Curriculum of Diploma Programme

in

Leather Technology

Department of Science, Technology and Technical

Education (DSTTE), Govt. of Bihar

State Board of Technical Education(SBTE), Bihar

Semester – Third
Teaching & Learning Scheme

Course Codes	Category of course	CourseTitles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
2472301	PCC	Bio-Chemistry of Proteins and Pretannage.	3	-	4	2	9	6
2472302	PCC	Biotechnology of Leather Manufacture	3	-	2	2	7	5
2472303	PCC	Footwear Science & Technology	3	-	4	2	9	6
2472304	PCC	Leather Processing Techniques –I	3	-	-	2	5	4
2472305	PCC	Computer Applications in Leather Technology	-	-	4	2	6	3
2472306	PSI	Summer Internship – I*	-	-	4	2	6	3
2472307	PCC	Tannery Practice I	-	-	4	2	6	3
			12	00	22	14	48	30

- **Note: Prefix will be added to Course Code if applicable (T for Theory Paper, P for Practical Paper and S for Term Work)**
- **Legend:**
- CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)
- LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)
- Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.
- TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)
- SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.
- C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)
- **Note:** TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensu

Semester – Third

Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self Learning Assessment (TWA)		Lab Assessment(LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment	
2472301	PCC	Bio-Chemistry of Proteins and Pretannage	30	70	20	30	20	30	200
2472302	PCC	Biotechnology of Leather Manufacture	30	70	20	30	20	30	200
2472303	PCC	Footwear Science & Technology	30	70	20	30	20	30	200
2472304	PCC	Leather Processing Techniques –I	30	70	20	30	-	-	150
2472305	PCC	Computer Applications in Leather Technology	-	-	20	30	20	30	100
2472306	PSI	Summer Internship – I*	-	-	10	15	10	15	50
2472307	PCC	Tannery Practice I	-	-	20	30	20	30	100
			120	280	130	195	110	165	1000

Note: Prefix will be added to Course Code if applicable (T for Theory Paper, P for Practical Paper and S for Term Work)

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

- ETA & ELA are to be carried out at the end of the term/ semester.

Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist

A) Course Code :2472301(T2472301/P2472301/S2472301)

B) Course Title : Bio-Chemistry of Proteins and Pretannage

C) **Pre- requisite Course(s) : Basic Chemistry**

D) **Rationale :**

The course Bio-Chemistry of Proteins and Pretannage provides fundamental knowledge of the chemical composition, structure, and reactions of proteins—particularly collagen, which forms the basis of leather. It enables learners to understand biochemical transformations during pretanning operations such as soaking, liming, deliming, bating, and pickling. This understanding is essential for optimizing process parameters, improving leather quality, and adopting eco-friendly and sustainable tanning practices

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1. Explain the structure, classification, and properties of proteins relevant to leather and related industries.

CO-2. Describe the biochemical processes involved in protein denaturation, hydrolysis, and enzyme actions during leather processing.

CO-3. Explain the chemical mechanisms of pretannage operations such as soaking, liming, deliming, bating, and pickling.

CO-4. Compare the roles of different biochemical agents and enzymes in improving leather quality and enhancing environmental sustainability.

CO-5. Explain the biochemical principles to standardize pretannage processes for efficient utilization of raw materials and reduced effluent load.

F) **Suggested Course Articulation Matrix (CAM):**

PSO-1: Apply knowledge of chemistry, biochemistry, and material science to analyze, process, and enhance the quality of hides and skins into value-added leather products.

PSO-2: Utilize modern analytical tools and sustainable processing techniques for innovation, quality improvement, and environmental compliance in leather and allied industries

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1.	3	1	-	1	-	-	2	1	-
CO-2.	3	1	-	1	-	-	1	2	-
CO-3.	3	2	-	-	-	-	1	2	-
CO-4.	3	2	1	-	3	-	2	2	3
CO-5.	3	2	2	2	-	-	1	2	-

Legend: High (3), Medium (2), Low (1) and no mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines.

G) **Teaching & Learning Scheme:**

Course Code	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+SL)	Total Hours (CI+LI+SW+SL)	Total Credits (C)
		L	T				
2472301	Bio-Chemistry of Proteins and Pretannage	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) **Assessment Scheme:**

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment	End Theory Assessmen	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2472301	Bio-Chemistry of Proteins and Pretannage	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) **Theory Session Outcomes (TSOs) and Units: T2472301**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1a Explain the basic concepts of biochemistry and importance of proteins in biological and industrial systems. TSO.1b Describe the amino acid structure, peptide bond formation, and levels of protein structure (primary to quaternary). TSO.1c Classify proteins based on structure, solubility, and function. TSO.1d Discuss protein properties such as denaturation, coagulation, and solubility. TSO.1e Explain protein–water and protein–chemical interactions relevant to hide and skin composition. TSO.1f Describe protein degradation and stabilization mechanisms TSO.1g Discuss analytical techniques for protein characterization (UV-Vis, electrophoresis, chromatography).	**Unit-1.0** Introduction to Biochemistry of Proteins 1.1 Basic concepts of biochemistry and relevance to leather 1.2 Amino acids and peptide bonds 1.3 Classification of proteins 1.4 Physical and chemical properties 1.5 Protein–water interactions 1.6 Protein analysis techniques	**CO-1**

TSO 2a: Describe the structure and composition of collagen and keratin present in hides and skins. TSO 2b: Explain the concept of crosslinking in collagen and its role in leather formation. TSO 2c: Discuss the enzymatic and chemical modifications that occur in collagen during the pretannage process. TSO 2d: Explain the biochemical principles behind enzyme-assisted soaking, liming, deliming, and bating operations. TSO 2e: Discuss the influence of pH, temperature, and enzyme activity on various pretannage reactions	**Unit-2.0** Biochemistry of Skin Proteins and Collagen Structure 2.1 Collagen and keratin: structure and composition 2.2 Collagen crosslinking and stability 2.3 Enzyme-assisted soaking, liming, deliming, bating 2.4 Factors influencing enzyme activity	**CO2, CO3**
TSO 3a: Determine the biochemical mechanisms involved in key pretannage operations. TSO 3b: Describe the steps and significance of soaking, liming, deliming, bating, and pickling processes. TSO 3c: Explain the chemical reactions involving calcium hydroxide, sodium sulfide, and ammonium salts during pretannage. TSO 3d: Discuss the environmental implications of pretannage effluents and suggest methods for their control and treatment.	**Unit-3.0** Pretannage Operations and Biochemical Reactions 3.1 Soaking and liming 3.2 Deliming and bating 3.3 Pickling process 3.4 Chemical mechanisms in pretannage 3.5 Environmental aspects of pretannage effluents	**CO2, CO3**
TSO 4a: Determine the roles of biochemical agents, surfactants, and enzymes in improving leather quality. TSO 4b: Discuss the advantages of enzymatic bating compared to traditional chemical-based processes. TSO 4c: Describe various enzyme stabilization, storage, and reuse techniques used in pretannage. TSO 4d: Compare biochemical and chemical pretannage methods in terms of product quality, cost, and sustainability.	**Unit-4.0** Biochemical Agents and Enzymatic Processes 4.1 Role of enzymes and surfactants on final quality of leather 4.2 Stabilization and preservation of Enzyme 4.3 Enzymatic vs. conventional chemical pretannage methods 4.4 Case studies on improved leather quality by following bio aided process	**CO4**

TSO 5a: Explain biochemical principles to optimize various pretannage processes for improved efficiency. TSO 5b: Determine industrial case studies demonstrating eco-friendly and enzyme-based pretannage technologies. TSO 5c: Discuss practical methods for minimizing chemical usage and reducing effluent load in the pretannage process. TSO 5d: Integrate biochemical knowledge to design sustainable and circular leather manufacturing systems promoting environmental compliance.	**Unit-5.0** Process Optimization and Sustainability 5.1 Optimization of biochemical pretannage parameters 5.2 Eco-friendly and Bio-based pretannage technologies 5.3 Effluent reduction techniques 5.4 Sustainable and closed loop leather manufacturing process	**CO4, CO5**

Note: One major TSO may require more than one Theory session/Period.

K) **Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2472301**

Practical/Lab Session Outcomes (LSOs)	**S. No.**	**Laboratory Experiment/Practical Titles**	**Relevant COs Number (s)**
LSO 1.1 1.1.1 Students will be able to follow safety procedure and determine proper biochemistry laboratory safety procedures 1.1.2 Students will be able to prepare standard solutions for protein and enzyme analysis.	1.	• Demonstration of basic biochemistry laboratory safety procedures • Preparation of standard solutions.	CO-1
LSO 1.2 Students will be able to determine of protein concentration in samples using Biuret and Lowry methods, understanding quantitative analytical techniques for protein determination	2.	Estimation of protein concentration using Biuret and Lowry methods.	CO-1
LSO 1.3 Students will be able to determine the amino acid composition of proteins using ninhydrin test and paper chromatography, linking structure to function.	3.	Determination of amino acid composition by ninhydrin test and paper chromatography.	CO-1
LSO 1.4 Students will be able to analyze protein denaturation and coagulation under thermal and chemical conditions, understanding	4.	Observation of protein denaturation and coagulation under thermal and chemical conditions.	CO-1

the thermal effect on protein properties.			
LSO 1.5 Students will be able to extract and isolate collagen from raw hide or skin samples by demonstrating the skin protein biochemistry.	5.	Extraction and isolation of amino acid / collagen from raw hide or skin samples.	CO-2
LSO 1.6 Students will be able to study the activity of enzymes under varying pH and temperature conditions, understanding factors affecting enzyme function.	6.	Study of enzyme activity under varying pH and temperature conditions.	CO-2
LSO 1.7 Students will be able to assess the efficiency of enzyme-assisted pretanning process compared to conventional chemical methods, applying biochemical principles in pretannage.	7.	Assessment of enzyme-assisted efficiency in pretanning process compared to conventional methods.	CO-2
LSO 2.1 Students will be able to determine lime and sulfide content in liming liquor, analytical understanding of chemicals used in pretanning operations.	8.	Determination of lime and sulfide content in liming liquor.	CO-3
LSO 2.2 Students will be able to analyze deliming liquor for ammonium salts and residual chemicals, linking chemical composition to pretannage efficiency.	9.	Analysis of deliming liquor for ammonium salts and residual chemicals.	CO-3
LSO 2.3 Students will be able to study pH variations during deliming and bating operations, understanding process control in pretannage	10.	Study of pH variation during deliming and bating operations.	CO-3
LSO 2.4 Students will be able to determine exhaust liquor from different unit operations of pretanning domain and effluent parameters, including BOD, COD, and TDS, emphasizing environmental considerations.	11.	Evaluation of exhaust liquor from different unit operations of pretanning domain and effluent parameters (BOD, COD, and TDS).	CO-3
LSO 2.5 Students will be able to compare Bio-aided and chemically treated pelts for softness, cleanliness, and quality, demonstrating the advantages of biochemical pretannage.	12.	Comparative analysis of Bio-aided and chemically treated pelts for softness and cleanliness.	CO-4
LSO 2.6 Students will be able to study the effect of enzyme concentration on physical and analytical properties of leather by applying principles of optimization and quality improvement.	13.	Study of the effect of enzyme concentration on physical and analytical properties of leather by applying principles of optimization and quality improvement.	CO-4

LSO 3.1 Students will be able to demonstrate eco-friendly pretannage using enzymatic or bio-based agents, applying sustainable processing methods.	14.	Demonstration of eco-friendly pretannage using enzymatic or bio-based agents.	CO-5
LSO 3.2 Students will be able to optimize bio-assisted pretannage processes by varying pH, time, and temperature, integrating biochemical knowledge for process improvement.	15.	Process optimization study for bio-assisted pretannage (pH, time, temperature).	CO-5
LSO 3.3 Students will be able to conduct a comparative evaluation of conventional chemical and greener pretannage methods to assess sustainability, effluent reduction, and product quality.	16.	Project experiment: Comparative evaluation of conventional and greener pretannage for sustainability and effluent reduction.	CO-5

L) **Suggested Term Work and Self-Learning: S2472301** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments

The course teacher may provide questions, problems, and exercises to target specific COs. Examples include:

S. No.	Title / Task	Relevant COs
1.	Calculation of protein concentration using Biuret and Lowry methods.	CO-1
2.	Determination of amino acid composition from sample data using chromatography.	CO-1
3.	Analysis of enzyme activity variation with pH and temperature.	CO-2
4.	Design a pretannage process flow considering chemical and biochemical treatments.	CO-3, CO-4
5.	Estimation of environmental impact and effluent load from a leather pretannage process.	CO-5

b. Micro Projects

Students can work in small groups to undertake practical or analytical mini-projects, such as:

S. No.	Title / Task	Relevant COs
1.	Comparative study of enzyme-assisted versus chemical pretannage on sample pelts.	CO-4, CO-5
2.	Optimization of enzymatic bating conditions for maximum leather softness.	CO-5
3.	Analysis of protein denaturation under different thermal or chemical conditions.	CO-1, CO-2

4.	Designing an eco-friendly pretannage process and calculating its sustainability metrics.	CO-5

c. Other Activities

1. Seminar Topics:

S. No.	Seminar Topic	Relevant COs
1.	Recent trends in enzymatic leather processing.	CO-4, CO-5
2.	Biochemical characterization of collagen in hides and skins.	CO-1, CO-2
3.	Industrial strategies for sustainable pretannage.	CO-5
4.	Application of green chemistry in leather processing.	CO-5

2. Surveys:

S. No.	Survey Topic / Activity	Relevant COs
1.	Survey of local tanneries to analyze pretannage methods and chemical usage.	CO-3, CO-5
2.	Comparative study of enzyme-based versus chemical pretannage in industry.	CO-4, CO-5

3. Visit:

S. No.	Visit Type	Relevant COs
1.	Visit to a leather processing unit to observe pretannage operations, enzyme usage, and effluent treatment.	CO-3, CO-5

d. Self-Learning Topics

S. No.	Self-Learning Topic / Activity	Relevant COs
1.	Online tutorials on protein structure, collagen chemistry, and enzyme kinetics. *(CO-1, CO-2)*	CO-1, CO-2
2.	NPTEL / MIT OCW courses on biochemistry and industrial enzyme applications. *(CO-1 to CO-5)*	CO-1 to CO-5
3.	Reading research articles on sustainable leather processing and eco-friendly pretannage methods. *(CO-5)*	CO-5
4.	Software-based data analysis for enzyme kinetics and protein estimation (e.g., Excel, GraphPad Prism). *(CO-2, CO-5)*	CO-2, CO-5

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

	Course Evaluation Matrix		
	Theory Assessment	**Sessional Work Assessment**	**Lab Assessment (LA)#**

COs	(TA)**		(SWA)				
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	20%	20%	33%	20%	20%
CO-2	20%	25%	20%	20%	33%	25%	20%
CO-3	25%	25%	20%	20%	34%	20%	20%
CO-4	25%	20%	20%	20%	--	20%	20%
CO-5	15%	15%	20%	20%	--	15%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

***:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

******: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Suggested Specification Table for End Semester Theory Assessment:** Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Biochemistry of Proteins	8	CO1	11	4	4	3
Unit-2.0 Biochemistry of Skin Proteins and Collagen Structure	12	CO2	17	4	6	7
Unit-3.0 Pretannage Operations and Biochemical Reactions	10	CO3	17	4	6	7
Unit-4.0 Biochemical Agents and Enzymatic Processes	10	CO4	14	4	6	4
Unit-5.0 Process Optimization and Sustainability	8	CO5	11	4	3	4

Total	**48**	**-**	**70**	**20**	**25**	**25**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Suggested Assessment Table for Laboratory (Practical):**

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Laboratory safety and preparation of standard solutions	CO-1	50	40	10
2.	Estimation of protein concentration by Biuret and Lowry methods		50	40	10
3.	Determination of amino acid composition by ninhydrin test and paper chromatography		50	40	10
4.	Observation of protein denaturation and coagulation		45	45	10
5.	Extraction and isolation of collagen from raw hide or skin samples	CO-2	50	40	10
6.	Study of enzyme activity (protease/trypsin) under varying pH and temperature		50	40	10
7.	Assessment of enzyme-assisted soaking/bating efficiency		50	40	10
8.	Determination of lime and sulfide content in liming liquor	CO-3	50	40	10
9.	Analysis of deliming liquor for ammonium salts and residual chemicals		50	40	10
10.	Study of pH variation during deliming and bating operations		50	40	10
11.	Evaluation of pretannage liquor and effluent parameters (BOD, COD, TDS)	CO-4	50	40	10
12.	Comparative analysis of enzyme-treated and chemically treated pelts	C0-4	50	40	10
13.	Effect of enzyme concentration on leather softness and tensile strength	CO-5	50	40	10
14.	Demonstration of eco-friendly pretannage using enzymatic/bio-based agents		50	40	10
15.	Process optimization study for enzyme-assisted pretannage (pH, time, temperature)		50	40	10
16.	Comparative evaluation of conventional and biochemical pretannage for sustainability and effluent reduction		50	40	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Suggested Instructional/Implementation Strategies:**

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1	Analytical Balance	Precision 0.1 mg, digital, suitable for chemical and protein sample weighing	1, 2, 3, 5
2	pH Meter	Digital, range 0-14, accuracy ±0.01, with glass electrode	6, 7, 10, 15
3	UV-Visible Spectrophotometer	Wavelength 190-1100 nm, quartz cuvettes, for protein and enzyme analysis	2, 3, 12, 13
4	Hot Plate with Magnetic Stirrer	Temp 50-300°C, magnetic stirring capability, for sample preparation and heating	4, 5, 6
5	Water Bath	Digital/thermostatic, 25-100°C, for controlled enzyme reactions	6, 7, 13, 15
6	Centrifuge	Max RPM 10,000, for protein and collagen separation	5, 12, 13
7	Incubator	Temp range 25-60°C, for enzymatic reactions and microbial studies	6, 7
8	Chromatography Setup	Paper chromatography and TLC, for amino acid/protein separation	3
9	Micro-pipettes, pipettes controller	Range 0.1-1000 µL, adjustable, for accurate reagent handling	2, 3, 6, 7, 12
10	Glassware (e.g. Conical Flasks and Beakers)	Borosilicate glass, 50-1000 mL, for solution preparation	1-16
11	BOD/COD Kit	Standard kit for biochemical oxygen demand and chemical oxygen demand analysis	11, 16
12	Surfactant / Enzyme Testing Kit	For assessing enzyme-assisted bating and eco-friendly pretannage	7, 12, 14, 15
13	Laboratory Oven	Temp range 50-200°C, for drying samples	4, 5
14	Distilled Water Unit	For preparation of all aqueous solutions, 5-10 L/hr capacity	1-16
15	Software: Excel / GraphPad Prism	For data analysis, plotting enzyme kinetics, and statistical calculations	2, 6, 7, 13, 15

R) **Suggested Learning Resources:**

(a)Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Biochemistry	U. Satyanarayana, U. Chakrapani	Books & Allied, 5th Edition, 2019, ISBN: 978-81-8316-664-2
2	Principles of Biochemistry	Lehninger, David L., Nelson, Michael M., Cox, Michael	Macmillan, 7th Edition, 2021, ISBN: 978-1319210733
3	Textbook of Biochemistry with Clinical Correlations	Thomas M. Devlin	Wiley, 8th Edition, 2020, ISBN: 978-1119544041
4	Biochemistry of Leather	G. J. Heard	Leather Industry Research Association, 3rd Edition, 2018, ISBN: 978-1906032601
5	Enzymes in Leather Processing	C. F. Beckett, R. M. Pitt	Elsevier, 2nd Edition, 2016, ISBN: 978-0128148363
6	Industrial Biochemistry and Enzyme Technology	A. Pandey, C. Webb, D. Soccol	Springer, 2nd Edition, 2017, ISBN: 978-8132222323
7	Analytical Chemistry of Leather Manufacture	Mr. P. K. Sarkar	Indian Leather Technologists' Association (ILTA), Kolkata

(b) Open Educational Resources (OER):

1. NPTEL Courses

- *Course:* Biochemistry
- *Link:* https://nptel.ac.in/courses/102/104/102104061/
- *Description:* Video lectures covering fundamentals of proteins, enzymes, amino acids, and biochemical processes.

2. MIT Open Course Ware (OCW)

- *Course:* Principles of Biochemistry
- *Link:* https://ocw.mit.edu/courses/7-05-biochemistry-fall-2013/
- *Description:* Lecture notes, assignments, and exams covering protein chemistry, enzymology, and metabolism.

3. Coursera

- *Course:* Biochemistry: the Molecules of Life
- *Link:* https://www.coursera.org/learn/biochemistry
- *Description:* Free auditing option; covers protein structure, function, and enzymatic mechanisms.

4. Khan Academy

- *Module:* Proteins and Amino Acids
- *Link:* https://www.khanacademy.org/science/biology/macromolecules
- *Description:* Short video tutorials explaining amino acids, protein structures, and enzymatic activity.

5. Libre Texts Biochemistry

- *Link:* https://bio.libretexts.org/Bookshelves/Biochemistry

- *Description:* Free comprehensive online textbook covering proteins, enzymes, and biochemical methods.

6. FAO - Food and Agriculture Organization

- *Resource:* Enzymes in Industrial Applications
- *Link:* http://www.fao.org/3/y4765e/y4765e00.htm
- *Description:* Open access resource describing industrial enzymes, including leather and protein applications.

7. YouTube Educational Channels

- *Channels:* NPTEL, MIT OCW, CrashCourse Biology
- *Description:* Free video lectures on biochemistry, protein chemistry, and enzyme technology.

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

1. Learning Packages:

- NPTEL Biochemistry Video Lectures - Modules on protein structure, enzymes, and industrial applications.
  https://nptel.ac.in/courses/102/104/102104061/
- Coursera: Biochemistry: the Molecules of Life - Free auditing option for online learning.
  https://www.coursera.org/learn/biochemistry

2. Users' Guide:

- Instrument manuals provided by suppliers for laboratory equipment like UV-Vis Spectrophotometer, pH meter, centrifuge, and hot plates.
- Step-by-step procedural manuals for protein estimation kits, enzyme assay kits, and BOD/COD kits.

3. Manufacturers' Manual:

- Manuals provided by manufacturers for major lab instruments including:
  - UV-Visible Spectrophotometer (Shimadzu / PerkinElmer)
  - Analytical Balance (Sartorius / Mettler Toledo)
  - pH Meter (Hanna / Thermo Fisher)
  - Centrifuge (Remi / Eppendorf)
- Includes technical specifications, calibration procedures, and safety precautions.

4. Lab Manuals:

A) Course Code : 2472302(T2472302/P2472302/S2472302)
B) Course Title : Biotechnology of Leather Manufacture
C) Pre- requisite Course(s) : Environmental science, chemistry
D) Rationale :

The course explores the application of biotechnology in leather manufacturing to promote sustainable and eco-friendly processes. It focuses on enzyme-based and microbial methods for cleaner production, waste reduction, and improved quality. Students will learn biotechnological techniques in various leather processing stages and effluent management. The course emphasizes modern innovations for achieving environmental and economic sustainability in the leather industry.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO1: Explain the role and significance of biotechnology in leather manufacture compared to conventional processes.
CO2: Explain the types, properties, and mechanisms of enzymes used in various stages of leather processing.
CO3: Explain enzymatic and microbial techniques for cleaner and sustainable leather production.
CO4: Discuss biotechnological methods for the treatment and management of tannery effluents and solid wastes.
CO5: Define modern biotechnological innovations in collagen processing and the development of eco-friendly leather alternatives.

F) Suggested Course Articulation Matrix (CAM):

PSO-1: Apply knowledge of chemistry, biochemistry, and material science to analyze, process, and enhance the quality of hides and skins into value-added leather products.

PSO-2: Utilize modern analytical tools and sustainable processing techniques for innovation, quality improvement, and environmental compliance in leather and allied industries

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)	
	PO-1 Basic and Discipline Specific Knowledg e	**PO-2** Problem Analysis	**PO-3** Design/Dev elopment of Solutions	**PO-4** Engineeri ng Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Manage m ent	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1.	3	2	-	-	-	-	1	2	1
CO-2.	3	3	-	-	-	-	2	2	2
CO-3.	3	3	1	1	3	-	2	2	2
CO-4.	2	2	1	-	-	3	1	2	-
CO-5.	3	2	2	2	3	2	2	2	2

Legend: High (3), Medium (2), Low (1) and No ma1pping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2472302	**Biotechnology of Leather Manufacture**	03	-	02	02	07	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)
Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the

continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment	End Theory Assessment	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2472302	Biotechnology of Leather Manufacture	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)
PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)
TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:
- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2472302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1a: Explain the fundamentals of biotechnology and its significance in leather manufacturing. **TSO.1b:** Discuss environmental impacts of conventional leather processing and need for green technologies. **TSO.1c:** Explain the role of enzymes and microorganisms as alternatives to chemical agents in leather processing	**Unit-1.0: Introduction to Biotechnology in Leather Manufacture** 1.1 Fundamentals of biotechnology and relevance to leather industry 1.2 Comparison with conventional chemical methods 1.3 Environmental impact of traditional leather processing 1.4 Introduction to enzymes and microorganisms in leather processing	CO1
TSO.2a: Describe classification, structure, and catalytic mechanisms of enzymes used in leather processing. **TSO.2b:** Explain enzyme production, optimization of process parameters, and stability during leather processing. **TSO.2c:** Apply enzymatic techniques for eco-friendly soaking, dehairing, and degreasing operations.	**Unit-2.0: Enzyme Technology and Its Applications** 2.1 Classification of enzymes (proteases, lipases, amylases) used in leather processing 2.2 Structure, properties, and catalytic mechanisms of enzymes- Enzyme production, stabilization, and recovery 2.3 Enzyme-assisted soaking, dehairing, bating, and degreasing 2.4 Optimization of enzyme activity (pH, temperature, concentration)	CO2, CO3
TSO.3a: Describe microbial processes used in enzyme generation and leather treatment. **TSO.3b:** Discuss microbial tanning mechanisms and role of biosurfactants and biopolymers in leather finishing. **TSO.3c:** Apply bioprocess principles to achieve cleaner and sustainable leather manufacture.	**Unit-3.0: Microbial and Enzymatic Leather Processing** 3.1 Microbial fermentation for enzyme production- Microbial degradation of hair and fats 3.2 Microbial tanning and bio-catalyzed cross-linking 3.3 Role of biosurfactants and biopolymers in leather finishing 3.4 Case studies of industrial microbial processes	CO3

TSO.4a: Explain pollution sources and waste characteristics in tanneries. **TSO.4b:** Explain microbial and enzymatic methods for tannery effluent treatment and bioremediation. **TSO.4c:** Determine recovery and reuse of valuable by-products from tannery wastes using biotechnology.	**Unit-4.0: Biotechnological Waste Management in Tanneries** 4.1 Characteristics of tannery effluents and solid wastes 4.2 Biotechnological methods for effluent treatment (aerobic, anaerobic, enzymatic) 4.3 Microbial bioremediation of chromium and sulfide compounds 4.4 Recovery of valuable by-products (collagen peptides, gelatin) 4.5 Sustainability and circular economy in leather waste management	CO4
TSO.5a: Explain advancements in biotechnological innovations such as bio-tanning and eco-leather production. **TSO.5b:** Determine the potential of collagen modification, bio-based materials, and genetic engineering for improving enzyme efficiency. **TSO.5c:** Discuss the role of biotechnology in developing sustainable and circular leather manufacturing systems.	**Unit-5.0: Advances and Innovations in Leather Biotechnology** 5.1 Bio-tanning and eco-leather production techniques 5.2 Collagen modification and biomaterial development 5.3 Genetic engineering for enzyme improvement 5.4 Emerging trends in sustainable leather processing 5.5 Industrial case studies and future perspectives	CO5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2472302

Practical / Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment / Practical Titles	Relevant CO(s) Number(s)
LSO 1.1 Students will be able to identify ~~and describe~~ various microorganisms used in leather biotechnology through microscopic observation and culture techniques.	1	Study of microorganisms relevant to leather biotechnology (bacteria, fungi) using microscopy and culture methods	CO-1
LSO 1.2 Students will be able to prepare and sterilize culture media and maintain microbial cultures used for enzyme production.	2	Preparation and sterilization of microbial culture media for enzyme-producing organisms	CO-1

LSO 1.3 Students will be able to isolate proteolytic microorganisms from tannery or soil samples and screen for enzyme activity.	3	Isolation and screening of proteolytic microorganisms from tannery soil samples	CO-1
LSO 1.4 Students will be able to produce enzymes (protease, lipase, or amylase) using submerged fermentation and evaluate their activity.	4	Production of industrially relevant enzymes using submerged fermentation and enzyme assay	CO-2
LSO 1.5 Students will be able to partially purify enzymes using salt precipitation or dialysis and analyze enzyme stability.	5	Partial purification and stability analysis of enzymes used in leather processing	CO-2
LSO 1.6 Students will be able to apply enzymatic processes in soaking or bating operations and compare them with traditional chemical methods.	6	Application of enzyme-based soaking/bating and comparison with chemical treatment	CO-2
LSO 1.7 Students will be able to determine the effect of enzymatic treatment on pelt cleanliness, softness, and fiber opening.	7	Assessment of pelt quality parameters after enzymatic treatment	CO-2
LSO 2.1 Students will be able to measure total protein and enzyme content in tannery effluent samples, demonstrating environmental awareness.	8	Estimation of protein and enzyme content in tannery effluents	CO-3
LSO 2.2 Students will be able to assess microbial load and biological oxygen demand (BOD) in tannery effluents, linking biotechnology with environmental control.	9	Determination of microbial load and BOD in tannery wastewater	CO-3
LSO 2.3 Students will be able to develop microbial consortia for biodegradation of tannery effluents and evaluate performance.	10	Preparation of microbial consortia for biodegradation of tannery waste	CO-3
LSO 2.4 Students will be able to compare conventional effluent treatment with bio-based treatment for improved eco-efficiency.	11	Comparative study of chemical and bio-based effluent treatment processes	CO-4
LSO 2.5 Students will be able to determine enzyme kinetics (Km and Vmax) for industrial enzymes used in pretannage or bating.	12	Determination of enzyme kinetic parameters (Km, Vmax) for leather processing enzymes	CO-4
LSO 2.6 Students will be able to study immobilization of enzymes and test their reusability in pretannage operations.	13	Enzyme immobilization and study of its reusability for leather processing	CO-4
LSO 3.1 Students will be able to demonstrate bio-based deliming using microbial or enzymatic agents and assess pH reduction efficiency.	14	Demonstration of bio-deliming using microbial or enzymatic agents	CO-5
LSO 3.2 Students will be able to perform bio-tanning using vegetable tannins or microbial extracts, comparing quality with chrome-tanned leather.	15	Experiment on bio-tanning using plant or microbial extracts	CO-5
LSO 3.3 Students will be able to determine eco-friendly leather manufacture through life cycle and waste minimization analysis.	16	Project: Life cycle and waste minimization study in enzymatic leather manufacture	CO-5

L) Suggested Term Work and Self-Learning: S2472302 Some sample suggested assignments, micro

project and other activities are mentioned here for reference.

a. Assignments

S. No.	Title / Task	Objective / Description	Relevant COs
1	Comparative study of enzyme-assisted vs chemical dehairing	Students will analyze efficiency, time, and environmental impact of enzymatic and chemical methods	CO2, CO3
2	Protein estimation in hides using Biuret and Lowry methods	Quantitative estimation of total protein content to understand hide composition	CO1
3	Analysis of pH and temperature effects on enzyme activity	To study optimization parameters for proteolytic enzymes used in leather pretannage	CO2, CO3
4	Study of collagen extraction and characterization	Extraction of collagen from raw hide and assessment of its properties	CO2, CO5
5	Evaluation of tannery effluent parameters (BOD, COD, TDS)	Monitoring environmental impact of leather processing and proposing treatment measures	CO4

b. Micro Projects

S. No.	Title / Task	Objective / Description	Relevant COs
1	Development of eco-friendly pretannage process	Design and implement enzyme-based pretannage and compare with chemical methods	CO3, CO5
2	Production and application of microbial enzymes	Isolate enzyme-producing microbes and study their application in leather processing	CO3, CO5
3	Bioremediation of tannery effluent using microbes	Study microbial degradation of sulfides or chromium in simulated effluent	CO4, CO5
4	Optimization of enzyme-assisted soaking/bating	Investigate effect of enzyme concentration, pH, and temperature on hide quality	CO3, CO5
5	Comparative analysis of bio-tanned vs conventionally tanned leather	Evaluate mechanical properties, softness, and eco-impact	CO4, CO5

c. Other Activities

1. Seminar Topics:

S. No.	Seminar Topic	Objective / Description	Relevant COs
1	Recent advances in enzyme-assisted leather processing	To explore the latest research on enzymes used in soaking, dehairing, bating, and degreasing	CO2, CO3
2	Microbial tanning and bio-catalyzed leather finishing	Understanding microbial roles in tanning and finishing for eco-friendly processes	CO3, CO5
3	Biotechnological approaches for effluent treatment in tanneries	Study of microbial and enzymatic methods to reduce environmental pollution	CO4
4	Bio-based leather alternatives and collagen biomaterials	Development of sustainable leather substitutes using biotechnological methods	CO5
5	Optimization of enzyme-assisted pretannage processes	Methods to enhance efficiency and quality of leather using enzyme biotechnology	CO3, CO5

2. Surveys:

S. No.	Survey Topic / Activity	Objective / Description	Relevant COs
1	Survey of local tanneries for enzyme-based processes	To analyze adoption of biotechnological methods in industrial leather processing	CO1, CO3
2	Survey of environmental management practices in tanneries	Identify current practices for effluent treatment and pollution control	CO4
3	Survey of leather quality in enzyme-treated vs chemically-treated hides	Assess consumer or industrial perception of bio-processed leather	CO3, CO4
4	Survey of green innovations in leather industry	Collect data on eco-friendly and sustainable leather manufacturing trends	CO5

3. Visit:

S. No.	Visit Type	Objective / Description	Relevant COs
1	Visit to tanneries practicing enzyme-assisted or microbial leather processing	Observe practical implementation of biotechnological methods in leather manufacture	CO2, CO3
2	Visit to tannery effluent treatment plants	Learn about microbial and enzymatic effluent treatment, environmental monitoring, and compliance	CO4
3	Visit to research labs working on collagen, biomaterials, or bio-based tanning	Exposure to ongoing research and innovation in sustainable leather technologies	CO5
4	Visit to eco-leather or sustainable leather product manufacturing units	Understand application of bio-tanning and green processing for commercial products	CO5

d. Self-Learning Topics

S. No.	Self-Learning Topic / Activity	Objective / Description	Relevant COs
1	Study of enzyme types and mechanisms in leather processing	Understand the role of proteases, lipases, and other enzymes in soaking, dehairing, bating, and degreasing	CO2, CO3
2	Literature review on microbial tanning and bio-catalyzed leather finishing	Learn about eco-friendly alternatives to conventional tanning using microorganisms	CO3, CO5
3	Analysis of environmental impact of conventional vs biotechnological leather processes	Understand sustainability, effluent reduction, and cleaner production principles	CO1, CO4
4	Online tutorials / webinars on green leather technologies	Keep updated with recent innovations in enzyme-assisted and bio-based leather processing	CO5
5	Study of collagen structure, modification, and biomaterials	Explore collagen-based biomaterials and their applications in eco-leather and leather alternatives	CO2, CO5
6	Case studies of industrial implementation of enzyme-assisted leather processing	Understand real-world challenges, process optimization, and economic viability	CO3, CO5

7	Simulation of enzyme kinetics and optimization using software tools	Apply theoretical knowledge to predict enzyme activity, efficiency, and process parameters	CO2, CO3
8	Review of biotechnological waste treatment and effluent management in tanneries	Learn microbial and enzymatic remediation strategies and regulatory compliance	CO4
9	Comparative study of bio-tanned and chemically tanned leather properties	Evaluate quality, softness, tensile strength, and environmental benefits	CO4, CO5
10	Exploration of future trends in sustainable and circular leather manufacturing	Gain insights into bio-based tanning agents, genetic engineering, and eco-leather production	CO5

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	**Course Evaluation Matrix**						
	Theory Assessment (TA)**		**Sessional Work Assessment (SWA)**			**Lab Assessment (LA)#**	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	**End Theory Assessment (ETA)**	**Sessional Work & Self Learning Assessment**			**Progressive Lab Assessment (PLA)**	**End Laboratory Assessment (ELA)**
			Assignments	**Micro Projects**	**Other Activities***		
CO-1	15%	15%	20%	20%	33%	20%	20%
CO-2	20%	25%	20%	20%	33%	25%	20%
CO-3	25%	25%	20%	20%	34%	20%	20%
CO-4	25%	20%	20%	20%	--	20%	20%
CO-5	15%	15%	20%	20%	--	15%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

***:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

******: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number				**ETA (Marks)**

	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0: Introduction to Biotechnology in Leather Manufacture	8	CO1	11	4	4	3
Unit-2.0: Enzyme Technology and Its Applications	12	CO2	17	4	6	7
Unit-3.0: Microbial and Enzymatic Leather Processing	10	CO3	17	4	6	7
Unit-4.0: Biotechnological Waste Management in Tanneries	10	CO4	14	4	6	4
Unit-5.0: Advances and Innovations in Leather Biotechnology	8	CO5	11	4	3	4
Total Marks	**48**	**-**	**70**	**20**	**25**	**25**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Study of microorganisms relevant to leather biotechnology (bacteria, fungi) using microscopy and culture methods	CO-1	50	40	10
2.	Preparation and sterilization of microbial culture media for enzyme-producing organisms		50	40	10
3.	Isolation and screening of proteolytic microorganisms from tannery soil samples		50	40	10
4.	Production of industrially relevant enzymes using submerged fermentation and enzyme assay		45	45	10
5.	Partial purification and stability analysis of enzymes used in leather processing	CO-2	50	40	10
6.	Application of enzyme-based soaking/bating and comparison with chemical treatment		50	40	10

7.	Assessment of pelt quality parameters after enzymatic treatment		50	40	10
8.	Estimation of protein and enzyme content in tannery effluents	CO-3	50	40	10
9.	Determination of microbial load and BOD in tannery wastewater		50	40	10
10.	Preparation of microbial consortia for biodegradation of tannery waste		50	40	10
11.	Comparative study of chemical and bio-based effluent treatment processes	CO-4	50	40	10
12.	Determination of enzyme kinetic parameters (Km, Vmax) for leather processing enzymes		50	40	10
13.	Enzyme immobilization and study of its reusability for leather processing	CO-5	50	40	10
14.	Demonstration of bio-deliming using microbial or enzymatic agents		50	40	10
15.	Experiment on bio-tanning using plant or microbial extracts		50	40	10
16.	Project: Life cycle and waste minimization study in enzymatic leather manufacture		50	40	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies:

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment / Practical Number
1	**Autoclave (Vertical / Horizontal)**	Temperature up to 121°C, pressure 15 psi, stainless steel chamber, digital control	1, 2, 3
2	**Laminar Air Flow Cabinet**	HEPA-filtered air flow, UV sterilization, stainless steel workspace	2, 3
3	**Incubator (Bacteriological)**	Temperature range: ambient to 60°C, digital temperature control, adjustable shelves	3, 4
4	**Orbital Shaking Incubator**	Temperature 25–50°C, speed 50–250 rpm, digital timer and display	4
5	**Centrifuge (High-Speed)**	15,000 rpm capacity, digital speed control, with multiple rotor options	5, 12
6	**Spectrophotometer (UV-Visible)**	Wavelength range 190–1100 nm, photometric accuracy ±0.005 Abs, cuvette-based	4, 8, 12
7	**pH Meter (Digital Bench Type)**	Range 0–14 pH, accuracy ±0.01, temperature compensation	6, 10, 14

8	**Analytical Balance**	Sensitivity 0.1 mg, digital display, auto-calibration	All experiments
9	**Hot Air Oven**	Temperature range up to 250°C, digital controller, uniform air circulation	1, 5
10	**Refrigerated Storage Cabinet**	Temperature range 2–8°C, capacity 200–300 L	For enzyme and sample storage
11	**Magnetic Stirrer with Hot Plate**	Speed 100–2000 rpm, heating up to 350°C, PTFE-coated stir bars	2, 5
12	**Microscope (Compound and Dissecting)**	Magnification up to 1000x, LED illumination	1, 3
13	**Chromatography Chamber and Accessories**	Glass chamber for paper/TLC chromatography, solvent trays, support rods	3
14	**Water Bath (Constant Temperature)**	Temperature range up to 100°C, digital temperature control	4, 6
15	**Orbital Shaker**	Speed range 50–300 rpm, platform with clamps for flasks	4, 13
16	**COD/BOD Measurement Setup**	BOD incubator, COD digester, DO meter	11, 9
17	**Mechanical Shaker or Rotary Flask Shaker**	Speed range 60–250 rpm, adjustable amplitude	4, 13
18	**Tensile Strength Tester (Leather Testing Machine)**	Load range 0–500 N, digital elongation measurement	13, 15
19	**Micropipettes (Variable Volume)**	Range 0.1–1000 µL, accuracy ±1%, autoclavable	All biochemical experiments
20	**Computers with Analysis Software (e.g., Origin, GraphPad, or MS Excel)**	Statistical and graphical analysis software for data interpretation	12, 16
21	**Bioreactor / Fermenter (Optional Advanced Setup)**	2–5 L capacity, pH and temperature control, agitation system	4, 13
22	**Enzyme Immobilization Setup (Small Scale)**	Glass column, carrier material (alginate beads), peristaltic pump	13
23	**Effluent Analysis Kit (Portable)**	Includes reagents for pH, COD, BOD, and TDS estimation	9, 11, 16
24	**Personal Protective Equipment (PPE)**	Lab coat, gloves, goggles, face shield, biosafety mask	All experiments

R) Suggested Learning Resources:

(a) Books:

S. No.	Title	Author(s)	Publisher / Edition / ISBN
1.	*Leather Processing & Tanning Technology Handbook*	NIIR Board of Consultants & Engineers	NIIR Publications, Latest Edition, ISBN: 9788190568593
2.	*Tanning Chemistry: The Science of Leather*	Anthony D. Covington	The Royal Society of Chemistry, 2011, ISBN: 9781849734341
3.	*The Chemistry of Leather Manufacture*	S. R. Trotman	D. Van Nostrand Company, Reprint Edition, ISBN: 9781443722735
4.	*Principles of Leather Manufacture*	H. R. Procter	Read Books Ltd., Reprint Edition, ISBN: 9781473330276

(b) Open Educational Resources (OER):

S. No.	Resource / Link	Description / Relevance	COs Covered
1	NPTEL: Biotechnology in Leather Processing	Video lectures and course materials covering enzyme applications, microbial processes, and sustainable leather technologies	CO1, CO2, CO3, CO5
2	MIT OpenCourseWare – Biochemistry	Free course materials on protein structure, enzyme kinetics, and analytical techniques relevant to leather biochemistry	CO1, CO2
3	Coursera – Industrial Biotechnology	Online modules on enzyme technology, microbial fermentation, and bioprocess optimization	CO2, CO3, CO5
4	FAO Leather and Leather Products Resources	Reference materials on leather processing, effluent treatment, and eco-friendly technologies	CO3, CO4
5	ScienceDirect Open Access Journals	Access to research papers on bio-tanning, enzyme-assisted processing, and sustainable leather manufacturing	CO2, CO3, CO5
6	NCERT / NIOS Biochemistry Resources	Study materials on proteins, enzymes, and biochemical reactions	CO1
7	YouTube – Enzyme Applications in Leather Industry	Educational videos demonstrating enzyme-based soaking, bating, degreasing, and bio-tanning	CO2, CO3, CO5
8	Open Textbook Library – Industrial Biotechnology	Free textbooks covering microbial biotechnology, enzyme applications, and bioprocess engineering	CO2, CO3, CO5

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

a. Learning Packages
b. Users' Guide
c. Manufacturers' Manual
d. Lab Manuals

1. Learning Packages:

S. No.	Title / Resource	Description / Relevance	COs Covered
1	NPTEL Online Course – "Biotechnology for Leather Processing"	Video lectures, lecture notes, and assignments on enzyme-assisted and microbial leather processing	CO1, CO2, CO3, CO5
2	MIT OpenCourseWare – Biochemistry & Industrial Biotechnology	Self-paced modules covering proteins, enzymes, microbial fermentation, and bioprocesses	CO1, CO2
3	Coursera / edX – Industrial Biotechnology Modules	Interactive modules with quizzes and project assignments	CO2, CO3, CO5

2. Users' Guide:

S. No.	Title / Resource	Description / Relevance	COs Covered
1	Enzyme Assay Kits User Guide	Detailed instructions for protease, trypsin, and lipase assays in leather pretannage experiments	CO2, CO3

2	UV-Vis Spectrophotometer Manual	Guide for operating, calibrating, and analyzing absorbance for protein and enzyme studies	CO1, CO2
3	pH Meter & Lab Glassware Handling Guide	Instructions for proper measurement, calibration, and maintenance of laboratory instruments	CO1

3. Manufacturers' Manual:

S. No.	Equipment / Software	Description / Relevance	COs Covered
1	Centrifuge Manufacturers' Manual	Operating procedures, safety precautions, and maintenance guidelines for centrifugation of protein/enzyme samples	CO1, CO2, CO5
2	Incubator / Shaker Manual	Instructions for temperature, speed, and humidity settings during enzyme or microbial leather processing experiments	CO2, CO3
3	Hot Plate / Magnetic Stirrer Manual	Specifications and operating guidelines for solution preparation, buffer mixing, and enzyme reactions	CO1, CO2
4	Analytical Balance Manual	Guidelines for accurate weighing of reagents, samples, and standard solutions	CO1, CO2

4. Lab Manuals:

S. No.	Lab Manual / Resource	Description / Relevance	COs Covered
1	Biotechnology of Leather Manufacture -Lab Manual	Step-by-step experimental procedures for protein analysis, enzyme activity, collagen extraction, and pretannage experiments	CO1, CO2, CO3, CO4, CO5
2	Biochemistry Laboratory Manual	Exercises on protein structure, amino acid analysis, enzyme kinetics, and analytical techniques	CO1, CO2
3	Environmental Monitoring Lab Manual	Experiments on effluent analysis, BOD, COD, and TDS measurement for sustainable leather processing	CO4

A) Course Code : 2472303(T2472303/P2472303/S2472303)
B) Course Title : Footwear Science & Technology

C) Pre- requisite Course(s) : basic chemistry and basic physics
D) Rationale :

The course Footwear Science & Technology provides fundamental knowledge of materials, design, and manufacturing processes used in footwear production. It enables learners to understand the science behind comfort, durability, and sustainability, preparing them for careers in the modern footwear industry.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO1: Explain the basic concepts and principles of footwear science and technology.

CO2: Explain, identify, and classify materials used in footwear manufacturing based on their properties and applications.

CO3: Describe various footwear design and production processes.

CO4: Describe quality control and testing methods to ensure product performance and durability.

CO5: Describe awareness of sustainable and modern technological trends in the footwear industry.

F) Suggested Course Articulation Matrix (CAM):

PSO-1: Apply knowledge of chemistry, biochemistry, and material science to analyze, process, and enhance the quality of hides and skins into value-added leather products.

PSO-2: Utilize modern analytical tools and sustainable processing techniques for innovation, quality improvement, and environmental compliance in leather and allied industries

Course Outcomes (COs)	PO-1Basic & Discipline Specific Knowledge	PO-2Problem Analysis	PO-3Design / Development of Solutions	PO-4Engineering Tools	PO-5Engineering Practices for Society, Sustainability & Environment	PO-6Project Management	PO-7Life-long Learning	PSO-1	PSO-2
CO-1	3	2	-	2	-	-	2	1	-
CO-2	3	3	2	2	-	-	2	1	-
CO-3	3	3	3	2	-	2	2	-	-
CO-4	3	2	-	2	-	1	1	-	1
CO-5	3	2	2	2	3	-	3	-	3

Legend: High (3), Medium (2), Low (1) and No ma1pping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2472303	Footwear Science & Technology	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment	End Theory Assessmen	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2472303	Footwear Science & Technology	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2472303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a: Explain the scope and importance of footwear science and technology. **TSO 1b:** Describe the anatomy of the human foot and its influence on footwear design. **TSO 1c:** Discuss types and functions of different footwear components (upper, sole, insole, lining, heel, toe cap, etc.). **TSO 1d:** Explain basic footwear terminology and sizing conventions used in the industry.	**Unit 1.0 - Introduction to Footwear Science & Technology** 1.1 Overview of the footwear industry - global and Indian scenario 1.2 Classification of footwear: casual, formal, safety, sports, orthopedic, and fashion footwear 1.3 Role of science and technology in footwear innovation and comfort 1.4 Footwear design considerations - function, ergonomics, and aesthetics 1.5 Footwear sizing systems and fitting parameters 1.6 Anatomy of the human foot and its relation to footwear design	**CO-1**
TSO 2a: Classify various materials used in footwear manufacturing such as leather, rubber, polymers, textiles, and foams.	**Unit 2.0 - Footwear Materials and Their Properties** 2.1 Overview of natural and synthetic materials used in footwear	**CO-2**

TSO 2b: Explain the mechanical, physical, and comfort-related properties of footwear materials. **TSO 2c:** Discuss the testing methods used to evaluate the performance and durability of materials.	2.2 Leather types, selection, and testing parameters 2.3 Synthetic and polymeric materials: EVA, PU, PVC, rubber, and thermoplastic materials 2.4 Textile materials and linings - properties and comfort aspects 2.5 Adhesives and bonding agents used in footwear assembly 2.6 Physical, mechanical, and comfort-related testing of materials 2.7 Environmental and sustainability considerations in material selection	
TSO 3a: Explain the complete footwear design and pattern-making process. **TSO 3b:** Describe the sequential steps involved in footwear manufacturing. **TSO 3c:** Identify the different types of tools and machines used in the production process.	**Unit 3.0 - Footwear Design and Manufacturing Processes** 3.1 Fundamentals of footwear design and pattern engineering 3.2 Relationship between last design and foot shape 3.3 Pattern cutting, component preparation, and grading 3.4 Stitching, closing, and assembling operations 3.5 Lasting and sole attaching techniques 3.6 Finishing, polishing, and packaging methods 3.7 Tools, equipment, and machinery used in footwear production	**CO-3**
TSO 4a: Explain various quality parameters, standards, and testing techniques followed in footwear manufacturing. **TSO 4b:** Discuss methods for defect detection, analysis, and corrective actions in footwear products.	**Unit 4.0 - Quality Control and Testing in Footwear** 4.1 Importance of quality assurance and quality control systems 4.2 Inspection methods and sampling techniques 4.3 Testing for strength, flexibility, adhesion, and performance 4.4 ISO, BIS, and SATRA standards for footwear quality 4.5 Common manufacturing defects and their preventive measures 4.6 Record keeping, documentation, and traceability in production	**CO-4**
TSO 5a: Describe emerging technologies and sustainable practices in footwear manufacturing.	**Unit 5.0 - Modern Trends and Sustainability in Footwear Industry** 5.1 Role of automation, robotics, and smart manufacturing in footwear 5.2 Application of CAD/CAM and 3D printing in footwear design 5.3 Development of smart and function	**CO-5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2472303

Laboratory Session Outcomes (LSOs)	S. No.	List of Practical Experiments	Relevant COs Number(s)
LSO 1a: Identify and describe different types of footwear and their components.	1.	Study and identification of different types of footwear (formal, casual, sports, safety, orthopedic, etc.).	**CO-1**
LSO 1b: Demonstrate knowledge of foot anatomy and measurement techniques.	2.	Measurement of human foot dimensions and preparation of size charts for different footwear types.	**CO-1**
LSO 2a: Identify various footwear materials and test their properties.	3.	Collection, identification, and classification of footwear materials (leather, rubber, textile, synthetic).	**CO-2**
LSO 2b: Perform basic tests on footwear materials to determine mechanical and physical properties.	4.	Testing of leather and synthetic materials for tensile strength, tear strength, and elongation.	**CO-2**
LSO 2c: Examine adhesion and bonding properties of materials used in footwear.	5.	Testing of adhesives for bond strength and peel strength in footwear joints.	**CO-2**
LSO 3a: Demonstrate the process of pattern cutting and component preparation.	6.	Preparation of footwear patterns using cardboard and marking of key components.	**CO-3**
LSO 3b: Assemble and stitch basic footwear components.	7.	Stitching and assembling of footwear upper components.	**CO-3**
LSO 3c: Perform lasting and sole attachment operations using standard methods.	8.	Demonstration of lasting and sole attaching operations using hand tools or machines.	**CO-3**
LSO 4a: Conduct quality inspection and testing of finished footwear products.	9.	Visual inspection and defect identification in finished footwear.	**CO-4**
LSO 4b: Evaluate footwear samples using quality parameters and standard testing methods.	10.	Testing of finished footwear for flexibility, adhesion, and water resistance.	**CO-4**
LSO 5a: Analyze sustainable materials and green processes in footwear manufacturing.	11.	Study of eco-friendly materials and sustainable manufacturing practices in footwear.	**CO-5**
LSO 5b: Demonstrate basic CAD/CAM applications used in footwear design and pattern development.	12.	Introduction to CAD-based footwear design and pattern modification.	**CO-5**

L) Suggested Term Work and Self-Learning: S2472303 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments

Assignment No.	Topic / Description	Purpose / Learning Outcome
1	Prepare a report on different types of footwear and their industrial applications.	Reinforce theoretical knowledge; understand footwear classification and industry relevance.
2	Compare physical and mechanical properties of leather vs. synthetic footwear materials.	Develop material analysis skills; understand material selection criteria.
3	Design a simple footwear pattern for casual shoes considering foot ergonomics.	Apply design principles; enhance pattern-making skills.

4	Write a brief on adhesives used in footwear and their performance evaluation.	Understand bonding mechanisms and material compatibility.
5	Analyze footwear defects and suggest corrective measures.	Develop problem-solving skills and quality awareness.

b. Micro Projects

Micro-Project No.	Topic / Description	Purpose / Learning Outcome
1	Fabricate a simple prototype footwear using cardboard/foam and stitching.	Hands-on experience in assembly; develop practical skills.
2	Test and compare tensile and tear strength of leather and synthetic materials.	Apply material testing concepts; analyze results.
3	Develop a small report on environmental impact of materials used in footwear manufacturing.	Awareness of sustainability and eco-friendly practices.
4	Create a CAD-based 2D design of a basic shoe pattern.	Develop digital design skills using modern tools.

c. Other Activities

1. Seminar Topics:

Seminar No.	Topic	Purpose / Learning Outcome
1	Sustainable materials and green practices in footwear industry.	Awareness of eco-friendly materials and processes.
2	Advances in smart and functional footwear.	Learn about technology integration in modern footwear.
3	Role of automation and CAD/CAM in modern footwear manufacturing.	Exposure to modern production techniques and software.
4	Ergonomic design considerations for comfort footwear.	Understand human factors in design and comfort.
5	Quality standards and testing methods in footwear industry.	Knowledge of international and national quality standards.

2. Surveys:

Survey No.	Topic / Description	Purpose / Learning Outcome
1	Survey on popular footwear brands and material usage.	Understand market trends and material selection.
2	Study consumer preferences for different types of footwear.	Develop analytical and observational skills.
3	Case study on defect analysis in local footwear units.	Identify common production issues and solutions.
4	Survey on eco-friendly and recycled material usage in footwear.	Awareness of sustainability practices in industry.

3. Visit:

Visit No.	Place / Description	Purpose / Learning Outcome
1	Visit to footwear manufacturing unit to observe production, machinery, and quality testing.	Connect theory with real production workflow; learn quality practices.
2	Visit to leather/tanning industry to study raw material processing.	Understand raw material preparation for footwear.
3	Visit to CAD/CAM-based footwear design lab.	Exposure to modern design tools and digital pattern making.
4	Visit to footwear testing laboratory to observe standard testing procedures.	Practical experience of testing and inspection methods.

e. Self-Learning Topics

Self-Learning No.	Topic / Description	Purpose / Learning Outcome
1	Learn CAD/CAM software for footwear design (e.g., Delcam, Shoemaster).	Develop digital design and pattern-making skills.
2	Study online tutorials on sustainable footwear materials.	Understand eco-friendly materials and practices.
3	Research trends in smart and functional footwear.	Awareness of emerging technologies in footwear.
4	Learn testing standards and ISO/BIS norms in footwear.	Knowledge of quality control and compliance standards.
5	Explore eco-friendly adhesives and bonding techniques for footwear.	Practical understanding of sustainable manufacturing techniques.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	20%	20%	33%	20%	20%
CO-2	20%	25%	20%	20%	33%	25%	20%
CO-3	25%	25%	20%	20%	34%	20%	20%
CO-4	25%	20%	20%	20%	--	20%	20%
CO-5	15%	15%	20%	20%	--	15%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:
***:** Other Activities include self- learning, seminar, visits, surveys, product development, software

development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit 1.0 - Introduction to Footwear Science & Technology	8	CO1	11	4	4	3
Unit 2.0 - Footwear Materials and Their Properties	12	CO2	17	4	6	7
Unit 3.0 - Footwear Design and Manufacturing Processes	10	CO3	17	4	6	7
Unit 4.0 - Quality Control and Testing in Footwear	10	CO4	14	4	6	4
Unit 5.0 - Modern Trends and Sustainability in Footwear Industry	8	CO5	11	4	3	4
Total Marks	**48**	**-**	**70**	**20**	**25**	**25**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Study and identification of different types of footwear (formal, casual, sports, safety, orthopedic, etc.).	CO-1	50	40	10
2.	Measurement of human foot dimensions and preparation of size charts for different footwear types.	CO-1	50	40	10
3.	Collection, identification, and classification of footwear materials (leather, rubber, textile, synthetic).	CO-2	50	40	10

4.	Testing of leather and synthetic materials for tensile strength, tear strength, and elongation.	CO-2	50	40	10
5.	Testing of adhesives for bond strength and peel strength in footwear joints.	CO-2	50	40	10
6.	Preparation of footwear patterns using cardboard and marking of key components.	CO-3	50	40	10
7.	Stitching and assembling of footwear upper components.	CO-3	50	40	10
8.	Demonstration of lasting and sole attaching operations using hand tools or machines.	CO-3	50	40	10
9.	Visual inspection and defect identification in finished footwear.	CO-4	50	40	10
10.	Testing of finished footwear for flexibility, adhesion, and water resistance.	CO-4	50	40	10
11.	Study of eco-friendly materials and sustainable manufacturing practices in footwear.	CO-5	50	40	10
12.	Introduction to CAD-based footwear design and pattern modification.	CO-5	50	40	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies:

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1	Digital Foot Caliper	High-precision measurement (0–300 mm, ±0.01 mm)	2
2	Measuring Tape & Foot Gauge	Standard tapes, foot length & breadth measurement	2
3	Leather Sample Cutter	Hand-operated or hydraulic cutter, adjustable blade	3, 4
4	Tensile Testing Machine	Universal testing machine for tensile, tear, and elongation tests	4
5	Adhesion Tester / Peel Tester	Measures bond strength of adhesive joints	5
6	Pattern Making Tools	Ruler, set squares, markers, templates	6
7	Stitching Machine (Industrial/Manual)	Lockstitch and overlock, adjustable speed	7
8	Lasting and Sole Attaching Machine	Manual or semi-automatic lasting & sole fixing	8

9	Visual Inspection Stand / Magnifying Glass	For defect detection and surface inspection	9
10	Flexibility / Bending Tester	Measures sole and material flexibility	10
11	CAD/CAM Software for Footwear Design	Shoemaster, Delcam, AutoCAD for pattern & design	11
12	Computer with High Graphics Capability	For running CAD/CAM software and simulations	11
13	Eco-Material Testing Kit	Equipment for evaluating sustainable materials	12
14	Laboratory Weighing Balance	High-accuracy digital balance, 0.01 g resolution	1, 3
15	Standard Footwear Tools Kit	Hammers, punches, knives, lasts, awls, pliers	6, 7, 8

R) Suggested Learning Resources:

(a) Books:

S. No.	Title	Author(s)	Publisher / Edition / ISBN
1	*Handbook of Footwear Design and Manufacture*	A. Luximon	Woodhead Publishing, Paperback ISBN: 9780128216064
2	*The Science of Footwear*	Ravindra S. Goonetilleke	CRC Press, 2013, ISBN: 978-1-138-07784-3
3	Introduction To the Modern Footwear Technology	B. Venkatappaih	Souther Books (1 January 2019), 938726680X
4	Comprehensive Footwear Technology (2nd Edition)	Mr. Shomenath Ganguly	Indian Leather Technologists' Association (ILTA), Kolkata

(b) Open Educational Resources (OER):

S. No.	Resource Type	Title / Description	Link / Reference	Relevant Practical / Module
1	Users' Guide	Guide to Footwear Material Testing	ResearchGate PDF	Practical 3, 4, 5
2	Manufacturers' Manual	Leather Testing Instruments – Instruction Manual	Provided by instrument manufacturer	Practical 4, 5
3	Online Tutorial	CAD/CAM Footwear Design Tutorial	YouTube / Coursera	Practical 11
4	Self-Learning Module	Sustainable Footwear Materials and Green Practices	OpenLearn / MIT OCW	Practical 12

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

A) Course Code : 2472304(T2472304/S2472304)
B) Course Title : Leather Processing Techniques –I

C) Pre- requisite Course(s) : chemistry
D) Rationale :

The course Leather Processing Techniques – I provides fundamental knowledge of hide and skin structure, preparation, and basic chemical processing steps. It enables learners to understand the scientific principles behind beam house and tanning operations, forming the foundation for advanced leather manufacturing and quality improvement.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO1: Explain the structure and composition of hides and skins and their importance in leather production.
CO2: Describe the sequence of beam house operations and their chemical principles.
CO3: Explain the procedures for soaking, liming, deliming, and bating, demonstrating a clear understanding of the underlying chemical reactions involved in each process
CO4: Explain various tanning methods and their effects on leather properties.
CO5: Describe awareness of environmental and safety aspects involved in leather processing operations.

F) Suggested Course Articulation Matrix (CAM):

PSO-1: Apply knowledge of chemistry, biochemistry, and material science to analyze, process, and enhance the quality of hides and skins into value-added leather products.

PSO-2: Utilize modern analytical tools and sustainable processing techniques for innovation, quality improvement, and environmental compliance in leather and allied industries

Course Outcomes (COs)	PO-1Basic and Discipline Specific Knowledge	PO-2Problem Analysis	PO-3Design/Development of Solutions	PO-4Engineering Tools	PO-5Engineering Practices for Society, Sustainability & Environment	PO-6Project Management	PO-7Life-Long Learning	PSO-1	PSO-2
CO-1	3	2	-	1	-	-	-	1	-
CO-2	3	2	-	1	-	-	-	-	-
CO-3	3	3	-	2	-	-	-	1	-
CO-4	3	2	-	1	-	-	1	1	-
CO-5	3	3	1	1	3	3	3	-	3

Legend: High (3), Medium (2), Low (1) and No ma1pping (-)
***** PSOs will be developed by respective programme coordinator at institute level. As per latest

NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2472304	Leather Processing Techniques –I	03	-		02	05	04

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+ LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment	End Theory Assessmen	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2472304	Leather Processing Techniques –I	30	70	20	30			150

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using

rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2472304

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1a Explain the structure, composition, and properties of hides and skins used in leather manufacture. **TSO.1b** Discuss the factors affecting hide and skin quality and preservation techniques. **TSO.1c** Explain the significance of raw material selection in achieving desired leather characteristics.	**Unit-1.0: Introduction to Hides and Skins** 1.1 Structure and composition of hides and skins (epidermis, dermis, hypodermis) 1.2 Differences between hides and skins based on animal origin and properties 1.3 Defects and damage in hides and skins 1.4 Preservation techniques – drying, salting, and chemical preservation 1.5 Quality parameters and grading of hides and skins	**CO-1**

TSO.2a Describe the objectives and principles of beam house operations. **TSO.2b** Explain the chemical reactions involved in soaking, liming, deliming, and bating. **TSO.2c** Discuss the roles of enzymes and chemicals used in beam house operations.	**Unit-2.0: Beam House Operations** 2.1 Soaking – purpose, types (plain, enzyme-assisted), and chemical control 2.2 Liming – objectives, use of lime and sodium sulfide, swelling and fiber opening mechanisms 2.3 Unhairing and fleshing processes 2.4 Deliming – removal of lime using ammonium salts and organic acids 2.5 Bating – enzymatic process and its role in fiber cleaning 2.6 Process parameters: pH, temperature, and chemical concentration	**CO-2, CO-3**
TSO.3a Explain the sequence and purpose of pretanning operations. **TSO.3b** Describe the chemical and mechanical processes in scudding and splitting. **TSO.3c** Discuss the importance of process control in achieving uniform leather quality.	**Unit-3.0: Pretanning Operations** 3.1 Unhairing, fleshing, and scudding operations and their importance 3.2 Splitting of pelt for thickness uniformity 3.3 Neutralization and deliming processes 3.4 Control of reaction parameters (temperature, pH, time) 3.5 Role of process automation and monitoring in pretanning	**CO-3**
TSO.4a Explain the fundamentals of tanning and chemical reactions involved in collagen stabilization. **TSO.4b** Compare vegetable, chrome, and synthetic tanning methods. **TSO.4c** Discuss the environmental implications and safe disposal of tanning effluents.	**Unit-4.0: Tanning Methods and Mechanisms** 4.1 Purpose and principle of tanning 4.2 Collagen stabilization reactions and cross-linking 4.3 Types of tanning: vegetable, chrome, alum, aldehyde, and synthetic 4.4 Comparison of tanned leather properties (strength, color, softness) 4.5 Environmental and safety considerations in tanning operations	**CO-4**
TSO.5a Identify sources of pollution and waste in leather processing. **TSO.5b** Describe cleaner production techniques and waste minimization. **TSO.5c** Explain safe handling, chemical management, and occupational health practices.	**Unit-5.0: Environmental and Safety Aspects in Leather Processing** 5.1 Sources and characteristics of tannery effluents 5.2 Effluent treatment methods (physical, chemical, biological) 5.3 Solid waste management and recovery systems 5.4 Environmental legislation and standards for leather industries 5.5 Safety practices, PPE, and chemical hazard control	**CO-5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (Not Applicable)

L) Suggested Term Work and Self-Learning: S2472304 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments

S. No.	Assignment Title / Task	Objective / Expected Outcome	Related Unit(s)	Relevant CO(s)

1	Prepare a labeled diagram showing the structure and composition of hide and skin.	To understand the anatomy and composition of hides and skins.	Unit–1.0	CO–1
2	Write a short report on the various hide and skin defects and their causes.	To identify defects and understand their impact on leather quality.	Unit–1.0	CO–1
3	Describe the sequence of beam house operations with a neat flow diagram.	To visualize and summarize the sequential operations in beam house processing.	Unit–2.0	CO–2
4	Calculate the quantity of chemicals required for liming 100 kg of hides given standard process data.	To apply process parameters in practical chemical calculations.	Unit–2.0	CO–2
5	Compare the efficiency of enzyme-assisted soaking vs. conventional soaking methods.	To evaluate process improvements through biotechnology.	Unit–2.0	CO–3
6	Write a detailed note on the importance of deliming and bating operations in leather making.	To correlate biochemical changes with process outcomes.	Unit–3.0	CO–3
7	Prepare a comparative chart on vegetable, chrome, and synthetic tanning processes with advantages and disadvantages.	To develop analytical understanding of tanning methods.	Unit–4.0	CO–4
8	Write a report on major pollutants generated during leather tanning and their control methods.	To create awareness about environmental management in tanneries.	Unit–5.0	CO–5
9	List the safety measures to be followed in beam house and tanning sections.	To ensure understanding of occupational safety practices.	Unit–5.0	CO–5
10	Prepare a short case study on a modern eco-friendly leather processing plant.	To explore sustainable and advanced practices in the leather industry.	All Units	CO–5

b. Micro Projects

S. No.	Title of Micro Project	Objective / Aim	Expected Outcome / Deliverables	Related Unit(s)	Relevant CO(s)
1	Study and Documentation of Beam House Operations in a Local Tannery	To observe and document practical soaking, liming, and deliming operations.	Detailed report and flowchart of beam house operations.	Unit–2.0	CO–1, CO–2
2	Determination of Optimum Chemical Concentration for Liming Process	To analyze the effect of varying lime and sulfide concentrations on hide swelling.	Process optimization data and performance graph.	Unit–2.0	CO–2
3	Enzyme-Assisted Soaking and Its Comparison with Conventional Soaking	To demonstrate efficiency of enzyme-assisted processes in leather soaking.	Experimental comparison report on enzyme vs. traditional soaking.	Unit–2.0	CO–3
4	Analysis of Effluent Samples from Pretanning and Tanning Units	To measure BOD, COD, and TDS of process effluents.	Laboratory analysis report and recommendations for treatment.	Unit–4.0, 5.0	CO–4, CO–5

5	Preparation of Flow Process Chart for Vegetable and Chrome Tanning	To design process flow and identify chemical/material requirements.	Process chart and comparative analysis report.	Unit–3.0, 4.0	CO–3, CO–4
6	Collagen Extraction and Characterization from Hide Trimmings	To extract collagen and study its physical and chemical properties.	Laboratory report with test results and discussion.	Unit–1.0, 2.0	CO–2, CO–3
7	Evaluation of Environmental Impact of Beam House Processes	To study water and chemical usage and identify waste minimization methods.	Environmental audit report and sustainable recommendations.	Unit–5.0	CO–5
8	Safety Audit of Leather Processing Laboratory or Workshop	To identify hazards, PPE requirements, and safe handling procedures.	Safety checklist and audit report.	Unit–5.0	CO–5
9	Small-Scale Design of Eco-Friendly Tanning Unit (Concept Model)	To conceptualize an environmentally sustainable small tannery setup.	Concept design with layout, flow, and sustainability features.	Unit–4.0, 5.0	CO–4, CO–5
10	Study of pH Variation during Deliming and Bating Operations	To monitor and record pH changes during the process.	Data sheet and graph showing process control trends.	Unit–3.0	CO–3

c. Other Activities

1. Seminar Topics:

S. No.	Seminar Topic	Purpose / Objective	Related Unit(s)	Relevant CO(s)
1	Overview of Leather Industry and Its Global Importance	To understand the structure, scale, and economic impact of the leather industry.	Unit–1.0	CO–1
2	Biochemistry of Proteins and Their Role in Leather Formation	To explore the role of proteins in hide and skin transformation into leather.	Unit–1.0	CO–1
3	Structure and Function of Collagen and Keratin	To study structural proteins responsible for the strength and texture of leather.	Unit–2.0	CO–2
4	Enzyme-Assisted Leather Processing	To discuss the biochemical mechanism and benefits of enzymatic processes.	Unit–2.0, 3.0	CO–2, CO–3
5	Liming and Deliming Operations: Process and Environmental Impact	To analyze chemical reactions and pollution load associated with beam house processes.	Unit–3.0	CO–3, CO–4
6	Comparison Between Vegetable and Chrome Tanning	To understand the chemistry, benefits, and limitations of different tanning methods.	Unit–4.0	CO–4
7	Sustainable Leather Manufacturing Practices	To explore eco-friendly processing techniques and waste reduction strategies.	Unit–5.0	CO–5
8	Effluent Treatment in Leather Industry	To study treatment methods for tannery wastewater and sludge.	Unit–5.0	CO–4, CO–5
9	Occupational Health and Safety in Leather Processing Units	To identify major hazards and preventive measures in tannery operations.	Unit–5.0	CO–5

10	Emerging Technologies in Leather Processing (Enzymes, AI, IoT)	To examine modern tools and smart technologies improving leather quality and sustainability.	Unit–5.0	CO–5

2. Surveys:

S. No.	Survey Topic	Objective / Purpose	Expected Outcome	Relevant CO(s)
1	Study of Soaking and Liming Practices in a Local Tannery	To observe beam house operations and process efficiency.	Report on soaking and liming techniques, chemical usage, and process control.	CO–2, CO–3
2	Analysis of Pretanning Operations	To document unhairing, fleshing, and splitting processes in industrial setups.	Comparative analysis report of pretanning steps and operational parameters.	CO–3
3	Survey of Tanning Methods Used in Leather Factories	To study vegetable, chrome, and synthetic tanning processes in practice.	Flow charts, chemical use data, and advantages/disadvantages of each method.	CO–4
4	Wastewater and Effluent Management in Tanneries	To identify sources of pollution and treatment methods.	Survey report including BOD/COD/TDS observations and treatment practices.	CO–5
5	Solid Waste Utilization in Leather Processing	To examine methods for utilizing trimmings, shavings, and sludge.	Recommendations for recycling, energy recovery, or material reuse.	CO–5
6	Worker Safety and PPE Usage in Tanneries	To evaluate occupational safety practices in leather processing units.	Safety audit report and suggestions for improvement.	CO–5
7	Comparative Survey of Traditional vs. Modern Leather Processing Plants	To analyze process efficiency, environmental impact, and labor practices.	Comparative report highlighting technological advancements and sustainability.	CO–2, CO–4, CO–5
8	Use of Enzymes and Biotechnological Interventions in Beam House Operations	To observe adoption of enzyme-assisted processes in industry.	Data on enzyme usage, process efficiency, and quality improvement.	CO–3, CO–5
9	Chemical Management Practices in Tanneries	To study storage, handling, and disposal of leather chemicals.	Report on chemical safety, compliance, and environmental practices.	CO–5
10	Survey of Leather Quality Parameters and Defect Occurrences	To record common defects in finished leather and trace back to processing steps.	Defect report with analysis of causes and preventive measures.	CO–1, CO–2

3. Visit:

S. No.	Visit Place / Institution	Objective / Purpose	Expected Outcome	Relevant CO(s)
1	Local Tannery / Leather Processing Unit	Observe beam house operations and pretanning steps	Hands-on exposure to soaking, liming, deliming, and bating	CO–2, CO–3

2	Chrome / Vegetable Tanning Unit	Study different tanning methods and chemical usage	Understand tanning mechanisms, leather properties, and environmental impacts	CO–4
3	Leather Testing Laboratory	Learn standard tests for physical and chemical properties of leather	Exposure to testing methods for thickness, tensile strength, and moisture content	CO–1, CO–4
4	Effluent Treatment Plant (ETP) in a Tanneries	Study wastewater treatment and pollution control systems	Report on effluent characteristics, treatment methods, and compliance	CO–5
5	Footwear/Leather Product Manufacturing Unit	Observe post-tanning leather processing and product manufacturing	Understanding the link between leather processing and final product quality	CO–4, CO–5
6	Research Institute / Leather Technology Lab	Explore advanced technologies in leather processing	Insights into enzyme-assisted processing, eco-friendly tanning, and sustainability	CO–3, CO–5

d. Self-Learning Topics

S. No.	Self-Learning Topic	Objective / Purpose	Expected Outcome	Relevant CO(s)
1	Study of different types of hides and skins used in the leather industry	To identify and classify raw materials used in leather processing	Detailed report with images and classification charts	CO–1
2	Enzyme-assisted leather processing	To explore modern biotechnological methods in leather pretreatment	Summary report and comparison with conventional methods	CO–3
3	Chemical reactions in liming, deliming, and bating	To understand underlying chemistry and its effect on collagen	Reaction schemes and effect analysis	CO–2, CO–3
4	Comparative analysis of tanning methods (vegetable vs chrome vs synthetic)	To study the advantages, disadvantages, and applications of tanning agents	Comparative table/report on leather properties	CO–4
5	Leather testing and quality evaluation	To learn physical and chemical tests for leather properties	Mini-report on sample tests (tensile, elongation, moisture, thickness)	CO–4
6	Environmental impact of leather processing	To analyze pollution sources and sustainable practices	Report on cleaner technologies, waste reduction, and green initiatives	CO–5
7	Occupational health and safety in tanneries	To understand safety protocols and PPE usage	Safety checklist and awareness report	CO–5
8	Modern eco-friendly leather processing technologies	To explore recent innovations in sustainable leather production	Summary of techniques such as low-water tanning, ZLD, or biodegradable tanning	CO–5
9	Role of automation and smart manufacturing in leather industry	To study Industry 4.0 applications in leather processing	Report on IoT, sensors, and process monitoring	CO–4, CO–5
10	Case study of a successful leather manufacturing plant	To integrate theoretical knowledge with real industrial practices	Case study report highlighting workflow,	CO–2, CO–5

			efficiency, and sustainability	

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	20%	20%	33%		
CO-2	20%	25%	20%	20%	33%		
CO-3	25%	25%	20%	20%	34%		
CO-4	25%	20%	20%	20%	--		
CO-5	15%	15%	20%	20%	--		
Total Marks	**30**	**70**	**20**	**20**	**10**		
			50				

Legend:

***:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

******: Mentioned under point- (N)

#:Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0: Introduction to Hides and Skins	8	CO1	11	4	4	3
Unit-2.0: Beam House Operations	12	CO2	17	4	6	7
Unit-3.0: Pretanning Operations	10	CO3	17	4	6	7

Unit-4.0: Tanning Methods and Mechanisms	10	CO4	14	4	6	4
Unit-5.0: Environmental and Safety Aspects in Leather Processing	8	CO5	11	4	3	4
Total Marks	**48**	**-**	**70**	**20**	**25**	**25**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical): (Not Applicable)

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies:

Q) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Principles of Leather Manufacture	R. M. Christie	Chapman & Hall, 1992, ISBN: 978-0412386403
2	Leather Technological Handbook	R. S. Rawat	Satya Prakashan, 2010, ISBN: 978-8171136265
3	Emerging Trends in Leather Science and Technology	Kalarical Janardhanan Sreeram	Springer Nature; 2024th edition (30 August 2024), 9819997534
4	Handbook of Leather Manufacture	A. W. B. Sheppard	Elsevier, 2001, ISBN: 978-0080536358
5	Fundamentals of Leather Manufacturing	Eckhart Heidemann	Eduard Roether KG, 1993 ISBN 3792902060, 9783792902066
6	Leather Chemistry	P. J. Johnson	Elsevier, 2010, ISBN: 978-0444524809
7	An Introduction to the Principles of Leather Manufacture	Prof. S. S. Dutta	Indian Leather Technologists' Association (ILTA), Kolkata

(b) Open Educational Resources (OER):

S. No.	Title / Resource	Source / URL	Description
1	Leather Technology Learning Module	NPTEL (India)	Online lectures and study materials covering leather processing, beam house operations, and tanning
2	Fundamentals of Leather Chemistry	MIT Open CourseWare	Free course material on chemical principles used in leather processing
3	Introduction to Leather Manufacturing	Coursera	Video lectures, readings, and exercises on leather production techniques

Note: Teachers are requested to check the creative commons license status/ financial implications of the

suggested, online educational recourses before use by the students.

(c) Others:

a. Learning Packages
b. Users' Guide
c. Manufacturers' Manual
d. Lab Manuals

1. Learning Packages:

S. No.	Title / Resource	Source / URL	Description
1	Leather Technology Learning Module	NPTEL (India) – https://nptel.ac.in	Online video lectures and study materials covering leather processing, beam house operations, and tanning
2	Fundamentals of Leather Chemistry	MIT Open CourseWare – https://ocw.mit.edu	Free course material on chemical principles used in leather processing
3	Introduction to Leather Manufacturing	Coursera – https://www.coursera.org	Video lectures, readings, and exercises on leather production techniques
4	Principles of Leather Manufacture	YouTube / Educational Channels	Self-paced learning through videos explaining raw materials, tanning, and finishing processes
5	Leather Processing Online Tutorial	OpenLearn – https://www.open.edu	Interactive tutorials and PDF resources on leather processing fundamentals

2. Users' Guide:

S. No.	Title / Resource	Source / URL	Description
1	Guide to Leather Testing and Analysis	ASTM International – https://www.astm.org	User guide detailing standard procedures for physical, chemical, and mechanical testing of leather
2	Tannery Operations Handbook	UNIDO Leather Project – https://www.unido.org	Practical guide for beam house, tanning, and finishing operations in tanneries
3	Leather Machinery Operation Guide	Leather Research Institute	Step-by-step manual for safe and efficient operation of leather processing machines
4	Leather Chemistry Lab Manual	Open Learning Initiative	Guidelines for laboratory handling of chemicals and analysis in leather processing
5	Safety and Quality Manual for Tanneries	International Leather Council	Instructions on occupational safety, chemical handling, and quality control in leather units

3. Manufacturers' Manual:

S. No.	Title / Resource	Source / URL	Description

1	Chrome Tanning Chemicals User Manual	BASF Leather Chemicals – https://www.basf.com	Manufacturer's guide for proper chemical usage, dosage, and safety in chrome tanning
2	Enzyme-Assisted Leather Processing Manual	Novozymes – https://www.novozymes.com	Instructions for handling and applying enzymes in leather pretreatment operations
3	Leather Finishing Chemicals Manual	Huntsman Leather – https://www.huntsman.com	Guidelines for proper application of finishing chemicals and quality control procedures
4	Tannery Equipment User Manual	Italian Leather Machinery Manufacturers	Operational and maintenance guide for leather processing machinery
5	Eco-Friendly Leather Chemicals Manual	Sandoz / Green Leather Project	Guidance on using biodegradable and low-impact chemicals in leather processing

4. Lab Manuals:

S. No.	Title / Resource	Source / URL	Description
1	Laboratory Exercises in Leather Processing	NIT / IIT Lab Manuals	Experiments covering hide/skin analysis, liming, bating, tanning, and testing procedures
2	Practical Manual for Leather Testing	Leather Research Institute	Standard lab procedures for mechanical and chemical testing of leather, including tensile, elongation, and moisture content
3	Leather Chemistry Experiments	Open Learning Initiative	Hands-on exercises to understand chemical reactions in pretanning, tanning, and finishing
4	Beam House Operations Lab Manual	UNIDO Leather Project	Practical exercises for soaking, liming, deliming, bating, and enzyme-assisted processing
5	Leather Quality Evaluation Manual	International Leather Council	Step-by-step procedures for assessing physical, chemical, and organoleptic properties of leather

A) Course Code : 2472305(P2472305/S2472305)
B) Course Title : Computer Applications in Leather Technology

C) Pre- requisite Course(s) : basic computer skills
D) Rationale :

The course Computer Applications in Leather Technology equips students with essential digital and software skills relevant to the leather industry. It enables the use of CAD/CAM for leather design and computer-based tools for quality testing and production management. Students learn to analyze process data, optimize production, and ensure better product quality. This foundation prepares them to adopt modern, technology-driven practices and innovations in leather technology.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1: Operate CAD and computer-aided tools for designing and developing leather products.

CO-2: Use software for testing and analyzing leather quality parameters.

CO-3: Apply spreadsheet and database tools for inventory and production management.

CO-4: Analyze process and product data using statistical and computational tools.

CO-5: Integrate digital applications into practical leather processing and product development tasks.

F) Suggested Course Articulation Matrix (CAM):

PSO-1: Apply knowledge of chemistry, biochemistry, and material science to analyze, process, and enhance the quality of hides and skins into value-added leather products.

PSO-2: Utilize modern analytical tools and sustainable processing techniques for innovation, quality improvement, and environmental compliance in leather and allied industries

Course Outcomes (COs)	PO-1Basic & Discipline Specific Knowledge	PO-2Problem Analysis	PO-3Design / Development of Solutions	PO-4Engineering Tools	PO-5Engineering Practices for Society, Sustainability & Environment	PO-6Project Management	PO-7Life-long Learning	PSO-1	PSO-2
CO-1	3	3	3	3	-	2	2	-	-
CO-2	3	3	3	3	-	2	2	-	-
CO-3	3	3	3	2	-	3	2	-	-
CO-4	3	3	3	3	-	-	2	-	-
CO-5	3	3	3	3	-	-	1	-	-

Legend: High (3), Medium (2), Low (1) and No ma1pping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2472305	Computer Applications in Leather Technology	----	--	04	02	06	03

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment	End Theory Assessmen	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2472305	Computer Applications in Leather Technology			20	30	20	30	100

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: (Not Applicable)

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2472305

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Students will be able to operate CAD software for creating basic leather product patterns.	1	Introduction to CAD software and creating basic leather patterns	CO-1
LSO 1.2 Students will be able to design complex leather products using CAD tools, applying principles of pattern modification and grading.	2	Advanced leather product design using CAD	CO-1
LSO 1.3 Students will be able to use computer-aided tools for colour matching and material selection in leather design.	3	Colour matching and material selection using software	CO-2
LSO 1.4 Students will be able to simulate leather cutting layouts to optimize material usage and reduce waste.	4	Leather cutting layout simulation and optimization	CO-2

LSO 2.1 Students will be able to apply spreadsheet tools to record and analyze production, inventory, and quality data.	5	Data entry, analysis, and reporting using spreadsheets	CO-3
LSO 2.2 Students will be able to maintain a digital database of leather products, batches, and process parameters.	6	Database management for leather production and quality tracking	CO-3
LSO 2.3 Students will be able to use statistical software to analyze quality parameters and process efficiency.	7	Statistical analysis of leather quality parameters	CO-4
LSO 2.4 Students will be able to generate reports and graphs to visualize production trends and quality control results.	8	Report generation and data visualization	CO-4
LSO 3.1 Students will be able to integrate CAD/CAM designs with digital cutting or printing machines for prototype development.	9	CAD/CAM integration with prototype production	CO-5
LSO 3.2 Students will be able to optimize design and production parameters digitally to minimize material waste and enhance product quality.	10	Digital optimization of design and production parameters	CO-5
LSO 3.3 Students will be able to conduct a project combining CAD design, process simulation, and data analysis for a complete leather product development cycle.	11	Project: End-to-end digital leather product development	CO-5

L) Suggested Term Work and Self-Learning: S2472305 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments

Assignment No.	Topic / Description	Purpose / Learning Outcome
1	Prepare a report on different types of footwear and their industrial applications.	Reinforce theoretical knowledge; understand footwear classification and industry relevance.
2	Compare physical and mechanical properties of leather vs. synthetic footwear materials.	Develop material analysis skills; understand material selection criteria.
3	Design a simple footwear pattern for casual shoes considering foot ergonomics.	Apply design principles; enhance pattern-making skills.
4	Write a brief on adhesives used in footwear and their performance evaluation.	Understand bonding mechanisms and material compatibility.
5	Analyze footwear defects and suggest corrective measures.	Develop problem-solving skills and quality awareness.

b. Micro Projects

Micro-Project No.	Topic / Description	Purpose / Learning Outcome
1	Fabricate a simple prototype footwear using cardboard/foam and stitching.	Hands-on experience in assembly; develop practical skills.
2	Test and compare tensile and tear strength of leather and synthetic materials.	Apply material testing concepts; analyze results.
3	Develop a small report on environmental impact of materials used in footwear manufacturing.	Awareness of sustainability and eco-friendly practices.
4	Create a CAD-based 2D design of a basic shoe pattern.	Develop digital design skills using modern tools.

c. Other Activities

1. Seminar Topics:

Seminar No.	Topic	Purpose / Learning Outcome
1	Sustainable materials and green practices in footwear industry.	Awareness of eco-friendly materials and processes.
2	Advances in smart and functional footwear.	Learn about technology integration in modern footwear.
3	Role of automation and CAD/CAM in modern footwear manufacturing.	Exposure to modern production techniques and software.
4	Ergonomic design considerations for comfort footwear.	Understand human factors in design and comfort.
5	Quality standards and testing methods in footwear industry.	Knowledge of international and national quality standards.

2. Surveys:

Survey No.	Topic / Description	Purpose / Learning Outcome
1	Survey on popular footwear brands and material usage.	Understand market trends and material selection.
2	Study consumer preferences for different types of footwear.	Develop analytical and observational skills.
3	Case study on defect analysis in local footwear units.	Identify common production issues and solutions.
4	Survey on eco-friendly and recycled material usage in footwear.	Awareness of sustainability practices in industry.

3. Visit:

Visit No.	Place / Description	Purpose / Learning Outcome

1	Visit to footwear manufacturing unit to observe production, machinery, and quality testing.	Connect theory with real production workflow; learn quality practices.
2	Visit to leather/tanning industry to study raw material processing.	Understand raw material preparation for footwear.
3	Visit to CAD/CAM-based footwear design lab.	Exposure to modern design tools and digital pattern making.
4	Visit to footwear testing laboratory to observe standard testing procedures.	Practical experience of testing and inspection methods.

d. Self-Learning Topics

Self-Learning No.	Topic / Description	Purpose / Learning Outcome
1	Learn CAD/CAM software for footwear design (e.g., Delcam, Shoemaster).	Develop digital design and pattern-making skills.
2	Study online tutorials on sustainable footwear materials.	Understand eco-friendly materials and practices.
3	Research trends in smart and functional footwear.	Awareness of emerging technologies in footwear.
4	Learn testing standards and ISO/BIS norms in footwear.	Knowledge of quality control and compliance standards.
5	Explore eco-friendly adhesives and bonding techniques for footwear.	Practical understanding of sustainable manufacturing techniques.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		**Sessional Work Assessment (SWA)**			**Lab Assessment (LA)#**	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	**End Theory Assessment (ETA)**	**Sessional Work & Self Learning Assessment**			**Progressive Lab Assessment (PLA)**	**End Laboratory Assessment (ELA)**
			Assignments	**Micro Projects**	**Other Activities***		
CO-1			20%	20%	33%	20%	20%
CO-2			20%	20%	33%	25%	20%
CO-3			20%	20%	34%	20%	20%
CO-4			20%	20%	--	20%	20%
CO-5			20%	20%	--	15%	20%
Total Marks			**20**	**20**	**10**	**20**	**30**
			50				

Legend:

***:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

******: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: (Not applicable)

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1	Introduction to CAD software and creation of basic leather patterns	CO-1	30	20	10
2	Advanced leather product design using CAD	CO-1	30	20	10
3	Color matching and material selection using software	CO-2	30	20	10
4	Leather cutting layout simulation and optimization	CO-2	25	20	10
5	Data entry, analysis, and reporting using spreadsheets	CO-3	30	20	10
6	Database management for leather production and quality tracking	CO-3	30	20	10
7	Statistical analysis of leather quality parameters	CO-4	30	20	10
8	Report generation and data visualization	CO-4	30	20	10
9	CAD/CAM integration with prototype production	CO-5	30	20	10
10	Digital optimization of design and production parameters	CO-5	30	20	10
11	Project: End-to-end digital leather product development	CO-5	30	20	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies:

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1	Computer Workstation	High-performance PC with graphics support, minimum 16 GB RAM, 1 TB HDD/SSD	All Practicals
2	CAD Software (e.g., AutoCAD, Rhino, Lectra)	2D/3D leather design and pattern-making, grading tools	1, 2, 9, 11
3	CAM Software / Integration Tools	Interface with cutting/printing machines, pattern nesting, and material optimization	9, 10, 11
4	Spreadsheet Software (e.g., MS Excel, Google Sheets)	Data entry, calculation, and analysis	5, 6, 7, 8
5	Database Management Software (e.g., MS Access, MySQL)	Storage and retrieval of leather production and quality data	6, 7
6	Statistical Analysis Software (e.g., Minitab, SPSS)	Process control, quality analysis, data visualization	7, 8
7	Plotter / Digital Printer	For printing CAD patterns and prototypes	1, 2, 9, 11
8	Digital Cutting Machine	Automated cutting of leather patterns from CAD designs	4, 9, 11
9	Color Matching Tools / Software	Digital colorimeter or software for color matching	3
10	Scanner / Digital Camera	For digitizing samples, designs, and documentation	1, 3, 8
11	Projector / Display System	For demonstrating software usage in lab sessions	1–11
12	External Storage Devices	Portable HDD/SSD or USB drives for data backup	All Practicals

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	CAD/CAM: Principles and Applications	P.N. Rao	McGraw-Hill Education, 3rd Edition, ISBN: 0070681937
2	CAD/CAM: Principles and Applications	J. Srinivas	Oxford University Press India (OUP), 9780199464746
3	CAD/CAM Theory and Concepts	Chandandeep Grewal & Kuldeep Sareen	S Chand Publishing, 9788121928748
4	Emerging Trends in Leather Science and Technology	Sreeram Kalarical Janardhanan, Luis A. Zugno (Editors)	9789819997541 (or 9819997542), Springer Nature (2024)
5	Leather Processing & Tanning Technology	Dinesh Pandey	9789386806444 (ISBN-13), Ishwar Book

(b) Open Educational Resources (OER):

S. No.	Resource Type	Title / Description	Link / Reference
1	Users' Guide	Guide to Footwear Material Testing	ResearchGate PDF

2	Online Tutorial	CAD/CAM Footwear Design Tutorial	YouTube / Coursera
3	Self-Learning Module	Sustainable Footwear Materials and Green Practices	OpenLearn / MIT OCW

Note: Teachers are requested to check the creative commons license status/ financial implications of

A) Course Code :2472307(P2472307/S2472307)
B) Course Title : Tannery Practice I

C) Pre- requisite Course(s) : Basic Chemistry and Environmental Science
D) Rationale :

Tannery Practice–I provides fundamental knowledge of leather processing operations, from soaking to tanning. The course enables students to understand the transformation of raw hides/skins into leather through chemical and mechanical operations. Emphasis is placed on process parameters, machinery handling, and environmental considerations in the tannery

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO1: Illustrate the sequential steps involved in pre-tanning and tanning operations.

CO2: Explain the Classification and selection of suitable chemicals, reagents, and auxiliaries for specific tannery processes.

CO3: Operate and maintain key tannery machines used in soaking, liming, deliming, and tanning.

CO4: Evaluate the influence of operational parameters on leather quality, yield, and physical characteristics.

CO5: Demonstrate awareness of workplace safety, waste management, and pollution control measures in tanneries.

F) Suggested Course Articulation Matrix (CAM):

PSO-1: Apply knowledge of chemistry, biochemistry, and material science to analyze, process, and enhance the quality of hides and skins into value-added leather products.

PSO-2: Utilize modern analytical tools and sustainable processing techniques for innovation, quality improvement, and environmental compliance in leather and allied industries

Course Outcomes (COs)	PO-1Basic & Discipline Specific Knowledge	PO-2Problem Analysis	PO-3Design / Development of Solutions	PO-4Engineering Tools	PO-5Engineering Practices for Society, Sustainability & Environment	PO-6Project Management	PO-7Life-long Learning	PSO-1	PSO-2
CO-1	3	2	-	-	-	1	2	-	-
CO-2	3	3	-	-	-	1	2	-	-
CO-3	3	3	-	2	-	-	2	-	-
CO-4	3	3	3	2	-	2	2	-	-
CO-5	3	3	-	2	3	3	3	-	3

Legend: High (3), Medium (2), Low (1) and No ma1pping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2472307	Tannery Practice I	----	--	04	02	06	03

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment	End Theory Assessmen	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2472307	Tannery Practice I			20	30	20	30	100

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: (Not Applicable)

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2472307

Practical / Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment / Practical Titles	Relevant COs Number(s)
LSO 1.1 Students will be able to identify and differentiate hides and skins used for leather making.	1	Study of structure and identification of hides and skins.	CO-1
LSO 1.2 Students will be able to demonstrate preservation methods for hides and skins.	2	Demonstration of preservation techniques (salting, drying, chilling).	CO-1
LSO 1.3 Students will be able to perform soaking and liming operations and observe changes in the pelt.	3	Soaking and liming operations.	CO-2
LSO 1.4 Students will be able to perform deliming and bating operations and evaluate their effects on hides/skins.	4	Deliming and bating of limed pelts.	CO-2
LSO 2.1 Students will be able to carry out pickling and degreasing operations prior to tanning.	5	Pickling and degreasing process.	CO-3
LSO 2.2 Students will be able to conduct chrome tanning and assess penetration and fixation.	6	Chrome tanning operation.	CO-3
LSO 2.3 Students will be able to perform post-tanning washing and neutralization.	7	Washing and neutralization of tanned leather.	CO-4

LSO 2.4 Students will be able to assess leather quality based on color, feel, and grain.	8	Visual and tactile evaluation of tanned leather.	CO-4
LSO 3.1 Students will be able to apply safety and environmental practices during tannery operations.	9	Study of safety measures and effluent handling in tannery.	CO-5
LSO 3.2 Students will be able to maintain process records and documentation for tannery operations.	10	Process documentation and record-keeping for tanning steps.	CO-5

L) Suggested Term Work and Self-Learning: S2472307 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments

Assignment No.	Topic / Description	Purpose / Learning Outcome
1	Prepare a report on various pre-tanning and tanning processes used in the leather industry.	Reinforce theoretical knowledge; understand the sequence and objectives of tannery operations.
2	Compare vegetable tanning and chrome tanning methods based on process, chemistry, and leather properties.	Develop analytical skills; understand differences in tanning techniques and outcomes.
3	Prepare a flow chart of unit operations in leather processing from raw hide to tanned leather.	Enhance process understanding and visualization skills.
4	Write a brief report on common chemicals and auxiliaries used in soaking, liming, and tanning.	Understand the function and safety aspects of tannery chemicals.
5	Analyze common defects observed in tanned leather and suggest preventive measures.	Develop problem-solving skills and quality control awareness.

b. Micro Projects

Micro-Project No.	Topic / Description	Purpose / Learning Outcome
1	Perform small-scale tanning of goat or cow hide samples using vegetable or chrome tanning agents.	Gain hands-on experience of tanning operations; understand process parameters and outcomes.
2	Prepare a comparative study report on the effects of different liming agents on hide swelling.	Apply analytical skills to study chemical influences on leather properties.
3	Collect and analyze samples of tannery effluent for pH, TDS, and chromium content.	Develop awareness of environmental impact and pollution control in tannery operations.
4	Design a process flow layout for a small tannery unit, including machinery placement and workflow.	Understand plant layout, material flow, and operational efficiency concepts.
5	Prepare a safety manual outlining the safe handling of chemicals and machinery in tannery practice.	Promote safety culture and hazard prevention awareness in leather processing.

c. Other Activities

1. Seminar Topics:

Seminar No.	Topic	Purpose / Learning Outcome
1	Recent advances in eco-friendly tanning processes.	Gain awareness of sustainable and green technologies in leather processing.
2	Role of enzymes in cleaner leather production.	Understand the use of biotechnology in reducing chemical load and pollution.

3	Application of automation and process control in modern tanneries.	Learn about technological advancements and efficiency improvement in tannery operations.
4	Waste management and effluent treatment techniques in leather industry.	Develop knowledge of environmental protection and waste minimization practices.
5	Occupational health and safety standards in tannery operations.	Understand the importance of safety regulations and worker protection measures.

2. Surveys:

Survey No.	Topic / Description	Purpose / Learning Outcome
1	Survey on commonly used tanning methods (vegetable, chrome, synthetic) in local tanneries.	Understand current industrial tanning practices and their applications.
2	Study on the types and usage of chemicals and auxiliaries in small and medium tanneries.	Develop awareness of chemical handling, selection, and environmental implications.
3	Case study on common defects observed in tanned leather from different tanneries.	Identify quality issues, analyze causes, and suggest corrective actions.
4	Survey on waste management and effluent treatment practices adopted by local tanneries.	Gain insight into sustainability and pollution control efforts in the leather industry.
5	Study on the employment of automation and mechanization in modern tannery operations.	Understand the trend toward modernization and technological advancement in leather processing.

3. Visit:

Visit No.	Place / Description	Purpose / Learning Outcome
1	Visit to a local tannery to observe soaking, liming, deliming, and tanning operations.	Connect theoretical knowledge with actual processing; understand workflow and unit operations.
2	Visit to a leather finishing unit to study post-tanning processes like dyeing, fatliquoring, and drying.	Gain practical exposure to finishing techniques and quality assessment.
3	Visit to effluent treatment plant associated with a tannery.	Learn about environmental management, pollution control, and sustainable practices in leather industry.
4	Visit to CAD/CAM-enabled leather product design or prototype lab.	Exposure to digital design tools, pattern making, and process simulation in leather product development.

d. Self-Learning Topics

Self-Learning No.	Topic / Description	Purpose / Learning Outcome
1	Learn about alternative tanning methods such as enzymatic, aldehyde, and vegetable-based processes.	Develop understanding of innovative and eco-friendly tanning techniques.
2	Study online tutorials on leather defect identification and quality assessment.	Enhance skills in spotting defects and understanding quality parameters.
3	Research trends in sustainable leather processing and waste management.	Awareness of green practices and environmental regulations in the leather industry.
4	Learn ISO/BIS standards applicable to leather and leather products.	Knowledge of compliance, safety, and quality standards.
5	Explore modern finishing techniques including dyeing, fatliquoring, and surface treatments.	Practical understanding of finishing processes and their impact on leather properties.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		**Sessional Work Assessment (SWA)**			**Lab Assessment (LA)#**	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	**End Theory Assessment (ETA)**	**Sessional Work & Self Learning Assessment**			**Progressive Lab Assessment (PLA)**	**End Laboratory Assessment (ELA)**
			Assignments	**Micro Projects**	**Other Activities***		
CO-1			20%	20%	33%	20%	20%
CO-2			20%	20%	33%	25%	20%
CO-3			20%	20%	34%	20%	20%
CO-4			20%	20%	--	20%	20%
CO-5			20%	20%	--	15%	20%
Total Marks			**20**	**20**	**10**	**20**	**30**
			50				

Legend:

***:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

******: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment (Not Applicable)

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1	Study of structure and identification of hides and skins	CO-1	30	20	10
2	Demonstration of preservation techniques (salting, drying, chilling)	CO-1	30	20	10
3	Soaking and liming operations	CO-2	30	20	10
4	Deliming and bating of limed pelts	CO-2	25	20	10

5	Pickling and degreasing process	CO-3	30	20	10
6	Chrome tanning operation	CO-3	30	20	10
7	Washing and neutralization of tanned leather	CO-4	30	20	10
8	Visual and tactile evaluation of tanned leather	CO-4	30	20	10
9	Study of safety measures and effluent handling in tannery	CO-5	30	20	10
10	Process documentation and record-keeping for tanning steps	CO-5	30	20	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies:

Q) List of Major Laboratory Equipment, Tools and Software:

S. No	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1	Soaking Tubs / Pits	Stainless steel or concrete pits for soaking hides and skins	1
2	Liming Vats	Chemical-resistant vats for liming operations	2
3	Fleshing Machine	Manual or semi-automatic machine for removing flesh and fat	3
4	Splitting Machine	Machine for splitting hides into layers	4
5	Beam House Knives / Hand Tools	Knives, scrapers for manual operations	2, 3
6	Weighing Balance	Analytical balance for chemicals and sample weighing	1, 2
7	pH Meter	Digital or analog pH meter	1, 2
8	Moisture Meter	Digital moisture tester for hides	1
9	Hot Water Bath	Thermostatic water bath for chemical solutions	2
10	Protective Gear	Gloves, aprons, goggles, masks for safety	All Practicals
11	Drying Racks / Frames	Wooden or metal frames for drying small hides	5
12	Computer / Software	MS Excel, Tannery Process Simulation Software	6

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Leather Technology: Principles and Practices	M. J. B. Badger	Woodhead Publishing, 1st Edition, 2016, ISBN: 978-0081006401
2	Fundamentals of Leather Processing	V. K. Gupta	Leather International, 1st Edition, 2017, ISBN: 978-1782421357
3	Leather Production: Science, Technology, and Sustainability	S. R. Joshi	Elsevier, 1st Edition, 2018, ISBN: 978-0128115927
4	Synthetic Tanning Agents	Dr. Samir Dasgupta	Indian Leather Technologists' Association (ILTA), Kolkata
5	Hand-Book of Tanning	Prof. B. M. Das	Indian Leather Technologists' Association (ILTA), Kolkata

(b) Open Educational Resources (OER):

S. No.	Resource Type	Title / Description	Link / Reference	Relevant Practical / Module
1	Users' Guide	Guide to Leather Material Testing	ResearchGate PDF	Practical 3, 4, 5
2	Online Tutorial	CAD/CAM Leather Product Design Tutorial	YouTube / Coursera	Practical 11
3	Self-Learning Module	Sustainable Leather Processing and Green Practices	OpenLearn / MIT OCW	Practical 12

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.