provide knowledge on fermentation methods and process involved
- To provide an overview on molecular biology
- To provide the basic understanding on biochemical engineering, unit process involved in

fermentation and down streaming process
- To Provide 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

DNA; genetic role, structure and replication - Structure of RNA and transcription - gentic Code - protein synthesis - control of gene expression — strain improvement by mutation/genetic engineering - principles and methods -recombinant DNA technology and its potentials.

UNIT IV BIOCHEMICAL ENGINEERING 9

Basic principles, kinetics of growth. , batch, fed-batch, continuous, well-mixed, plug flowtubular, 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 micro organisms 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

REFERENCES :

1. P.F.Stanbury and A.Whitaker, "Principles of Fermentation Technology", Pergamon Press, 3rd edition, 2016.
2. Lehninger "Biochemistry: the molecular basis of cell structure and function, 2nd Edition,"Kalyani Publishers, Ludhiana, 1978.
3. G.S.Stent and C.Calendar, "Molecular Genetics : an introductory narrative, 2nd Edition," Freeman, San Francisco, 1978.
4. A.Wiseman, "Topics in Enzyme and Fermentation Biotechnology" (Several volumes). Vol.5, 1982

5. T. A. Brown, “Gene Cloning and DNA Analysis: An Introduction”, Blackwell Publishing, Sixth edition, 2010.
6. “Microbes and Enzymes - -Basics and Applied”, R. Puvanakrishnan, Former Sc.G. and Head, Dept. of Biotechnology, CLRI.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	2	2
CO2	2	1	3	-	2	2
CO3	3	2	3	2	2	2
CO4	2	1	3	2	2	2
CO5	2	-	3	2	1	2
Average	2.4	1.6	3	2	1.9	2

LE3003 ADVANCED ORGANIC AND INORGANIC CHEMISTRY L T P C
3 0 0 3

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 provide basic understanding on the mechanism of metal complexes

UNIT I BONDING MODELS 9

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 9

Free radical reactions, addition to carbon- carbon, carbon — oxygen multiple bonds,

eliminationreactions, molecular rearrangements, oxidation and reduction reactions.

UNIT III MECHANISM OF ORGANIC REACTIONS USED IN THE MANUFACTURE OF LEATHER CHEMICALS 9

Methods of determining reaction mechanism, factors influencing SN1 and SN2, E1, E2reactions. 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 9

General properties, electronic configuration, Oxidization states, Ionization energy of D-block element. Chemistry of Chromium, Titanium, Iron, Aluminum and Zirconium including their redox behaviour. Variable oxidation statics, stabilization of oxidation states.

UNIT V REACTION MECHANISMS OF METAL COMPLEXES 9

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 :

1. Jerry March, "Advanced organic chemistry, Reactions, mechanisms and structure, 7th Ed.Wiley Eastern, New Delhi, 2015.
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", 12th Ed., Wiley, New York, 2016.
4. R.O.C.Norman, "Principles of Organic Synthesis", 3rd Ed., Chapman and Hall, London, 2017.
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, VI Edition, 1999.
9. James Huheey, Inorganic Chemistry IV Edition, 1993.
10. Kettle, "Co-ordination compounds", ELBS, 1975.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	1	1
CO2	3	-	3	-	-	2
CO3	3	1	3	-	1	2
CO4	3	2	3	2	2	3
CO5	2	1	3	-	2	3
Average	2.8	0.8	3	0.4	1.5	2.2

LE3004 COLLOIDS AND SURFACE CHEMISTRY L T P C
3 0 0 3

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 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 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 9

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 flocculants, 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 9

Emulsion and pseudo emulsion filmsPhase 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 9

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)

TOTAL: 45 PERIODS

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
5. Bienkienwicz, "Physical chemistry of leather making", Krieger Publishing Co., Florida, 1983.
6. Surfactant Science Series, John-Wiley Interscience Publications, New York.
7. Surface and Interfacial Forces - From Fundamentals To Applications" by Doris Vollmer
8. Colloidal Dispersions : Suspensions, Emulsions, and Foams by I.D. Morrison and S. Ross (2002, Wiley Interscience, NY; ISBN : 0-471-17625-7)

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	2	2
CO2	3	1	3	2	2	2
CO3	2	-	3	-	2	2
CO4	2	-	3	1	2	3
CO5	2	-	3	2	2	3
Average	2.4	1	3	1.6	2	2.4

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 equip individuals with competencies for effective field interventions, research and management of CSR interventions
- To provide an insight into present CSR strategies of model business organization
- To provide a global insight into the requirements of the leather and footwear industry
- To enable the students with conceptual clarity on need, purpose and relevance of researchapplicability in CSR practice

UNIT I INTRODUCTION 9

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 9

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 9

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 9

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 9

Identifying key stakeholders of CSR & their roles. Role of Public Sector in Corporate, government programs that encourage voluntary responsible action of corporations. Role of Nonprofit & Local Self-Governance in implementing CSR; Contemporary issues in CSR & MDGs. Global Compact Self-Assessment Tool, National Voluntary Guidelines by Govt. of India. Understanding roles and responsibilities of corporate foundations. Review current trends

and opportunities in CSR.CSR as a Strategic Business tool for Sustainable development. Review of successful corporate initiatives & challenges of CSR. Case Studies of Major CSR Initiatives.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students are able to

CO1. Gain comprehensive knowledge to describe the multidisciplinary, strategic,and evolving nature of corporate social responsibility.
CO2. 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 :

1. Corporate Social Responsibility: An Ethical Approach - Mark S. Schwartz, Peterborough, Ont :Broadview, 2011.
2. The World Guide to CSR : a Country-by-Country Analysis of Corporate Sustainability and Responsibility, Routledge, 2017
3. Innovative CSR by Lelouche, Idowu and Filho
4. Corporate Social Responsibility in India -Sanjay K Agarwal, London Responce Books 2008
5. Handbook on Corporate Social Responsibility in India, CII.
6. Handbook of Corporate Sustainability: Frameworks, Strategies and Tools -M. A.Quaddus, Muhammed Abu B. Siddique, Cheltenham : Edward Elgar Publishing, ©2011
7. Growth, Sustainability, and India's Economic Reforms — T.N Srinivasan, Oxford : OxfordUniversity Press, 2011
8. Corporate social responsibility : concepts and cases : the Indian experience,C V Baxi; Ajit Prasad, New Delhi : Excel Books, 2006
9. Mallin, Christine A., Corporate Governance (Indian Edition), Oxford University Press, New Delhi.
10. Blowfield, Michael, and Alan Murray, Corporate Responsibility, Oxford University Press, 2014

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	2	-	1	1
CO2	2	3	3	3	-	1
CO3	-	2	2	-	2	2
CO4	2	2	2	-	1	3
CO5	2	3	2	2	1	3
Average	1.4	2.6	2.2	2.5	1	2

LE3006 ENERGY MANAGEMENT IN INDUSTRIES L T P C
3 0 0 3

OBJECTIVE

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

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.

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 9

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

UNIT IV ENERGY AUDIT 9

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

UNIT V ENERGY MANAGEMENT AND AUDITING IN LEATHER IDUSTRY 9

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

Performance evaluation of Motor, Pump and Air compressor used in leather production and treatment units

TOTAL: 45 PERIODS

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.

REFERENCES :

1. Jernold H. Krentz, “Energy conservation and Utilisation”, Allyu andBacunInc, 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.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	3
CO2	2	3	2	2	2	3
CO3	2	3	1	2	-	2
CO4	1	2	2	2	2	3
CO5	2	2	2	2	3	3
Average	2	2.4	2	2.4	2.3	2.8

LE3051 ENGINEERING ECONOMICS IN PRODUCTION L T P C
3 0 0 3

OBJECTIVE

- The objective of this course is to present students on project identification and preparations
- To enable the students to understand the principles of Investment appraisal and financial analysis
- To enable the students to understand the risk and uncertainty of the implementation and management
- To provide knowledge in handling finances
- To provide 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

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

UNIT V METHODS OF BUDGETING 7

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

TOTAL : 45 PERIODS

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:

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 MirrleesJ.A., Project Appraisal and Planning for Developing countries,H.E.B, London.
4. Price Gittinger J., “Economic Analysis of agricultural projects”, The World Bank, 1984.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	1	-	-
CO2	-	-	-	-	2	-
CO3	-	2	-	1	-	2
CO4	-	-	-	-	1	-
CO5	1	-	-	-	2	-
Average	1	2	1	1	1.6	2

LE3007 SUSTAINABLE CHEMISTRY APPROACHES FOR LEATER MANUFACTURE L T P C
3 0 0 3

OBJECTIVE

- To provide an overview on the concepts of green chemistry and life cycle assessment

- To provide knowledge on the 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 9

Principles and Concepts of Green Chemistry-Atom Economy-Life Cycle Assessment-Use of Renewable Resources

UNIT II PRINCIPLES OF SUSTAINABLE CHEMISTRY IN LEATHER PROCESSING 9

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 9

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 9

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 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students are able to

CO1. Gain knowledge on the various concepts of greener chemistry involving in the leatherprocess (*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. Recommend the sustainable chemistry concepts to industries.

CO5. Understand the cleaner tanning process for waste management.

REFERENCES :

BOOKS

1. Clark, J. H., & Macquarrie, D. J. (Eds.). (2008). Handbook of green chemistry and technology. John Wiley & Sons.
2. DeSimone, J. M., & Tumas, W. (Eds.). (2003). Green chemistry using liquid and supercritical carbon dioxide. Oxford University Press.

JOURNALS

1. Thanikaivelan, P., Silambarasan, S., Aravindhan, R., & Rao, J. R. (2017). Non-polar Medium Enables Efficient Chrome Tanning. JOURNAL OF THE AMERICAN LEATHER CHEMISTS ASSOCIATION, 112(10), 338-346.
2. Madhan, B., V. Subramanian, J. Raghava Rao, Balachandran Unni Nair, and T. Ramasami. "Stabilization of collagen using plant polyphenol: role of catechin." International journal of biological macromolecules 37, no. 1-2 (2005): 47-53.
3. Sathish, M., Silambarasan, S., Madhan, B., & Rao, J. R. (2016). Exploration of GSK'S solvent selection guide in leather industry: a CSIR-CLRI tool for sustainable leather manufacturing. Green Chemistry, 18(21), 5806-5813.
4. Clifford, A. A., & Williams, J. R. (2000). Introduction to supercritical fluids and their applications. In Supercritical fluid methods and Protocols (pp. 1-16). Humana Press.
5. Anastas, P., & Eghbali, N. (2010). Green chemistry: principles and practice. Chemical Society Reviews, 39(1), 301-312.
6. Kerton, F. M., & Marriott, R. (2013). Alternative solvents for green chemistry (No. 20). Royal Society of chemistry.
7. Leitner, W. (2000). Green chemistry: designed to dissolve. Nature, 405(6783), 129.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	2	3
CO2	3	-	3	1	2	3
CO3	3	-	3	-	2	3
CO4	2	-	2	-	3	3
CO5	3	-	2	-	2	3
Average	2.8		2.6	1.5	2.2	3

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 9

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. Factorsimpeding safety.

UNIT II ACCIDENT PREVENTION AND 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- In plant& 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 management 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. 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.

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, McGrawHill 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, 2004,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, 1999.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	-	-
CO2	1	-	-	1	-	-
CO3	-	-	3	2	-	-
CO4	-	-	3	3	-	-
CO5	1	-	-	-	-	-
Average	1	2	3	2	-	-

LE3008 MARKETING OF LEATHER AND LEATHER CHEMICALS L T P C
3 0 0 3

OBJECTIVE

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

UNIT I MARKETING CONCEPTS 9

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 9

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 9

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 9

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 9

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:

At the end of the course, the students will be able 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. Explain of India’s share in the global level.
CO4. Choose advanced marketing strategies
CO5. Explain international market standards for trading

REFERENCES :

1. Philip Kolter, "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
5. Footwear (FAO of UN).
6. Employment and working conditions and competitiveness in Leather and Footwear
7. Industry (ILO of UN).
8. Thyagarajan, G., Srinivasan, A.V. and Amudeswari, A, "Indian Leather 2O1O, A technology, Industry and Trade Forecast", CLRI, Madras, 1994.
9. Sadulla, S.,The Leather Industry Kothari's Deskbook Series, H.C. Kothari Group (Publications Division), Madras 1995.
10. ILO Tanning of hides and skins, Third Impression 1989, Geneva.
11. CLRI, Report of nationwide survey on leather product units in India, CLRI, Chennai, 1997

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	-	-	-
CO2	2	2	3	-	3	-
CO3	2	3	2	-	-	-
CO4	2	3	2	-	-	-
CO5	2	3	3	-	-	-
Average	2	2.8	2.5	_	0.6	

LE3009 NANOTECHNOLOGY AND ITS APPLICATION IN LEATHER L T P C
3 0 0 3

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 NANOTECHNOLOGY 9

The nanoscale. What is nanotechnology? Structure and bonding, Electronic band structure, electron statistics, Consequences of the nanoscale for technology and society. Beyond Moore's Law.

UNIT II NANOMATERIALS SYNTHESIS 9

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 NANOMATERIALS: CHARACTERIZATION 9

Spectroscopic Techniques- Dynamic light scattering, Atomic Spectroscopy, Infrared (IR) Spectroscopy, Raman Spectroscopy Microscopic Techniques- Scanning and Transmission Electron Microscopy, Atomic Force microscopy Scanning tunneling microscopy Diffraction Techniques- X-ray powder diffraction – single crystal diffraction techniques Surface Techniques- Hardness testing of thin films and coatings- BET analysis

UNIT IV APPLICATION OF NANO TECHNOLOGY IN LEATHER PROCESSING 9

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

UNIT V NANO LEATHER CHEMICALS 9

Manufacture of Nano based 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:

At the end of the course, the students will be able to

CO1. Acquire knowledge about the various methods for nanomaterials synthesis.
CO2. Gain knowledge on nanomaterial and its characterization.
CO3. Categorize the environmental aspects of nanotechnology.
CO4. Choose the advancements in nano technology for leather chemicals preparation.
CO5. Design and develop nanotechnological interventions in leather processing.

REFERENCES :

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

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	2	3
CO2	3	-	3	2	2	2
CO3	2	-	3	2	2	3
CO4	3	-	3	1	1	2
CO5	2	-	2	1	2	3
Average	2.7	-	2	1.6	2	2.5

LE3010 SCIENCE AND TECHNOLOGY OF LEATHER SUPPLEMENTS AND SYNTHETICS

L	T	P	C
3	0	0	3

OBJECTIVE

- To provide an overview on polymers in leather industry
- To provide knowledge on the concepts polymerization techniques
- To provide 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 9

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 9

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 9

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 9

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

UNIT V FABRICATION 9

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

COURSE OUTCOMES:

At the end of the course, the students will be able to

CO1. Have knowledge on the chemistry of most common polymeric materials used in leather industry as supplements.

CO2. Elaborate the importance of polymers for industrial application.

CO3. Classify the various polymerization techniques.

CO4. Understand the principles and characterization techniques of polymers.

CO5. Construct the fabrication process of polymer.

REFERENCES :

1. Williams, D.J., `Polymer Science and Engineering', Prentice Hall, New York, 1971.
2. Austin, G.T., Shrere's `Chemical Process Industries',5th ed., McGraw Hill InternationalBook 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.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	1	2
CO2	2	-	3	2	2	3
CO3	1	-	3	2	2	3
CO4	3	-	3	1	1	2
CO5	3	-	3	2	3	2
Average	2.5		3	1.9	1.9	2.5

LE3053 SELF- MANAGEMENT AND ENTREPRENEURSHIP L T P C
3 0 0 3

OBJECTIVE:

To enable the students to understand about

- The need for self-management and other management competencies for a successful entrepreneurship
- The business development and entrepreneurial skills necessary for success in self-management
- The financial management and documentation
- The basic time management concepts to assessing health of business
- The 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 Partnershipbuilding; 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 able to

CO1 Understand the concept of self-management.
CO2 Recognize the various roles of managers and types of business management.
CO3 Understand of basic finance management concepts.
CO4 Identify the fundamentals of managing the time and finance.
CO5 Evaluate and formulate suitable marketing management for the footwear products.

REFERENCES:

1. Brigham, Ehrhardt, Financial Management Theory & Practice, 14th edition, Cengage Learning.
2. Samuel J. Mantel, Jr, Jack R. Meredith, Scott M. Shafer, Margaret M. Sutton, M.R. Gopalan, "Project Management – Core Textbook" First Indian Edition (2006), Wiley India publication, 2011.
3. Philip Kotler, Kevin Lane Keller, Abraham Koshy, and MitheleswarJha, "MarketingManagement", 13th Edition, Pearson Publications Limited.2012.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-	3
CO2	-	-	1	-	3	2
CO3	-	2	-	-	2	-
CO4	-	-	-	-	1	1
CO5	-	-	-	-	2	-
Average	1	2	1	-	2	2

LE3011 SUSTAINABILITY ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVE

- To provide an overview on the concepts sustainability and its tools
- To provide insight on environmental sustainability practices
- To provide insight on the strategies to attain economic sustainability in leather industries
- To provide 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

Introduction to Sustainability and the Environment, Environmental life cycle assessment, Environmental Protection- Role of Government, Legal aspects, initiatives by Non-governmental organizations (NGO), Environmental Education, Specific Environmental Concerns — Climate Change, Air & Water pollution, Waste, Human Health and Diversity of life, Strategies for Environmental Sustainability — Hazardous waste management, Solid waste management and Reduce-Reuse-Recycle concept.

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 andInduced impact.

UNIT IV SOCIAL SUSTAINABILTY 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 9

Sustainable Development Goal (SDG)s, Securing a sustainable future, Relationship between environmental, economic and social on industry development, Strategies for sustainability in Industries, Sustainable Industrial Manufacture, Energy consumption and reducing emissions, Manufacturing Waste reduction – recycle & Reuse, Water Usage — Reducing water consumption, Wastewater Systems — Water treatment & Management, Case Study: Study of core technologies in leather industry relating to sustainability.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students are expected to

CO1. Gain a fundamental knowledge of issues, principles, concepts, and processes related to sustainability, describe how core technologies in the industry relate to sustainability.

CO2. Understand the sustainability in environment, economic and social.

CO3. Categorize the strategy for sustainable leather industry development.

CO4. Understand the concepts of ISO standards and life cycle assessment.

CO5. Design the strategies to reduce waste emission.

REFERENCES :

1. Bendell , J & Kearins, K. (2005). The political bottom line: the emerging dimension to corporate responsibility for sustainable development. Business Strategy and the Environment 14(6), 372–383
2. Bennet, N & Van der Lugt, C (2004). Tracking global governance and sustainability: is the system working? In Henriques & Richardson (2004)
3. Daly, HE (1990). Toward some operational principles of sustainable development. Ecological Economics 2, 1–6
4. Hopwood, B, Mellor, M & O'Brien, G (2005). Sustainable development: mapping different

approaches. Sustainable Development 13, 38–52

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	2	3
CO2	2	-	3	2	3	3
CO3	3	2	3	1	2	3
CO4	2	3	2	-	3	3
CO5	3	-	3	2	2	3
Average	2.7	1	2.7	1	2.5	3

LE3012 TANNERY WASTE MANAGEMENT AND ENGINEERING L T P C
3 0 0 3

OBJECTIVE

- To give an overview on the leather industry wastewater generation and characterization
- To provide 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 provide knowledge on 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 & Flocculation – 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 - Aerobic attached 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

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 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 – Bacterical compositing – 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 able to

CO1. Understand the methods and means to manage tannery wastes.
CO2. Design wastewater treatment plants.
CO3. Categorize various treatment options for waste water management.
CO4. Explain the importance of solid and liquid waste discharge norms.
CO5. Understand the basic concepts of carbon footprints and circular economy approaches

REFERENCES :

1. Arceivala S.J. "Waste water treatment and disposal" Marcel Dekkar Inc., New York, 1981.
2. Metcalf and Eddy,H `Tchobanoglous, G. and Burton, F.L. (Ed), Waste water Engineering,treatment, disposal and reuse, 3rd edn. Tata-McGraw Hill Publishing, New Delhi 1991.
3. esselievie, B.E. and Schwartz, M. "The Treatment of Industrial wastes", 2nd edn.,McGraw Hill.
4. McCarty, P., Parkin, G.F. and Sawyer, C.N., "Chemistry for Environmental Engineering4th Edition", McGraw Hill, 1994.
5. Hans-Joachim Jordening and Josef Winter, "Environmental Biotechnology", Wiley-VCHVerlag GmbH & Co. KGaA, Weinheim, 2004.
6. M.C.Carre, A Vulliermet and B.Vulliermet, "Environment and Tannery", Centre TechniqueduCuir, 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.

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	3
CO2	3	-	3	3	2	2
CO3	3	-	3	-	2	2
CO4	-	3	2	-	-	3

CO5	3	3	2	2	2	3
Average	2.4	2.6	2.6	1.4	1.8	2.8

LE3013 DESIGN OF EXPERIMENTS AND STATISTICAL TOOLS

L	T	P	C
3	0	0	3

OBJECTIVE

- To provide knowledge on the basic principles of design of experiments
- To provide expertise on the application of response surface methodology
- To provide the ability to understand and expertise on correlation and regression
- To provide knowledge on understanding the concepts of sampling, identifying the errors through hypothesis evaluation for attain best fitting
- To provide knowledge on understanding 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 , ax^2+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 :

1. Das, M. N. and Giri, N. S. (1986). Design and Analysis of Experiments (2nd Edition). Wiley.
2. Dean, A. and Voss, D. (1999). Design and Analysis of Experiments. Springer-Verlag, New York.
3. Federer, W.T. (1955). Experimental Design: Theory and Applications. Oxford & IBH Publishing Company, Calcutta, Bombay and New Delhi.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, Asia, 2016

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	3	3	3	–
CO2	3	–	3	3	-	2.5
CO3	2	–	-	2	2.5	-
CO4	3	-	-	3	2	–
CO5	2	–	-	3	-	–
Average	2.6	–	3	2.8	3	2.5