

Outcome-Based Curriculum

(Sustaining OBE Compliance)

Part A

1. Title of the Academic Program: B.Sc. in Leather Engineering

2. Name of the University: University of Dhaka

3. Vision of the University: To emerge as an institute of eminence in the fields of engineering, technology, business and management in serving the industry and the nation by empowering students with a high degree of technical, managerial and practical competence.

4. Mission of the University

M1: To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a culture of research and innovation among faculty members and students.

M2: To encourage long term interaction between the academia and industry through the involvement of the industry in the design of the curriculum and its hands-on implementation.

M3: To strengthen and mold students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extra-curricular activities.

5. Name of the Program Offering Entity: Institute of Leather Engineering and Technology

6. Vision of the Program Offering Entity

To enable a center of excellence by providing advance educational programs with innovative research, in the field of leather, footwear, leather products and allied sector to produce competent graduates.

7. Mission of the Program Offering Entity

- Provide a contemporary educational approach that integrates high-tech and modern methods, enhancing their learning experience through research conducted locally and internationally.
- Promote industry-academia collaboration for the better understanding and skill development in undergraduate programs in the fields of leather, footwear and leather products.

- To undertake actions to motivate students for life-long learning, students' personal development by fostering ethical and moral values.

8. Objectives of the Program Offering Entity

- To produce competent graduate in the field of leather, footwear and leather products sector;
- To initiate, organize and undertake research in the fields of leather, footwear and leather products engineering;
- To provide industry-oriented training programs in various fields of leather, footwear and leather products engineering;
- To ensure quality control and laboratory facilities for testing raw materials, consumable and finished products;
- To provide facilities for environmental pollution control, chemical management and occupational health and safety compliances;
- To organize seminars, conferences, workshops, exhibitions and other events to disseminate knowledge about state-of-the-art technologies for the relevant fields;
- To establish bridge-programs and research collaborations with various academic, research and industrial organizations both in home and abroad;

9. Name of the Degree: B.Sc. in Leather Engineering

10. Description of the Program

Institute is committed to providing students with the very best education and training opportunities to enable them utilizing their potentials towards the ambitions through B.Sc. in Leather Engineering. The program provides its undergraduate students with the opportunity to participate in industrial training, where they can relate theories, concepts and techniques learned from the academic courses with real-life experiences. At the end of the final year, students are involved in project work, report writing and oral presentation.

B.Sc. in Leather Engineering is a total 160.0 credits program, comprising 93.5 credits of core coursework (including field tour, capstone project, internship and comprehensive viva), 45.5 credits of general education coursework (basic science, mathematics and humanities) and 21.0 credits of allied engineering courses. . With a rationalized course curriculum and advanced tools

and teaching methods, the graduates will attain competency at the global standard and they will perform high level of professional activities.

11. Graduate Attributes: The process of achieving mission and vision of the program is divided into equal contributions, stated from responses given by the key stakeholders like employers and alumni. Employers happen to motivate graduates and know the performance of their traits in some key areas of graduate attributes such as knowledge, problem analysis skills, work skills, communication skills, digital literacy and interpersonal skills. Each of the key graduate attributes is further subdivided into subcategories (as shown in the list below) to provide an in-depth understanding of our graduate’s status in that specific field.

Attribute-1: Knowledge profile
K1: A systematic, theory-based understanding of the natural sciences applicable to the discipline
K2: Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline
K3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
K4: Engineering specialized knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
K5: Engineering knowledge that aids effective practice-area problem-solving.
K6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
K7: Comprehension of the role of engineering in society and of the identified issues in engineering practice in the discipline: ethics and the engineer’s professional responsibility to public safety; the impacts of engineering activity in economic, social, cultural, environmental and sustainability terms
K8: Engagement with selected knowledge in the research literature of the discipline
Attribute-2: Creative and critical thinking, and problem solving

Creative: Able to find new ways to address problems sustainably, answer questions or expressing meaning.
Critical thinking: Able to evaluate and draw conclusions from information, to find sustainable solutions to complex problems and make decisions
Innovation: Involve the creative use of engineering principles and research-based knowledge in novel ways
Attribute-3: Interpersonal skills and digital literacy
Communication: Graduates convey ideas and information effectively to a range of audiences for a variety of purposes and contribute in a positive and collaborative manner to achieving common goals.
Professionalism and leadership: Graduates engage in professional behavior and have the potential to be entrepreneurial and take leadership roles in their chosen occupations or careers and communities.
Collaboration: Able to work effectively with others and in teams, encouraging collaboration and contributing positively.
ICT proficient: Able to use the devices, applications and software commonly used in the discipline and in general use. Stays up-to-date with the latest advancements and effectively utilizing widely used digital tools, programs, and apps within and beyond the industry are essential components for success in the digital age.
Information and digital literacy: Demonstrate a comprehensive understanding of legal, ethical, and security requirements is essential for interpreting, critically analyzing, and accurately representing information in various contexts.
Attribute-4: Ethics and sustainability
Integrity: Acting ethically, honestly and fairly in personal, academic and workplace settings.
Appropriate conduct: Demonstrating appropriate and socially responsible behavior, including academic conduct.
Sustainability: Acquiring the knowledge and skills to promote societal and environmental sustainability.

12. Program Educational Objectives (PEOs)

PEO1: To produce leather engineering graduates equipped with in-depth knowledge of science, engineering and technology and capability of critical analysis.

PEO2: To advance in career paths associated with the leather engineering and technology disciplines, including industrial engineering and environmental engineering and sciences-related opportunities

PEO3: To nurture graduates in adapting to emerging technologies through continued educational and professional development, upholding high ethical and professional standards in the practice of engineering.

PEO4: To engage in life-long learning and stay abreast of the ever-evolving technological landscape related to the leather engineering disciplines.

PEO5: To provide leather engineering graduates with communication proficiency and digital literacy who contribute to the well-being of their organizations and communities

13. Program Learning Outcomes (PLO)

PLO1: Engineering Knowledge (Fundamental)

Able to apply the knowledge of mathematics, science, engineering fundamentals and leather products engineering as specified in K1 to K4 to the solution of complex engineering problems.

PLO2: Problem Analysis (Thinking Skill)

Able to identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the leather products and allied engineering sciences (K1 to K4, K8).

PLO3: Design/development of solutions (Thinking Skill)

Able to design solutions for complex leather products allied engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns (K5).

PLO4: Investigation (Thinking)

Able to conduct investigations of complex problems using research-based knowledge (K8), considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

PLO5: Modern Tool Usage (Fundamental)

Able to create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations (K6).

PLO6: The Engineer and Society (Social)

Able to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice (K7).

PLO7: Environment and Sustainability (Social)

Able to appraise the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development (K7).

PLO8: Ethics (Personal)

Able to practice ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice (K7, C6).

PLO9: Individual Work and Teamwork (Personal)

Able to function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings (C5 and A4).

PLO10: Communication (Social)

Able to communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions (C1 to C6).

PLO11: Project Management and Finance (Personal)

Able to demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments (A1 to A5).

PLO-12: Life-long Learning (Personal)

Able to recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change (C1 to C6 and A3 to A5).

14. Mapping mission of the university with PEOs

	Mission 1	Mission 2	Mission 3
PEO1	✓		✓
PEO2	✓	✓	✓
PEO3	✓	✓	✓
PEO4	✓		✓
PEO5	✓		✓

15. Mapping of PLOs with PEOs

PLOs	PEO1	PEO2	PEO3	PEO4	PEO5
PLO1	✓		✓	✓	
PLO2	✓	✓	✓	✓	
PLO3	✓	✓	✓	✓	
PLO4	✓	✓			✓
PLO5	✓	✓		✓	
PLO6		✓	✓	✓	✓
PLO7	✓	✓			
PLO8	✓	✓	✓		
PLO9		✓	✓		✓
PLO10	✓	✓	✓		✓
PLO11	✓	✓	✓		✓

PLO12	✓	✓	✓	✓	✓
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16. Mapping courses with the PLOs

Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
0723-LE-1101	✓	✓	✓	✓	✓	✓	✓					
0541-Math-1103	✓	✓	✓	✓								
0533-Phy-1105	✓	✓	✓	✓	✓							✓
0531-Chem-1107	✓	✓	✓	✓								
0531-Chem-1109	✓	✓	✓				✓	✓				✓
0531-Chem-1110	✓	✓	✓	✓				✓	✓	✓		✓
0715-ME-1112	✓	✓	✓	✓					✓	✓		✓
0417-Hum-1114					✓	✓			✓	✓	✓	✓
0723-LE-1116	✓	✓			✓				✓	✓		✓
0723-LE-1201	✓	✓	✓	✓		✓	✓					
0723-LE-1202	✓	✓	✓	✓	✓		✓		✓			
0713-EEE-1203	✓	✓				✓	✓					✓
0533-Phy-1204	✓	✓	✓		✓				✓	✓		✓
0541-Math-1205	✓	✓		✓	✓							
0611-CSE 1207	✓	✓	✓	✓	✓	✓				✓		✓
0611-CSE 1208	✓	✓	✓	✓	✓	✓				✓	✓	✓
0531-Chem-1209	✓	✓	✓	✓	✓							✓

0531-Chem-1210	✓	✓	✓		✓			✓	✓	✓		✓
0723-LE-2101	✓	✓	✓	✓	✓							
0723-LE-2102	✓	✓		✓	✓				✓			
0723-LE-2103	✓	✓	✓	✓	✓	✓	✓					
0723-LE-2104	✓	✓		✓	✓				✓	✓		
0723-LE-2105	✓	✓	✓	✓	✓							
0723-LE-2116	✓	✓	✓	✓	✓				✓	✓		
0723-LE-2107	✓	✓	✓									
0723-LE-2108	✓	✓	✓		✓	✓					✓	✓
0541-Math-2109	✓	✓		✓								
0723-LE-2201	✓	✓	✓	✓								
0723-LE-2202	✓	✓	✓		✓	✓	✓		✓			✓
0531-Chem-2203	✓	✓	✓	✓	✓	✓	✓					✓
0531-Chem-2204	✓	✓	✓		✓			✓	✓	✓		✓
0531-Chem-2205	✓	✓		✓	✓		✓					
0531-Chem-2206	✓	✓	✓		✓		✓	✓	✓	✓		✓
0717-ME-2207	✓	✓	✓	✓	✓							✓
0717-ME-2208	✓	✓	✓	✓	✓				✓			✓
0723-LE-2210	✓				✓				✓	✓		✓
0723-LE-3101	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓

0723-LE-3102	✓	✓	✓		✓	✓	✓		✓	✓		
0531-Chem-3103	✓	✓	✓	✓	✓							
0531-Chem-3104	✓	✓	✓	✓	✓	✓	✓			✓		
0723-LE-3105	✓	✓	✓	✓	✓	✓	✓	✓				✓
0717-ME-3107	✓	✓	✓	✓	✓	✓	✓					
0314-Hum-3109	✓	✓		✓		✓		✓	✓	✓		✓
0723-LE-3111	✓	✓	✓	✓	✓							
0723-LE-3112	✓	✓	✓	✓	✓				✓			
0723-LE-3201	✓	✓	✓		✓	✓	✓	✓				✓
0723-LE-3202	✓	✓	✓	✓	✓	✓	✓		✓	✓		
0723-LE-3203	✓	✓	✓	✓								✓
0723-LE-3204	✓	✓	✓	✓	✓				✓			✓
0723-LE-3205	✓	✓	✓	✓	✓				✓	✓		
0723-LE-3206	✓	✓	✓	✓	✓				✓	✓		
0723-LE-3207	✓	✓	✓	✓	✓							
0417-Hum-3208	✓	✓	✓	✓	✓				✓	✓	✓	✓
0542-Math-3209	✓	✓	✓	✓								✓
0723-LE-3210	✓					✓			✓	✓		✓
0723-LE-4101	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
0723-LE-4102	✓	✓	✓	✓	✓	✓	✓		✓	✓		

0723-LE-4104	✓	✓	✓	✓	✓				✓			
0723-LE-4105	✓	✓	✓		✓	✓			✓			✓
0723-LE-4106	✓	✓		✓	✓				✓	✓		✓
0411-Hum-4107	✓	✓	✓	✓	✓						✓	
0723-LE-4109	✓	✓		✓	✓				✓			✓
0723-LE-4110	✓	✓	✓		✓							✓
0723-LE-4111	✓	✓	✓	✓	✓		✓	✓				
0723-LE-4201	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
0723-LE-4202	✓	✓	✓	✓	✓		✓		✓		✓	✓
0723-LE-4203	✓	✓	✓	✓	✓				✓			✓
0723-LE-4205	✓	✓	✓	✓	✓	✓	✓	✓		✓		
0723-LE-4206	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
0723-LE-4208	✓	✓	✓							✓		✓
0723-LE-4210	✓	✓	✓			✓				✓		✓
	70	68	58	52	55	26	24	13	35	28	9	40

Part B

17. Structure of the Curriculum

(a) Duration of the Program: Years: 4, Semesters: 8

(b) Admission Requirements:

DU-Science unit entrance examination requirements

- i. A candidate has to be a recently passed student in HSC in Science group or recognized equivalent examinations.

- ii. Candidates must be obtained at least GPA of 3.50 (scale of 5.00) in both SSC and HSC/ equivalent examinations, and the total GPA should be 8.00 (including additional subjects).
- iii. DU Science unit admission exam will be based on multiple choice question (MCQ) and written exam.
- iv. Other criteria and selection of the candidates for admission shall be decided as per the University admission rules and regulations.

Leather Engineering program requirements

- i. A candidate must pass the DU Science unit entrance examination.
 - ii. A Candidate must be either in the merit or waiting list of the DU Science unit entrance examination announced by DU Science unit admission authority.
 - iii. A candidate has to select the Leather Engineering program in his/her preference list and he/she has to be among the leading candidates preferring this discipline based on their merit position and seat capacity of the discipline in DU.
- (c) Total credit requirement to complete the program: 160.0
- (d) Total class weeks in a semester: 14 weeks
- (e) Minimum CGPA requirements for graduation: 2.50
- (f) Maximum academic years of completion: **6 academic years**
- (g) Category of Courses:

i. General Education Courses: Total 45.5 credits

Theoretical Courses				
Course Code	Course Title	Course Credit	Year	Semester
0541-Math-1103	Algebra and Geometry	3.0	1 st	I
0533-Phy-1105	Engineering Physics	3.0	1 st	I
0531-Chem-1107	Inorganic Chemistry	3.0	1 st	I
0531-Chem-1109	Physical Chemistry	3.0	1 st	I

0541-Math-1205	Calculus	3.0	1 st	II
0531-Chem-1209	Organic Chemistry	3.0	1 st	II
0541-Math-2109	Differential Equation and Numerical Methods	3.0	2 nd	I
0531-Chem-2205	Analytical Chemistry	3.0	2 nd	II
0531-Chem-3103	Instrumental Analysis	3.0	3 rd	I
0314-Hum-3109	Industrial Sociology	2.0	3 rd	I
0542-Math-3209	Probability and Statistics	3.0	3 rd	II
0411-Hum-4107	Cost and Management Accounting	3.0	4 th	I
Lab Courses				
0531-Chem-1110	Inorganic and Physical Chemistry Lab	1.5	1 st	I
0417-Hum-1114	Employability Skills-I	1.5	1 st	I
0533-Phy-1204	Physics and Electronics Lab	1.5	1 st	II
0531-Chem-1210	Organic Chemistry Lab	1.5	1 st	II
0531-Chem-2206	Analytical Chemistry Lab	1.5	2 nd	II
0531-Chem-3104	Chemical Analysis of Leather and Leather Products Lab	1.5	3 rd	I
0417-Hum-3208	Employability Skills-II	1.5	3 rd	II

ii. Core Courses: In Leather Engineering program, ILET, DU would like to divide the core courses further in to 2 sub categories under core course category i.e., Core Engineering Courses, and Allied Engineering Courses

Core Engineering Courses: Total 82.0 credits

Theoretical Courses				
Course Code	Course Title	Course Credit	Year	Semester
0723-LE-1101	Fundamentals of Leather	3.0	1 st	I
0723-LE-1201	Leather Processing-I	3.0	1 st	II
0723-LE-2101	Leather Processing-II	3.0	2 nd	I
0723-LE-2103	Leather Biotechnology	3.0	2 nd	I
0723-LE-2105	Dyeing and Finishing-I	2.0	2 nd	I
0723-LE-2107	Leather Products Manufacturing	3.0	2 nd	I
0723-LE-2201	Leather Processing-III	3.0	2 nd	II
0723-LE-3101	Leather Processing-IV	3.0	3 rd	I
0723-LE-3105	Environmental Science and Engineering	3.0	3 rd	I
0723-LE-3111	Footwear Manufacturing	3.0	3 rd	I
0723-LE-3201	Eco-Friendly Leather Processing	2.0	3 rd	II
0723-LE-3203	Testing of Leather and Allied Materials	3.0	3 rd	II
0723-LE-3205	Dyeing and Finishing-II	2.0	3 rd	II
0723-LE-3207	Supply Chain Management	3.0	3 rd	II
0723-LE-4101	Tannery Wastewater Management	3.0	4 th	I
0723-LE-4105	Industrial Utility and Maintenance	3.0	4 th	I
0723-LE-4109	Total Quality Management	3.0	4 th	I

0723-LE-4111	Leather Processing Chemicals	2.0	4 th	I
0723-LE-4201	Solid Waste Management	3.0	4 th	II
0723-LE-4203	Production Planning and Quality Control	3.0	4 th	II
0723-LE-4205	Green Manufacturing of Leather	2.0	4 th	II
Lab Courses				
0723-LE-1202	Leather Processing-I Lab	1.5	1 st	II
0723-LE-2102	Leather Processing-II Lab	1.5	2 nd	I
0723-LE-2104	Leather Biotechnology Lab	1.5	2 nd	I
0723-LE-2106	Dyeing and Finishing-I Lab	1.5	2 nd	I
0723-LE-2108	Leather Products Manufacturing Lab	1.5	2 nd	I
0723-LE-2202	Leather Processing-III Lab	1.5	2 nd	II
0723-LE-3102	Leather Processing-IV Lab	1.5	3 rd	I
0723-LE-3112	Footwear Manufacturing Lab	1.5	3 rd	I
0723-LE-3202	Eco-Friendly Leather Processing Lab	1.5	3 rd	II
0723-LE-3204	Testing of Leather and Allied Materials Lab	1.5	3 rd	II
0723-LE-3206	Dyeing and Finishing-II Lab	1.5	3 rd	II
0723-LE-4102	Wastewater Treatment Lab	1.5	4 th	I
0723-LE-4104	Computer Aided Design of Leather Products	1.5	4 th	I
0723-LE-4106	Industrial Utility and Maintenance Lab	1.5	4 th	I

0723-LE-4110	Quality Management Lab	1.5	4 th	I
0723-LE-4202	Waste Management Lab	1.5	4 th	II

Allied Engineering Courses: Total 21.0 credits

Theoretical Courses				
Course No	Course Title	Course Credit	Year	Semester
0713-EEE-1203	Fundamentals of Electrical and Electronics Engineering	3.0	1 st	II
0611-CSE 1207	Fundamentals of Computer and Information Technology	3.0	1 st	II
0717-ME-2207	Fundamentals of Mechanical Engineering	3.0	2 nd	II
Chem 2203	Polymer Science and Engineering	3.0	2 nd	II
ME 3107	Materials Science and Engineering	3.0	3 rd	I
Lab Courses				
0715-ME-1112	Engineering Drawing	1.5	1 st	I
0717-ME-2208	Mechanical Workshop Practice	1.5	2 nd	II
0611-CSE 1208	Fundamentals of Computer and Information Technology Lab	1.5	1 st	II
0531-Chem-2204	Polymer Science and Engineering Lab	1.5	2 nd	I

iii. Elective Courses: In B. Sc. Engineering in Leather Engineering program, all of the courses are compulsory course. So, there is no elective/optional course in this program.

iv. Capstone Course/Internship/Field Tour/Project: Total 11.5 credits

Course Code	Course Title	Course Credit	Year	Semester
0723-LE-1116	Field Tour-I	1.0	1 st	I
0723-LE-2210	Field Tour-II	1.0	2 nd	I
0723-LE-3210	Field Tour-III	1.0	3 rd	II
0723-LE-4206	Capstone Project	3.0	4 th	II
0723-LE-4208	Comprehensive Viva	2.5	4 th	II
0723-LE-4210	Internship	3.0	4 th	II

18. Semester wise distribution of courses

Year-1, Semester-I			
Course Code	Course Title	Credit	
		Theoretical	Lab
0723-LE-1101	Fundamentals of Leather	3.0	
0541-Math-1103	Algebra and Geometry	3.0	
0533-Phy-1105	Engineering Physics	3.0	
0531-Chem-1107	Inorganic Chemistry	3.0	
0531-Chem-1109	Physical Chemistry	3.0	
0531-Chem-1110	Inorganic and Physical Chemistry Lab		1.5
0715-ME-1112	Engineering Drawing		1.5
0417-Hum-1114	Employability Skills-I		1.5
0723-LE-1116	Field Tour-I		1.0
	Total	15.0	5.5
	Semester Total	20.5	

Year-1, Semester-II			
Course Code	Course Title	Credit	
		Theoretical	Lab
0723-LE-1201	Leather Processing-I	3.0	
0723-LE-1202	Leather Processing -I Lab		1.5
0713-EEE-1203	Fundamentals of Electrical and Electronics Engineering	3.0	
0533-Phy-1204	Physics and Electronics Lab		1.5
0541-Math-1205	Calculus	3.0	
0611-CSE 1207	Fundamentals of Computer and Information Technology	3.0	
0611-CSE 1208	Fundamentals of Computer and Information Technology Lab		1.5
0531-Chem-1209	Organic Chemistry	3.0	
0531-Chem-1210	Organic Chemistry Lab		1.5
	Total	15.0	6.0
	Semester Total	21.0	

Year-2, Semester-I			
Course Code	Course Title	Credit	
		Theoretical	Lab
0723-LE-2101	Leather Processing-II	3.0	
0723-LE-2102	Leather Processing-II Lab		1.5
0723-LE-2103	Leather Biotechnology	3.0	
0723-LE-2104	Leather Biotechnology Lab		1.5
0723-LE-2105	Dyeing and Finishing-I	2.0	
0723-LE-2116	Dyeing and Finishing-I Lab		1.5
0723-LE-2107	Leather Products Manufacturing	3.0	
0723-LE-2108	Leather Products Manufacturing Lab		1.5
0541-Math-2109	Differential Equation and Numerical Methods	3.0	
	Total	14.0	6.0
	Semester Total	20.0	

Year-2, Semester-II			
Course Code	Course Title	Credit	
		Theoretical	Lab
0723-LE-2201	Leather Processing-III	3.0	
0723-LE-2202	Leather Processing-III Lab		1.5
0531-Chem-2203	Polymer Science and Engineering	3.0	
0531-Chem-2204	Polymer Science and Engineering Lab		1.5
0531-Chem-2205	Analytical Chemistry	3.0	
0531-Chem-2206	Analytical Chemistry Lab		1.5
0717-ME-2207	Fundamentals of Mechanical Engineering	3.0	
0717-ME-2208	Mechanical Workshop Practice		1.5
0723-LE-2210	Field Tour-II		1.0
	Total	12.0	7.0
	Semester Total	19.0	

Year-3, Semester-I			
Course Code	Course Title	Credit	
		Theoretical	Lab
0723-LE-3101	Leather Processing-IV	3.0	
0723-LE-3102	Leather Processing-IV Lab		1.5
0531-Chem-3103	Instrumental Analysis	3.0	
0531-Chem-3104	Chemical Analysis of Leather and Leather Products Lab		1.5
0723-LE-3105	Environmental Science and Engineering	3.0	
0717-ME-3107	Materials Science and Engineering	3.0	
0314-Hum-3109	Industrial Sociology	2.0	
0723-LE-3111	Footwear Manufacturing	3.0	
0723-LE-3112	Footwear Manufacturing Lab		1.5
	Total	17.0	4.5
	Semester Total	21.5	

Year-3, Semester-II			
Course Code	Course Title	Credit	
		Theoretical	Lab
0723-LE-3201	Eco-Friendly Leather Processing	2.0	
0723-LE-3202	Eco-Friendly Leather Processing Lab		1.5
0723-LE-3203	Testing of Leather and Allied Materials	3.0	
0723-LE-3204	Testing of Leather and Allied Materials Lab		1.5
0723-LE-3205	Dyeing and Finishing-II	2.0	
0723-LE-3206	Dyeing and Finishing-II Lab		1.5
0723-LE-3207	Supply Chain Management	3.0	
0417-Hum-3208	Employability Skills-II		1.5
0542-Math-3209	Probability and Statistics	3.0	
0723-LE-3210	Field Tour-III		1.0
	Total	13.0	7.0
	Semester Total	20.0	

Year-4, Semester-I			
Course Code	Course Title	Credit	
		Theoretical	Lab
0723-LE-4101	Tannery Wastewater Management	3.0	
0723-LE-4102	Wastewater Treatment Lab		1.5
0723-LE-4104	Computer Aided Design Lab		1.5
0723-LE-4105	Industrial Utility and Maintenance	3.0	
0723-LE-4106	Industrial Utility and Maintenance Lab		1.5
0411-Hum-4107	Cost and Management Accounting	3.0	
0723-LE-4109	Total Quality Management	3.0	
0723-LE-4110	Quality Management Lab		1.5
0723-LE-4111	Leather Processing Chemicals	2.0	
	Total	14.0	6.0
	Semester Total	20.0	

Year-4, Semester-II			
Course Code	Course Title	Credit	
		Theoretical	Lab
0723-LE-4201	Solid Waste Management	3.0	
0723-LE-4202	Waste Management Lab		1.5
0723-LE-4203	Production Planning and Quality Control	3.0	
0723-LE-4205	Green Manufacturing	2.0	
0723-LE-4206	Capstone Project		3.0
0723-LE-4208	Comprehensive Viva		2.5
0723-LE-4210	Internship		3.0
	Total	8.0	10.0
	Semester Total	18.0	

Part C

19. Description of all courses of the program:

Course Code: 0723-LE-1101 **Course Title:** Fundamentals of Leather **Credits:** 3.0

Rationale of the Course: This course is designed to provide basic knowledge about types and sources of hides, skins, carcasses, kip, chemical compositions of hides and skins. This course also covers the defects of hides and skins, preservation methods, and histological structure that will enable students to ensure quality leather production.

Course content

Introduction: Hides and skins- Historical background, different parts, types, sources, world supply, national supply, and regional status.

Slaughtering: Slaughtering and flaying of animals; tools, modern equipment and techniques of slaughtering and flaying, hides and skins of slaughtered and fallen animals; cares to be taken during flaying.

Preservation/curing of hides and skins: Handling and storage, collection practice in Bangladesh, degradation, degradation factors, importance and principles of preservation, methods of preservation/curing, advantages and disadvantages of different types of curing, factors affecting preservation/curing process, preservation defects.

Skin structure and its components: Structural difference between hides and skins of different origin, chemical composition; structure of fibrous and globular proteins; tissues- epithelial

tissues, connective tissues and cells; importance of histology in leather production, histological structure of hide and skin and microscopic appearances of cross-section.

Molecular structure and properties of collagen: Formation of the collagen fiber structure, hierarchy of collagen structure, arrangement of amino acid, peptide chain, collagen genes and RNA, amino acid composition and primary structure, helix stabilization, diameter, strength, three dimensional weaves of collagen in leather, interweave, bonding, tensile strength and flexibility. Properties of crosslinks.

Natural and synthetic polymer: Natural- vegetable (cellulose), cotton, jute, etc., animal (protein)- leather, wool, virgin wool, silk, hair etc., mineral- asbestos, Man-made cellulosic, viscose, acetate, rubber, synthetic polymers etc.

Course Objectives

- a. To introduce students to the historical background, different types, sources, and world supply of hides and skins.
- b. To familiarize students with animal slaughtering and flaying techniques and the importance of care during flaying.
- c. To equip students with the principles and methods of preservation and curing of hides and skins.
- d. To provide students with an understanding of the structure and composition of hides and skins and their components.
- e. To enable students to comprehend collagen's molecular structure and properties and its applications in leather technology.

Course Learning Outcomes (CLOs): Upon successful completion of this course, students will be able to-

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	State different parts, types, sources, and world supplies of hides and skins.	C1, A1
CLO2	Explain the modern slaughtering and flaying techniques for animals.	C2, A3
CLO3	Compare and analyze diverse, modern, and environment-friendly curing methods.	C3, C4
CLO4	Illustrate and analyze the histological structure of hides and skins, including their importance in leather production.	C4, A4
CLO5	Correlate the role of various natural and man-made polymers used in leather, leather products, and the footwear industries.	C4, A4

Mapping of Course Learning Outcomes (CLOs) with Programs Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	3	-	3	-	-	-	-	-	-	-	-
CLO2	3	2	2	-	3	1	-	-	-	-	-	-
CLO3	3	-	3	-	3	-	2	-	-	-	-	-
CLO4	3	3	-	3	2	-	-	-	-	-	-	-
CLO5	3	3	3	2	3	-	3	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, White board illustration, Group discussion	Assignment, In-course assessment, Final examination
CLO2	Lecture, Multimedia presentation and Group discussion	In-course Exam, Final Exam
CLO3	Lecture, Video presentation, Group discussion, Multimedia presentation.	In-course Assessment, Final examination, Assignment, Case study and quiz
CLO4	Lecture, Audio-visual presentation	Oral presentation, In-course Assessment, Final examination
CLO5	Lecture and Multimedia presentation	In-course Assessment and Final examination

Learning Materials

i. Recommended Readings

- a) Anthony D. Covington- Tanning Chemistry: The Science of Leather
- b) Dutta S.S.-An introduction to the principles of leather manufacture.
- c) Sarkar K.T.-Theory and Practice of Leather Manufacture.

ii. Supplementary Readings

- a) Procter H.R.-The Principle of Leather Manufacture.
- b) Venkatappaiah B.-Introduction to The Modern Footwear Technology.

iii. **Others:** Handout/lecture material provided by the course teacher.

Course Code: 0541-Math-1103 **Course Title:** Algebra and Geometry **Credits:** 3

Rationale of the Course: This course covers formulas, algebraic expressions, first-degree equations, inequalities, the rectangular coordinate system, the area, perimeter, and volume of geometric shapes, as well as the properties of triangles and circles which are essential for engineers as a fundamental course.

Course Content

Inequalities, Vector Algebra and Vector Calculus: Review of geometric vectors in R^2 and R^3 space, scalar and vector products, solutions of vector equations, applications of vectors in geometry, vectors in R^n and C^n , inner product, norm and distance in R^n and C^n .

Matrices and Determinants: Notion of matrix, types of matrices, matrix operations, laws of matrix algebra, determinant function, properties of determinants, minors, cofactors, expansion and evaluation of determinants, elementary row and column operations and row-reduced echelon matrices, invertible matrices.

System of Linear Equations: Linear equations, system of linear equations (homogeneous and non-homogeneous) and their solutions, Application of Matrices and determinants for solving system of linear equations, applications of the Algebra in science, engineering and business.

Two-dimensional Geometry: Change of axes, pair of straight lines, general equation of second degree, circle and system of circle, parabola and hyperbola.

Three-dimensional Geometry: Rectangular co-ordinates, direction ratios and cosines of a line, equations of a line and a plane, intersecting planes, symmetric form of a straight line, angle between lines and planes, coplanar lines, skew lines, shortest distance, equations of a sphere.

Course Objectives: Enable students-

- To know about inequalities, vector algebra, and vector calculus.
- To know about matrices and determinants.
- To know about applications of algebra in science, engineering, and business.
- To know about two- and three-dimensional geometry.

Course Learning Outcomes (CLOs): Upon completion of the course, the students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the basic ideas of inequalities, vector algebra, and vector calculus.	C1, A1
CLO2	Narrate the properties of matrices and determinants; and solve systems of linear equations.	C2, A2
CLO3	Relate applications of algebra in science, engineering, and business.	C3, A3
CLO4	Sketch graphs of and discuss relevant features of lines, circles, and other conic sections.	C3, A3
CLO5	Find equations of lines and planes in space and identify and describe quadratic surfaces.	C4, A4

Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	-	1	-	-	-	-	-	-	-	-
CLO2	3	3	-	1	-	-	-	-	-	-	-	-
CLO3	3	3	1	1	-	-	-	-	-	-	-	-
CLO4	3	3	-	1	-	-	-	-	-	-	-	-
CLO5	3	3	-	1	-	-	-	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion, and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO2	Lecture, group discussion, and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO3	Lecture, group discussion, and problem-based learning (PBL): Identifying the problem to be solved	Assignment, In-course Exam, and Final Exam
CLO4	Lecture, group discussion, and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO5	Lecture, group discussion, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) H. Anton, and C.Rorres, Linear Algebra with Applications
- b) S. Lipschutz, Linear Algebra, Schaum's Outline Series.
- c) Brestscher, Linear Algebra with Applications.

ii. Supplementary Readings

- a) Khosh Mohammad, Analytic Geometry and Vector Analysis.
- b) G. Strang, Linear Algebra with Applications.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0533-Phy-1105

Course Title: Engineering Physics

Credits: 3.0

Rationale of the Course: Engineering physics will provide a more thorough ground in applied physics for a selected specialty such as wave and oscillations, forces and motion, heat, elasticity, properties of matter, electricity and magnetism, nuclear physics, modern physics, and optics. The course will also bridge the gap between theoretical science and practical engineering.

Course Content

Elasticity: Rigid body, perfectly elastic body, plastic body, stress and strain, stress-strain curve for ductile and brittle material, Hooke's law and different elastic constants-moduli of elasticity, poisson's ratio, determination of elastic constants, factors affecting elasticity.

Optics: Theories of light, electromagnetic spectrum, optical instruments, compound microscope, polarizing microscope, camera and photographic techniques, spectrophotometer, interference of light, Young's experiment, Fresnel's bi-prism, Newton's rings, diffraction of light, Fresnel and Fraunhofer diffraction, diffraction gratings, resolving power of a grating, polarized and unpolarized light, polarization by reflection and refraction, Brewster's and Malu's law, double refraction, polarization by scattering, optical activity.

Heat: Humidity, vapor pressure, temperature-related humidity, transmission of heat, thermal conductivity of solids and liquids, coefficient of thermal conductivity, good and bad conductor of heat, heat flow through compound walls.

Electricity and magnetism: Electric charge, Coulomb's law, electric field, electric dipole, electric flux and Gauss's law, applications of Gauss's law, electric potential, equipotential surface, capacitor capacitance and dielectrics, combination of capacitors in series and parallel, dielectrics and Gauss's law, energy storage in an electric field, electric current and current density, resistance, resistivity and conductivity, continuity equation, Ohm's law, combination of resistances, Kirchhoff's laws, Wheatstone bridge, Lorentz force, Ampere's circuital law with applications, solenoid, toroid, electromagnetic induction-Faraday's laws, Lenz's law, self and mutual induction, inductor and inductance, energy stored in magnetic field.

Nuclear physics and modern physics: Properties of atomic nucleus, mass defect, binding energy, nuclear stability, natural and artificial radioactivity, laws of radioactive disintegration, half-life and mean life, radio-toxicity, radioactive waste management. X-ray and their applications, wave-particle duality, de-Broglie hypothesis, photoelectric effect, Compton effect.

Course Objectives:

- To provide fundamental knowledge and illustrate to the students on different topics of Physics.
- To impart knowledge in basic concepts of physics relevant to engineering applications.
- To relate the physical phenomena with proficiency in problem-solving, critical thinking, and analysis.

Course Learning Outcomes (CLOs): By the end of the course students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	State various physical laws and fundamental concepts of physics.	C1, A1
CLO2	Explain the factors and related theories of elasticity, optics, heat, electricity and magnetism, nuclear physics, and modern physics.	C2, A2
CLO3	Analyze and apply a conceptual and quantitative understanding of properties of elasticity, optics, heat, electricity, and nuclear physics.	C3, C4, A3
CLO4	Relate and evaluate application-driven ideas that can be applied in	C5, A4

	solving engineering problems of the leather industry.	
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Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	-	-	-	-	-	-	-	-	-	-
CLO2	3	2	2	2	-	-	-	-	-	-	-	-
CLO3	3	3	3	3	2	-	-	-	-	-	-	-
CLO4	3	2	2	1	2	-	-	-	-	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture whiteboard lustration, slide presentation, problem practices, interactive discussion	In-course Exam; Final Exam
CLO2	Interactive audiovisual lecture, whiteboard lustration, slide presentation, problem practices	In-course Exam; Final Exam
CLO3	Lecture, whiteboard illustration, problem-based excesses	Quiz, Assignment, and Final Exam
CLO4	Lecture, slide presentation, group discussion, whiteboard illustration, and problem-based exercises	Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- Resnick/Halliday/Krane-Physics, Vol I and II.
- David Halliday/Robert Resnick/Jearl Walker-Fundamentals of Physics.
- Dr. Gias Uddin Ahmad: Physics for Engineers Part-1 and 2

ii. Supplementary Readings

- Arther Beiser-Concepts of Modern Physics.
- Francis A. Jenkins and Harvey E. White: Fundamentals of Optics

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0531-Chem-1107 **Course Title:** Inorganic Chemistry **Credits:** 3.0

Rationale of the Course: The course is designed to provide applied knowledge on inorganic chemistry related to leather, footwear, and allied engineering education. The different concepts from this course will help students understand the mechanism involved in different leather processing and footwear manufacturing.

Course Contents

Concepts in chemical bond: A review of ionic, covalent and co-ordinate bond, covalent character in ionic compounds: Polarization, Fajan's rules; VSEPR theory, valence bond theory: General description, hybridization, multiple bonding; molecular orbital theory: MO diagram of molecules, bond order; ionic character covalent compound, hydrogen bond and other intermolecular forces, metallic bond.

Acids and bases: Arrhenius concept, Bronsted-Lowry concept, Lewis concept, solvent system concept, hard and soft acid-base, acid-base strengths, acid strength of BX_3 , oxoacids, haloacids, self-ionization of water, pH, buffer solutions and mechanism, importance of pH in tanning processes, acid base titrations, equivalent point and end point, selection of indicator in acid-base titration, common ion effect, common ion effect in group separation table.

Redox reactions: Oxidation-reduction reactions, oxidation number, balancing oxidation-reduction equations by half-reaction method, strengths of oxidizing and reducing agents, disproportion reaction, auto-oxidation, induced oxidation, redox titration, redox indicator, iodometry and iodimetry, Back titration and its application, applications of redox titration.

Transitional and inner-transitional metals: d-block and 1st transitional elements, characteristics of transitional elements, shape and orientation of d-orbitals, structure and property relations in 'd' block elements; 4f-block element: Lanthanides, general characteristics, application of transition metal compounds in leather tanning.

Theories of co-ordination chemistry: double salt and complex compounds, ligand and its types, coordination number, Werner's coordination theory, chelate complexes, nomenclature, Sidgwick theory; Valence Bond Theory (VBT) of structure of inorganic complex with simple examples, Crystal Field Theory, application of crystal field theory color of transition metal complexes.

Inorganic compounds used for tanning: Chromium salts, their behavior in solution, variable oxidation state of chromium, color of chromium compounds, structure and bonding of chromium in leather.

Course Objectives: This course will guide the students to learn about-

- the basic concepts involved in inorganic chemistry that will prepare the students for advanced coursework in chemistry as well as leather and footwear engineering.
- different types of bonds and interactions related to leather, polymeric and other footwear materials.
- in-depth knowledge of chemical science directed towards materials, energy technology, and leather manufacturing.

Course Learning Outcomes (CLOs): Upon completing this course students will be able to

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Define chemical bonding, and molecular geometry based on established theories, and develop critical thinking skills in different intermolecular forces.	C1, A1
CLO2	Apply the fundamentals principle of chemical bonding and transitional metal chemistry in different steps of leather processing.	C3, A2
CLO3	Illustrate and analyze the chemistry theories to explain the interactions between acids and bases and the fundamental ideas of buffer solutions.	C3, C4, A3
CLO4	Describe the concept of redox reactions and the various redox titration techniques, and apply them in real-life applications purpose.	C2, C3, A2
CLO5	Analyze the theories of coordination chemistry along with aqueous chemistry of chromium and apply them in tanning process.	C4, A3

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	2	2								
CLO2	2	2	2									
CLO3	3	2	1									
CLO4	3	2	1									
CLO5	3	2	2									

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive audiovisual lecture, whiteboard illustration, slide presentation, problem practices	In-course Exam; Final Exam
CLO2	Interactive audiovisual lecture, whiteboard illustration, slide presentation, problem practices	In-course Exam; Final Exam
CLO3	Lecture, whiteboard illustration, problem-based exercises	Quiz, Assignment, and Final Exam
CLO4	Lecture, slide presentation, group discussion, whiteboard illustration, and problem-based exercises	Quiz, In-course Exam, and Final Exam
CLO5	Lecture, whiteboard illustration, group discussion, and problem-based exercises	In-course Exam, Assignment, Final Exam

Learning materials

i. Recommended readings

- a) G. F. Lipotrot- Modern Inorganic Chemistry.

- b) F. Albert Cotton, Geoffrey Wilkinson, Paul L. Gaus- Basic Inorganic Chemistry
- c) Darren Ebbing and Steven D. Gammon - General Chemistry, 10th edition

ii. Supplementary Readings

- a) R. D. Madan- Modern Inorganic Chemistry.
- b) K. N. Upadhyaya- A Text Book of Inorganic Chemistry.

iii. Others: Lecture/hand notes provided by the course teachers.

Course Code: 0531-Chem-1109 **Course Title:** Physical Chemistry **Credits:** 3.0

Rationale of the Course: The course is designed to give the students an understanding of different topics on physical chemistry like introductory concepts on surface chemistry, reaction kinetics, thermodynamics, photochemistry, colloidal science, colligative properties as well as corrosion and reaction. After completion of the course, students will be able to gather theoretical knowledge of physical chemistry and apply it in related engineering fields.

Course Contents

Surface chemistry: Residual force of surface, adsorption and absorption, nature and characteristics of adsorption, types of adsorption, types of adsorption isotherms, theoretical study of adsorption of gas by solid: Freundlich, Langmuir, and BET isotherms, adsorption of solid from solution, applications adsorption.

Colloidal solution: True solution, suspension, types of colloids, general methods of preparation and purification, general properties of sols, the origin of charge, protective action; emulsion, types and preparation of emulsion, emulsifier, stability of emulsions, application of colloids in tanning processes.

Photochemistry: Laws of photochemistry - Grotthuss-Draper law, Stark-Einstein law and Beer-Lambert law (derivation and problems), quantum yield, significance of quantum yield, photophysical processes: Jablonski diagram, chemiluminescence, fluorescence, phosphorescence, photosensitization and photoquenching, applications of photochemistry.

Chemical kinetics: Rate of reaction, order, and molecularity, elementary and overall reaction integral rate equation for 1st, 2nd, and 3rd order kinetics, half-life, order determination methods, temperature dependence of reaction rate, simple theories of reaction rate, energy of activation, collision theory of reaction rates.

Properties of dilute solution: Review of different types of solution, colligative properties, lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure and osmosis, deduction of their formula, molecular weight from Raoult's Law, their experimental determination, application of colligative properties, applications of colligative properties.

Corrosion and reactions: Introduction, different types of corrosion, influence of different factors on corrosion, thermodynamics of corrosion, mechanisms of corrosion, different corrosion prevention methods

Thermodynamics: Work, heat, energy, internal energy and enthalpy, thermodynamics systems, 1st law of thermodynamics, reversible and irreversible processes, isothermal and adiabatic expansion of ideal gas, 2nd law of thermodynamics, spontaneous process, entropy, Carnot's cycle, efficiency of a machine.

Course Objectives:

- To state and explain different laws of physical chemistry.
- To provide lessons on analysis and derivation of different standard equations using various parameters and variables.
- To improve the ability of the students to interpret the tabulated experimental data for different physical processes.
- To promote knowledge of the basic concepts of physical chemistry to enter into the field of engineering education.

Course Learning Outcomes CLOs: At the completion of this course students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Narrate the physical law and principles of surface chemistry and apply them in environmental remediation methods.	C1, C3, A3
CLO2	Explain colloids and emulsion, their classification, preparative methods, and properties of sol, and illustrate the real-life applications.	C2, C4, A3
CLO3	Illustrate different principles of photochemistry, and concepts of photochemical and photophysical processes, and compare them with thermal reactions.	C3, A3
CLO4	Compare the kinetics of zero, 1 st , 2 nd , and 3 rd order reactions and narrate the different reaction order determination techniques and the theories of reaction rate.	C3, C4, A3
CLO5	Explain four colligative properties, and concepts of thermodynamics and apply them in real-life practices.	C3, A3
CLO6	Explain the concept of corrosion of materials in different environmental conditions and design the methods for the prevention of corrosion.	C2, C5, A4

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	1	-	-	-	-	-	-	-	-	1
CLO2	3	2	2	-	-	-	-	-	-	-	-	1
CLO3	3	3	2	-	-	-	2	-	-	-	-	-
CLO4	2	2	-	-	-	-	-	-	-	-	-	-
CLO5	3	2	-	-	-	-	2	-	-	-	-	1

CLO6	3	2	-	-	-	-	2	1	-	-	-	-
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Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive audiovisual lecture, whiteboard illustration, problem-solving practices	In-course Exam; Final Exam
CLO2	Interactive audiovisual lecture, whiteboard illustration, problem-solving practices	In-course Exam; Final Exam
CLO3	Lecture, whiteboard illustration, slide presentation, problem-based exercises	Quiz, Assignment, and Final Exam
CLO4	Lecture, slide presentation, group discussion, whiteboard illustration, and problem-based exercises	In-course Exam, and Final Exam
CLO5	Lecture, whiteboard illustration, group discussion, and problem-based exercises	In-course Exam, Assignment, Final Exam
CLO6	Lecture, whiteboard illustration, and problem-based exercises	Assignment, Final Exam

Learning Materials

i. Recommended Readings

- a) S. Glasstone-Text Book of Physical Chemistry.
- b) Moron and Lando- Fundamentals of Physical Chemistry.

ii. Supplementary Readings

- a) Bahl And Tuli- Essentials Physical Chemistry.
- b) S.S. Dara- Engineering Chemistry, 1st Edition.

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0531-Chem-1110 **Course Title:** Inorganic and Physical Chemistry Lab **Credits:** 1.5

Rationale of the course: This course is designed to provide knowledge related to safety during working in the chemistry laboratory, and the development of skills for the use of lab apparatus and equipment using mainly quantitative and qualitative analysis.

Course Contents

1. Uses of some common apparatus and reagents: Preparation of the substance for analysis and weighing the sample, Preparation of the standard solution of primary standard substances like oxalic acid, succinic acid, sodium carbonate, potassium dichromate.

2. Titration: Acid- base titration: standardization of secondary standard substances like sodium hydroxide, hydrochloric acid, sulphuric acid; redox titration: standardization of secondary standard substances like potassium permanganate, sodium thiosulphate; estimation of Fe and Cu from supplied sample solution.

3. Systematic qualitative analysis of inorganic salts: Physical appearance, preliminary dry test, wet test for acid radicals, flame test, group separation table.

Course Objectives: The course learning objectives of this course are to

- familiarize a student with the basic techniques of chemistry laboratory such as weighing, measuring, and transferring liquids, heating, and filtering.
- impart knowledge on the identification of different cations and anions by systematic semi micro qualitative analysis.
- prepare different standard solutions and perform quantitative analysis.

Course Learning Outcomes CLOs: At the end of the course, students will be able to -

CLOs	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Explain the principles behind the experiment performed in the laboratory.	C2, P2
CLO2	Perform the hands-on experimental work on volumetric analysis using the equipment/set-up in the laboratory to achieve the respective objectives of the experiments individually or in a group.	C3, P3
CLO3	Inspect the salts and analysis them to determine the cations and anions present in the sample salts through systematic quantitative analysis.	C4, P3
CLO4	Write laboratory reports that compare and contrast theoretical predictions and experimental measurements as well as observations and draw conclusions and inferences from agreements and/or disagreements observed.	C3, P3

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	-	-	-	-	-	-	-	-	-	-
CLO2	3	2	1	-	-	-	-	-	2	-	-	-
CLO3	3	2	2	2	-	-	-	-	-	-	-	-
CLO4	3	2	-	-	-	-	-	2	-	2	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning, and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive Lectures, Group Discussions, Demonstration, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO2	Lecture, Demonstration, Hands-on practice, and Group work	Presentation, Report evaluation, Final Exam
CLO3	Lecture, Demonstration, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO4	Lecture, Demonstration, Hands-on practice, and Group work	Report evaluation, Final Exam

Learning materials

i. Recommended readings

- a) Vogel A. I. - Qualitative Chemical Analysis
- b) Vogel A. I. - Text Book of Quantitative Chemical Analysis

ii. Supplementary Readings

- a) P. K. Sarker - Analytical Chemistry for Leather Manufacture.
- b) Fifield and Haines-Environmental Analytical Chemistry.

iii. **Others:** Lecture notes and Lab procedure provided by the course teachers.

Course Code: 0715-ME-1112 **Course Title:** Engineering Drawing **Credits:** 1.5

Rationale of the Course: This course is designed to provide knowledge and practice the types of drawing instruments, types of projection, projection of points, straight lines, and solids; development of surface, etc. The students will be able to develop skills in basic engineering drawings related to Leather and allied engineering.

Course Content

Drawing equipment and the uses of instruments; basic drafting techniques, planning of drawing sheet; dimensioning, types of lines, lettering, numbering.

Geometrical construction, theory of projection, orthographic projection, first and third angle projection, multi-view projection problems, oblique and isometric drawings, perspective views, sectional views, auxiliary views, assembly drawings, and basic concepts of working drawing.

Course Objectives: This course is designed to provide adequate knowledge on-

- a. different types of drawing tools, and equipment.
- b. letters and numbers in drawing sheets.
- c. different types of projections related to points, straight lines, and solids.
- d. the development of different types of views and surfaces.

Course Learning Outcomes (CLOs): Upon successful completion of this course, students will be able to

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Define and identify different types of lines, shapes, and views.	C1, A1, P1
CLO2	Explain and illustrate different theories or concepts of engineering drawing.	C2, A2, P2
CLO3	Apply various geometrical construction rules and techniques for drawing different projections of 3D objects.	C3, A3, P3
CLO4	Solve the drawing-related problems of different projections, views, and angles.	C4, A4, P3

Mapping of Course Learning Outcomes (CLOs) with Programs Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	1	-		-							
CLO2	3	1	-	-	-	-	-	-	-	-		
CLO3	3	3	2	2	-	-	-	-	2	1	-	-
CLO4	3	3	2	2	-	-	-	-	-	-	-	1

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning, and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive Lectures, Group Discussions, Demonstration, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO2	Lecture, Demonstration, Hands-on practice, and Group work	Presentation, Report evaluation, Final Exam
CLO3	Lecture, Demonstration, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO4	Lecture, Demonstration, Hands-on practice, and Group work	Report evaluation, Final Exam

Learning Materials

i. Recommended Readings

- a) Chandra Mandal, Dr. Amalesh and Islam, Dr. Md. Kamrul.,- “Mechanical Engineering for Engineers”.

- b) Geisecke E., Federick; Mitchel E., Alva; Spencer C., Henry; Hill L., Ivan; Dygdon Thomas., John; Novak E., James; Loving O. R.; Lockhart E., Shawna-“Technical Drawing with Engineering Graphics”.

ii. Supplementary Readings

- a) Simmons H., Colin; Dennis E., Maguire and Phelps., Neil- “Mechanical Engineering Drawing”
- b) Warren J. Luzadder and Jon M. Duff.-“Fundamental of Engineering Drawing”

iii. Others: Handout/Lecture notes provided by course teacher.

Course Code: 0417-Hum-1114 **Course Title:** Employability Skills-I **Credits:** 1.5

Rationale of the Course: This course is designed to enable students in employability-related communication to enhance their performance in different types of communicative English. The students will be competent in speaking, listening, writing, reading, and developing communicative skills in technical and business English.

Course Content

Language: Function, Difference between written and spoken language, Planning format, paragraph heading, Listening, understanding and speaking skills, effective communication, techniques of description, uses of visual aids, reading skills.

Different types of Communication: Intrapersonal, interpersonal, small group, organizational, intercultural, and mass communications; significance of communication in corporate and multinational business organizations; communication network- Vertical communications downward communication and upward communication, horizontal communication, systems of communication: Stimulus to communication, communication components.

Business letters: Drafting letters, applications, letters of complaint, letters to the press, apology and explanation, request letters, functions of a first, middle and last paragraph(s), characteristics and drafting process of positive letters, negative letters, persuasive letters, routine letters and memos.

Report Writing: Types of report, characteristics, and importance of different types-Purpose-Scope-different styles of writing reports. The process of preparing informal and formal reports, drafting reports, progress reports, technical reports, and industrial reports.

Proposals: For new equipment, increasing production, description of visits, experiments, etc.
Explaining: Process explaining, complaining, and reporting damage.

Course Objectives

- a. To assist students in becoming well-versed, responsible, and creative communicators through individual skill assessments by exploring their values and career choices.
- b. To encourage students about realistic employment choices and to identify the steps necessary to achieve their goals.

- c. To develop students' communication skills in the structure, elucidation, and delivery of messages in diverse professional, cultural, and global communities.

Course Learning Outcomes (CLOs): The course is designed to achieve the following learning outcomes

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Demonstrate the basic domains of English language, business letters, reports, and proposal writing.	C2, A2, P2
CLO2	Manipulate and apply the language skills, tools, and techniques to develop technical and professional letters, reports, and proposals.	C3, A2, P3
CLO3	Relate and apply the acquired skills on Communicative English to explore future career.	C4, A3, P3

Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	-	-	-	-	-	2	-	-	3	3	3	2
CLO2	-	-	-	-	2	3	-	-	2	3	2	3
CLO3	-	-	-	-	-	2	-	-	2	3	3	3

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course-Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation, group discussion	Lab Performance Report, Continuous Assessment; Final Examination
CLO2	Lecture, Video presentation, Problem-based Learning (PBL): Identifying the problems to be solved	Lab Performance Report, Assignment, Continuous Assessment; Final Examination
CLO3	Lecture, multimedia presentation, literature review, group discussion, analysis, and comparison through various circumstances	Lab Performance Report, Continuous Assessment; Final Examination

Learning Materials

i. Recommended Readings

- Mishra. B, Sharma. S (2011) Communication Skills for Engineers and Scientists. PHI Learning Pvt. Ltd. ISBN: 8120337190.
- Chaturvedi P. D, Chaturvedi M. (2011) Business Communication: Concepts, Cases and Applications. Pearson Education India. ISBN: 8131718727.

- c) Greenbaum. Sidney. College Grammar of English. Longman Publishers. ISBN: 9780582285972.

ii. Supplementary readings:

- a) Frances Trought (2017) Employability Skills: How to stand out from the crowd in the graduate job market ISBN: 978-1-292-15890-7 (print)

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0723-LE-1116 **Course Title:** Field Tour-I **Credit Value:** 1.0

Rationale of the Course: Industrial visits serve as an excellent platform to learn for students pursuing B.Sc. in Leather Engineering degree and they help in bridging the gap between classroom learning and the actual work conditions. The Field Tour-I course is designed to help inculcate the practical workplace environment to the students and to render a holistic engineering education to them.

Course Content

In 1st Year 1st Semester, students will visit a reputed leather industry.

Discussions with the company supervisor about any project or assignment/task.

Understanding the systems in the workplace – Processes, Organization, Administration.

Recording all the work done or knowledge gained.

Maintaining a logbook and giving feedback to the guide teacher.

Course Objectives

- a. To provide exposure to the students to leather engineering practices in the tannery.
- b. To instill communication skills in engineering which include interaction with the working environment and technical writing.

Course Learning Outcomes (CLOs): At the completion of this course students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify and recognize the machines and equipment of the leather industry.	C2, A2, P1
CLO2	Describe and analyze the process flowchart, faults, remedies and recent development in leather processing.	C2, C4, A3, P3
CLO3	Write technical reports and deliver oral presentations related to the industrial visit/work completed.	C3, A2, P2

Mapping Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	2	-	-	-	2	-	-	2
CLO2	2	2	-	-	2	-	-	-	2	-	-	-
CLO3	2	-	-	-	-	-	-	-	2	3	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course-Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive Lecture, Display and demonstration, Presentation and viva	Participation and performance assessment, Presentation, Report Evaluation
CLO2	Interactive Lecture, Display and demonstration, Presentation and viva	Participation and performance assessment, Presentation, Report Evaluation
CLO3	Discussion, Self-study, Motivational discussion, Presentation and viva	Participation and performance assessment, Presentation, Report Evaluation

Learning Materials

i. Recommended Readings

- a) Writing the Winning Thesis or Dissertation: A Step-by-Step Guide - By Allan A. Glatthorn, Randy L. Joyner.
- b) Relevant books, scientific journals, handbooks, patents and manuals.

Course Code: 0723-LE-1201 **Course Title:** Leather Processing-I **Credits:** 3.0

Rationale of the Course: This course explores the essential pre-tanning processes in leather manufacturing, including sorting, grading, beam house operations, soaking, unhairing, liming, deliming, bating, pickling, and degreasing. Students will develop the knowledge and skills needed to analyze, evaluate, and apply these processes for the production of high-quality leathers.

Course Content

Sorting and grading of raw hides and skins: Principles; objectives, methods, and importance in leather processing.

Beam house operation/ pre-tanning Processes: Introduction and role of beam house operations in leather making.

Soaking: Objectives and mechanism, soaking of different hides and skins, enzymatic soaking, influencing factors, role of hyaluronic acid, aids and controls, eco-friendly process technologies in soaking, defects and their remedies, green fleshing.

Unhairing and liming: Objectives, types, advantages and disadvantages, immunization of keratin, swelling of collagen based on Dornan's theory, mechanism of unhairing, sulphide free unhairing system, enzymatic unhairing, control of enzymatic unhairing and advantages and, scope of hair utilization or disposal, prevention of H₂S emission from lime effluent.

Fleshing: Objectives, types, advantages and disadvantages.

Deliming and bating: Objectives, selection of delimiting agents, completion test of delimiting, mechanism of bating, effect of bating on leather quality, acid and alkali bating: advantages and disadvantages, bating completion test, pollutants emission, cleaner technology options.

Pickling: Acid binding capacity of collagen, organic acids and salts in pickling, importance and controls, de-pickling.

Degreasing: Objectives and importance, different systems and methods of degreasing.

Course Objectives

- To provide students with a comprehensive understanding of sorting, grading and beam house operations in the leather making process.
- To enable students comprehending the processes of soaking, unhairing, liming, and fleshing.
- To familiarize students with the objectives, types, advantages, and disadvantages of delimiting, bating, pickling, and degreasing in leather manufacturing.

Course Learning Outcomes (CLOs): Upon completion of the course, the students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Recall and explain the principles of sorting and grading raw hides and skins in leather processing.	C1, C2
CLO2	Describe the role and importance of beam house operations in leather making.	C2, A2
CLO3	Analyze the mechanism, environmental impact and factors influencing soaking process.	C3
CLO4	Compare and evaluate different techniques of unhairing, liming process and fleshing operation.	C3, C4
CLO5	Evaluate the suitability of delimiting, bating, pickling, and degreasing methods based on specific leather manufacturing requirements.	C3, C4

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	2										
CLO2	3	2										
CLO3	3	3	2	2		2	3					
CLO4	3	3	2	2								

CLO5	3	3	2	2		2	3					
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Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation, demonstration and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO2	Lecture, group discussion and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO3	Lecture, guided reading and problem-based learning (PBL): Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam, and Final Exam
CLO4	Lecture, multimedia presentation, group discussion, literature review, demonstration, and problem-based exercises	Group Presentation, In-course Exam, and Final Exam
CLO5	Lecture, group discussion, literature review, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) Theory and Practice of Leather Manufacture–K. T. Sarkar, Macmillan India Press, Madras
- b) Tanning Chemistry: The Science of Leather-Anthony D Covington
- c) Possible Defects in Leather Production-Gerhard John.

ii. Supplementary Readings

- a) Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edition.
- b) Leather Technician`s Handbook–J. H. Sharpouse, Vernon Lock Ltd., 125 High Holborn, London W-C1

- iii. **Others:** Handout/lecture material provided by the course teacher

Course Code: 0723-LE-1202 **Course Title:** Leather Processing-I Lab **Credits:** 1.5

Rationale of the Course: This course is designed to develop graduates' essential knowledge of leather manufacturing. This course will develop necessary skills for manufacturing of wet-blue leather. It deals with the different stages of pre-tanning process, and their impacts resulting in enhancing interest in the chemistry and mechanism of leather making.

Course Content

1. Curing of freshly flayed cow hides and goat skins with sodium chloride (common salt) and its effect on moisture content at different time intervals.

2. Determination of rate of moisture uptake and degree of swelling of cow hides and goat skins during soaking.
3. Painting method of unhairing for wet salted goat skins/ sheep skins.
4. Liming with slaked lime and/or sodium sulfide.
5. Comparative effects of deliming with boric acid, lactic acid, ammonium chloride, and ammonium sulfate.
6. Bating with acidic/alkaline bate powder of wet salted goat skins/ sheep skins/cowhides.
7. Determination of the effect of sodium chloride on pickling of wet salted goat skins/ sheep skins/cowhides.
8. Manufacturing of chrome-tanned wet blue leather from wet salted hides and skins.
9. Identification of raw hides and skins/ wet blue/ crust leather/ finished leather.

Course Objectives:

- a) To introduce students to quantitative and qualitative control parameters in pre-tanning operations.
- b) To enhance the student's ability to analyze and alleviate the issues during leather manufacturing.
- c) To guide students in assessing different completion parameters of different stages of the pre-tanning operations.
- d) To develop students' skills on the manufacturing of wet blue leather.

Course Learning Outcomes (CLOs): Upon completion of the course, the students will be able to

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify and classify different types of leather, according to origin, grain patterns, and texture.	C2, A2, P2
CLO2	Apply and analyze the process of curing and pre-tanning operations of hides and skins.	C3, C4, A2, P3
CLO3	Compare and evaluate the effectiveness of different techniques of beam house operations.	C4, C5, A3, P4
CLO4	Demonstrate practical skills in the manufacturing of wet-blue leather as an individual and/or teamwork.	C5, A3, P4

Mapping of CLO with PLO

CLOs	PLO 1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	2	2	1	-	1	-	-	-	-	-
CLO2	3	3	2	3	2	-	2	-	-	-	-	-
CLO3	3	3	2	3	2	-	3	-	-	-	-	-
CLO4	3	3	2	3	2	-	3	-	3	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO2	Lecture, Demonstration, Hands-on practice, Group discussion, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO3	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO4	Lecture, Demonstration, Hands-on practice, and Group discussion	Lab Performance, Continuous assessment: Viva, Report, Final Exam

Learning Materials

i. Recommended Readings

- a) Leather Technician`s Handbook–J. H. Sharphouse, Vernon Lock Ltd., 125 High Holborn, London W-C1
- b) Theory and Practice of Leather Manufacture- K.T. Sarkar.
- c) Possible Defects in Leather Production-Gerhard John.

ii. Supplementary Readings

- a) Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edn. I. L. T. A., Calcutta.
- b) Tanning Chemistry, The Science of Leather-Anthony D Covington.

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0713-EEE-1203 **Course Title:** Fundamentals of Electrical and Electronics Engineering **Credits:** 3.0

Rationale of the course: This course offers a thorough review of electric circuit analysis in electrical and electronics engineering. The course is designed at a very basic level and included in the Leather and allied engineering program as an allied engineering course.

Course Contents

Electrical Engineering: Introduction to Voltage, current, power, energy, D.C. fundamentals, Series- parallel network, Network Theorems, Generators and their characteristics, Motors, and their characteristics, and Speed control process.

AC Current: AC fundamentals, Flow of AC through inductance, capacitance, and resistance in series and parallel; Power in AC Circuit, Power Factor and its improvement; Resonance in AC circuits, Transformer, Poly phase circuits, Induction motors (types and purpose). Sub-station equipment, Distribution board, and sub-distribution board.

System network: Typical distribution circuits, cables, and wiring systems and their selection.

System protection: Types of faults, (transformer and motor) principles of protection, Protective devices.

Electrical hazards: Electrocution, Electric Shock and its factors, Electric current on human body, Identifying and recognizing hazards, PPE, protection against shock and fire, earthing and its importance, procedure to be adopted when a person is in contact with a live conductor.

Electronics: Semiconductor physics, Diodes and their uses, Rectifiers, Transistors, Amplifiers, Voltage amplification, Power amplification, Photo sensor, Clippers, Clampers, Transducer, Integrated Circuits.

Course Objectives

- a. To provide a comprehensive understanding of the theoretical background in circuit theory.
- b. To enable the students to analyze the DC circuits, distribution circuits, cables, and wiring systems.
- c. To familiarize the basics of AC circuits.

Course Learning Outcomes (CLOs): At the end of the course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Explain the theory behind DC circuits, and magnetic circuits and solve complex AC circuits using network theorems.	C2, C3, A3
CLO2	Analyze DC and AC circuits using KVL, KCL, or other analysis methods.	C4, A4
CLO3	Recognize, select, and evaluate measurement devices used in electrical and electronics engineering.	C2, C5, A4
CLO4	Identify the electrical hazards and take protective measures in real-life.	C1, C3, A2

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	3	2										
CLO2	3	3										
CLO3	3	3										
CLO4	3	3				2	2					2

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of CLOs with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, whiteboard illustration, problem-solving exercises	In-course Exam, Final Exam
CLO2	Lecture, slide presentation, problem-solving exercises	Assignment, In-course Exam, Final Exam
CLO3	Lecture, whiteboard illustration, slide presentation	Quiz, In-course Exam, Final Exam
CLO4	Lecture, group discussion, audio-visuals	Case study, Oral presentation, In-course Exam, Final Exam

Learning materials

i. Recommended readings

- a. Charles K. Alexander, Matthew N. O. Sadiku – Fundamentals of Electric Circuits (5th edition)
- b. Robert Boylestad – Introductory Circuit Analysis (13th edition).
- c. R. M. Kerchner, G.F. Corcoran – Alternating Current Circuits, 4th Edition.

ii. Supplementary Readings

- a. A Textbook of Electrical Technology (vol: I and II), B. L. Theraja
- b. Alternating Current Circuit, George F. Corkoran

iii. Others: Lecture/hand notes provided by the course teachers.

Course Code: 0533-Phy-1204 **Course Title:** Physics and Electronics Lab **Credits:** 1.5

Rationale of the course: This course will cover the basic principles of fundamental physics and Electronics through experiments that will help the students getting practical knowledge on application of theory to practical aspects. It also provides an elementary training to the students on carefulness in handling scientific instruments in a laboratory for accomplishing an experiment successfully.

Course Contents

Part A: Physics

1. Determination of the value of “g” by Kater’s reversible pendulum.
2. Verification of Ohm’s law and measurement of low resistance by ammeter and voltmeter.
3. Determination of the refractive index of a material of a given prism by a spectrometer.
4. Determination of the grating constant of a plane diffraction grating.
5. Determination of the value Y , η and σ for the material of a given wire by Searle’s apparatus.
6. Determination of the modulus of rigidity of a cylindrical wire by dynamic method.

Part B: Electronics

1. Verification of voltage divider and current divider rule.

2. Verification of Thevenin's theorem.
3. Determination of the characteristics of I-V curve of a diode.
4. Verification of the mechanism of half wave rectifier.
5. Study the basic characteristics of logic GATES.

Course Objectives

- a) To provide a broad training in physics and electronics principles with laboratory experiments.
- b) To assist the students become more proficient in measurements, dimensioning, critical thinking, and data analysis.
- c) To help the students to pursue independent research towards the development of new devices and products using sophisticated engineering concepts.

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify the different physical parameters and their importance in understanding and manipulating voltages, currents and resistances in electronic circuits.	C2, P2, A3
CLO2	Apply experimental techniques on the basis of established theory to determine/compare the values of specific parameters.	C3, A3
CLO3	Design and conduct experiments, as well as to analyze and interpret data.	C5, P3, A4
CLO4	Develop the ability to collaborate with peers in a scientific/lab environment which will eventually help to communicate their ideas with others and function effectively in multidisciplinary terms.	C3, A3
CLO5	Draw meaningful conclusions from the experimental data and present them as a part of a clear, well-organized lab report.	C4, A4

Mapping of CLO with PLO

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	3										
CLO2	3	3										
CLO3	3	3	2		2							
CLO4	3	3							2	2		2
CLO5	3	3								2		2

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, Demonstration, and Hands-on practice	Lab Performance, Final Exam
CLO-2	Lecture, Demonstration, and Hands-on practice	Lab Performance, Final Exam
CLO-3	Lecture, Demonstration, Hands-on practice, Video presentation, and Problem-based group discussion	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO-4	Lecture, Demonstration, Hands-on practice, Video presentation, and Problem-based group discussion	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO-5	Lecture, Demonstration, Hands-on practice, Video presentation, and Problem-based group discussion	Lab Performance, Continuous assessment: Viva, Report, Final Exam

Learning materials

- i. **Recommended readings**
 - a) Charles K. Alexander, Matthew N. O. Sadiku – Fundamentals of Electric Circuits (5th edition)
 - b) Robert Boylestad – Introductory Circuit Analysis (13th edition).
 - c) R. M. Kerchner, G.F. Corcoran – Alternating Current Circuits, 4th Edition.
- ii. **Supplementary Readings**
 - a) A Textbook of Electrical Technology (vol: I & II), B. L. Theraja
 - b) Alternating Current Circuit, George F. Corkoran
- iii. **Others:** Lecture/hand notes provided by the course teachers

Course Code: 0541-Math-1205 **Course Title:** Calculus **Credits:** 3.0

Rationale of the Course: This course will help students develop a deeper grasp of functions, differentiation, and integration. Calculus concepts explored include limits and continuity, derivatives, definite integrals, exponential and logarithmic functions, trigonometric functions, and techniques of integration. Examining how calculus is used in the actual world is a major focus of this course.

Course Content

Differential calculus: Functions of real variable and their graphs, limits of functions, continuity and derivative, higher derivatives, Leibnitz theorem, Rolle's theorem, mean value theorem, Taylor's theorem, Taylor's and Maclaurin's series, Maximum and minimum values of functions

and applied maximum and minimum problems in science, and engineering, functions of two and three variables.

Integral calculus: Antiderivatives and indefinite integrals, Techniques of integration, Definite integration using antiderivatives, Definite integration using Riemann sums, Applications of the definite integral in geometry, science, and engineering.

Fundamental theorems of calculus: Basic properties of integration, Integration by reduction, Application of integration: Plane areas, Solids of revolution, Volumes by cylindrical shells, Volumes by cross-sections, Arc length and surface of revolution, Improper integrals: Gamma and beta functions.

Vector calculus: vector function of scalar variables, differentiation of vector functions and applications.

Course Objectives:

- a) To provide a firm foundation in the concepts and techniques of the calculus, including basic functions and graphs and their properties, curve sketching, limits, continuity, differentiation, relative extrema and applications.
- b) To introduce the students with integral calculus, the techniques of integration and some of the applications of integration to physical problems.
- c) To provide knowledge on the applications of calculus in commerce and economics.

Course Learning Outcomes (CLOs): Upon completion of the course, the students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify a function from an algebraic, numerical, graphical, and verbal perspective and extract information relevant to the phenomenon modeled by the function.	C1, A1
CLO2	Describe the concept of limit and continuity of a function at a point graphically and algebraically using appropriate techniques.	C2, A1
CLO3	Calculate the area between curves, volumes of solids of revolution, surface area, arc length using integration.	C3, A2
CLO4	Interpret the derivative of a function at a point as the instantaneous rate of change and as the slope of the tangent line, the consequences of Rolle's theorem, and the mean value theorem.	C4, A3
CLO5	Evaluate integrals using different techniques of integration.	C5, A4

Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	3	-	1	-	-	-	-	-	-	-	-
CLO2	3	3	-	1	-	-	-	-	-	-	-	-
CLO3	3	3	-	2	-	-	-	-	-	-	-	-
CLO4	3	3	-	2	1	-	-	-	-	-	-	-
CLO5	3	2	-	2	-	-	-	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and literature review	Assignment, In-course Exam, and Final Exam
CLO2	Lecture, group discussion, and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO3	Lecture, guided reading, and problem-based learning (PBL)	Assignment, In-course Exam, and Final Exam
CLO4	Lecture, group discussion, and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO5	Lecture, group discussion, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) H. Anton, I. C. Bivens, S. Davis, Calculus.
- b) E.W. Swokowski, Calculus.
- c) James Stewart, Calculus: Early Transcendentals.

ii. Supplementary Readings

- a) Deborah Hughes-Hallett, Applied Calculus.
- b) Stefan Waner and Steven Costenoble, Applied Calculus.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0611-CSE 1207 **Course Title:** Fundamentals of Computer and Information Technology **Credits:** 3.0

Rational of the Course: The main objective of this course is to introduce the fundamentals of computing devices and reinforce computer vocabulary, particularly with respect to personal use of computer hardware and software, the internet, networking and mobile computing. It focuses on such computer literacy that prepares students for life-long learning of computer concepts and skills. Students discover why computers are essential components in education, leather industries, business and society in this course.

Course Content

Computer Basics: Generations of computer, block diagram of a computer, functions of the different units: input unit, output unit, memory unit, CPU (ALU+CU), input and output devices, computer memories: primary memory, secondary memory.

Computer Hardware and Software: Computer hardware, computer software, types, computer languages: machine language, assembly language, high-level language, program language translators: assembler, compiler, interpreter, computer virus: types of virus.

Operating System: Some popular operating Systems - UNIX - MS-DOS - Windows XP - Windows Vista – Linux, process management - multi-programming - multi-Tasking - multi-threading - multi-processing - time sharing - memory management - file management.

Digital Logic Design: Boolean algebra - logic gates - AND, OR, NOT, NAND, NOR gate - logic circuits - converting expression to logic circuit - universal NAND gate - universal NOR gate - Exclusive OR and equivalence function - design of combinational circuit - design of half-adder - design of full- Adder

Computer Networks: Resource share: hardware, software, information, network types: private, public, peer-to-peer, client-server, PAN, LAN, MAN, WAN, Network-relate devices: modem, NIC, hub, switch, router, gate-away, bridge, repeater, network topology: star, mesh, ring, bus, tree, hybrid, cloud computing

Communication systems: Analog signal, digital signal, data communication system, data transmission speed, data transmission method, bit synchronization, data transmission skills, data transmission mode, wired communication media: co-axial cable, twisted pair cable, optical fiber cable, wireless communication media: Wifi, bluetooth, hotspot, etc, mobile communication: 1G, 2G, 3G, 4G, TDMA, FDMA, CDMA, GSM, Telephone Number Systems in Bangladesh.

Internet: How internet works, internet server, ARPANET, types of internet, OSI Model, TCP/IP model, IP addressing, VPN.

Course Objectives:

- a) To introduce essential terms related to the computer and to software program menus
- b) To provide students with the fundamental vocabulary of key terms related to computer hardware and software.
- c) To develop knowledge of computer operating systems and language.

d) To introduce students to data management, and communication systems.

Course Learning Outcomes (CLOs): Upon completion of the course, the students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the computer and information technologies, their internal mechanisms, and classifications.	C1, A1
CLO2	Explain the basics of the internet, mobile and wireless communications.	C2, A2
CLO3	Apply the fundamental of computer programming as well as the software development process and networking.	C3, A2
CLO4	Analyze and evaluate the information system briefly with real-life examples.	C5, A3

Mapping of CLOs with PLOs

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO 1	3	2	1	1	2	-	-	-	-	2	-	-
CLO 2	3	2	2	1	2	1	-	-	-	2	-	-
CLO 3	3	2	2	2	3	-	-	-	-	3	-	-
CLO 4	3	2	1	3	3	1	-	-	-	3	-	3

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, multimedia presentation, group discussion,	Assignment, In-course Exam, and Final Exam
CLO2	Lecture, multimedia presentation, group discussion	Assignment, In-course Exam, and Final Exam
CLO3	Lecture, multimedia presentation, group discussion	Assignment, In-course Exam, and Final Exam
CLO4	Lecture, multimedia presentation, group discussion	Group Presentation, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

a) H. Anton S. France- Computer Science.

- b) Warford- Computer Science.
- c) Peter Norton – An Introduction to Computer Science.
- d) L. Rosch- Hardware Bible, Baraddy Publishing, Indianapolis.
- e) Clive Finkelstein – An Introduction to Information Engineering.
- f) Ian Macdonald - Information Engineering.

ii. Supplementary Readings

- a) James Martin - Information Engineering: Introduction.
- b) Kenneth C. Laudon and Jane P. Laudon- Management Information Systems: Managing the Digital Firm.
- c) Managing the Digital Firm.
- d) James A. O'Brien George M. Marakas - Introduction to Information System.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0611-CSE 1208 **Course Title:** Fundamentals of Computer and Information Technology Lab

Credits: 1.5

Rational of the Course: A hands-on introduction to personal computers and application software. Students will learn basic computer terminology, the role of computers in society, and the use of word processing, spreadsheet, presentation, database, and Internet software.

Course Content

Operating Computer using GUI Based Operating System: What is an Operating System; Basics of Popular Operating Systems; The User Interface, Using Mouse; Using right Button of the Mouse and Moving Icons on the screen, Use of Common Icons, Status Bar, Using Menu and Menu-selection, Running an Application, Viewing of File, Folders and Directories, Creating and Renaming of files and folders, Opening and closing of different Windows; Using help; Creating Short cuts, Basics of O.S Setup; Common utilities.

Understanding Word Processing: Word Processing Basics; Opening and Closing of documents; Text creation and Manipulation; Formatting of text; Table handling; Spell check, language setting and thesaurus; Printing of word document, Latex.

Making Small Presentation: Basics of presentation software; Creating Presentation; Preparation and Presentation of Slides; Slide Show; Taking printouts of presentation/handouts. Using Spread Sheet: Basics of Spreadsheet; Manipulation of cells; Formulas and Functions; Editing of Spread Sheet, printing of Spread Sheet.

Web meeting: GoToMeeting, Cisco WebEx, TeamViewer, Skype, Join.me, Zoom, Google Meet, Microsoft Teams, Dialpad Meetings, Apache Open Meeting.

Database Management System: My SQL language.

Course Objectives: Make the students able to-

- Solve basic information systems problems using MS Office products appropriate for the solution.
- Communicate in a business environment using the MS Office product appropriate for communication.
- Use computing technology ethically, safely, securely, and legally.
- Describe and analyze computer hardware, software, and the internet.
- Use file management techniques for file and directory/folder organization.

Course Learning Outcomes (CLOs): Upon completion of the course, the students will be able to –

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Apply the basic MS Office tools to prepare word files, and spreadsheets with figures, columns, and tables.	C3, A2, P1
CLO2	Illustrate how to use a popular spreadsheet to maintain a minor bookkeeping, statistical and graphical analysis of data.	C2, A2, P2
CLO3	Prepare academic and professional PowerPoint presentations using MS Office products and Illustrator.	C4, A3, P3
CLO4	Execute the basics of computer programming.	C4, A4, P4

Mapping of CLOs with PLOs

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	3	2	1	1	2	-	-	-	-	-	-	3
CLO2	3	2	-	1	3	1	-	-	-	2	-	2
CLO3	3	2	-	2	2	-	-	-	-	2	1	3
CLO4	3	2	1	2	3	-	-	-	-	-	2	1

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, multimedia presentation, group discussion	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO-2	Lecture, multimedia presentation, group discussion	Group Presentation, Lab Performance, Continuous assessment: Viva, Report, Final

		Exam
CLO-3	Lecture, multimedia presentation, group discussion	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO-4	Lecture, multimedia presentation, group discussion	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO-5	Lecture, multimedia presentation, group discussion, and problem-based exercises	Group Presentation, Lab Performance, Continuous assessment: Viva, Report, Final Exam

Learning Materials

i. Recommended Readings

- a) Clive Finkelstein – An Introduction to Information Engineering.

ii. Supplementary Readings

- a) James A. O'Brien George M. Marakas - Introduction to Information System.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0531-Chem-1209 **Course Title:** Organic Chemistry **Credits:** 3.0

Rationale of the Course: The course is designed to provide fundamental knowledge related to basic organic chemistry. The students will learn about different organic functional groups, their synthesis, reaction mechanisms as well as structural orientations. This course also provides basic knowledge about fat, oil, wax, pigment, paints, varnish, and lacquers.

Course Contents

Introduction: A review of different organic functional groups, factors affecting melting and boiling point of organic compounds, hybridization of simple organic compounds, isomerism: geometrical and optical isomerism.

Concept of organic reaction: Electronic displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; carbocations, carboanions, free radicals, nucleophiles, electrophiles, organic acids and bases and their relative strength.

Aromatic compounds: Aromaticity: Hückel's rule, aromaticity of common heterocyclic compound, electrophilic and nucleophilic aromatic substitution reactions, orientation of substitution reaction of benzene derivatives, aromatic amines, types of amines, diazonium salt, azo compounds, coupling reaction.

Carboxylic acids: Structure, preparation, properties, and use of carboxylic acids; Functional derivatives of carboxylic acid: Structure, preparation, properties, relative reactivity of acid halides, acid anhydrides, esters, and amides.

Amino acids and protein: Introduction, synthesis and reaction of amino acids, physical and chemical properties of amino acids, peptide bond, structure of proteins: primary, secondary, tertiary, and quaternary, denaturation.

Fats, oils, and waxes: Introduction to fat, oil and wax, fatty acids, physical and chemical properties, analysis of fat and oil: Free acid and alkali value, acid value, iodine value, saponification value, and unsaponifiable matter, Acetyl value, Reichert meissl and Polenske value.

Paint, varnish, and lacquers: Pigment, classification of pigment, paints, constituents of paints, varnish, characteristics, constituents, types of varnish, comparison between varnish and lacquers.

Course Objectives:

- To provide the fundamental principles of organic chemistry, synthesis, and reactivity of important functional groups.
- To impart knowledge on functional group transformations, simple reaction mechanisms, and the synthesis of organic molecules by multi-step synthesis strategies.
- To deliver conceptual knowledge about fat, oil, wax, pigment, paints, varnish, and lacquers.

Course Learning Outcomes (CLOs): Upon completing this course students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the fundamental principles of organic chemistry that include chemical bonding, hybridization, physicochemical properties, and isomerism.	C1, A1
CLO2	Explain the concepts of aromaticity and the reaction orientation of benzene derivatives with mechanisms.	C2, A2
CLO3	Illustrate the preparative methods, properties, reactions, and uses of carboxylic acid and its functional derivatives as well as aromatic amines and diazonium salt.	C3, A3
CLO4	Compare the structural properties of amino acids and the formation of protein.	C4, A3
CLO5	Analyze and interpret the physicochemical properties of lipids, and surface-coating materials.	C4, C5, A3

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO	3	2	-	-	-	-	-	-	-	-	-	-

1												
CLO 2	3	2	-	-	-	-	-	-	-	-	-	-
CLO 3	2	2	1	-	-	-	-	-	-	-	-	-
CLO 4	3	3	2	2	-	-	-	-	-	-	-	-
CLO 5	3	2	2	2	2	-	-	-	-	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive audiovisual lectures, group discussions, problem-solving practices	In-course Exam; Final Exam
CLO2	Lecture, whiteboard illustration, slide presentation, problem-based exercises	Quiz, Final Exam
CLO3	Lecture, slide presentation, group discussion, whiteboard illustration, and problem-based exercises	In-course Exam, Final Exam
CLO4	Lecture, multimedia presentation	In-course Exam, Final Exam
CLO5	Lecture with whiteboard illustration, multimedia presentation, audio-visual	Assignment, In-course Exam, Final Exam

Learning materials

i. Recommended readings

- Morrison and Boyd- Organic Chemistry.
- I. L. Finar- Organic Chemistry, Volume - 1
- O.G. Palanna- Engineering Chemistry

ii. Supplementary Readings

- Raghupati Mukhopadhyay- Engineering Chemistry.
- B. S. Bahl and Arun Bahl- Organic Chemistry.

iii. Others: Lecture/hand notes provided by the course teachers.

Course Code: 0531-Chem-1210 **Course Title:** Organic Chemistry Lab **Credits:** 1.5

Rationale of the Course: The course is designed to provide practical knowledge related to safety during working in an organic chemistry laboratory, and the development of skills for the use of lab apparatus and equipment using mainly qualitative and quantitative analysis of organic compounds and leather chemicals.

Course Content

1. Identification of organic compounds: Physical appearance, elemental analysis (detection of N, S, and halogens in organic compounds), solubility test, functional group analysis: carboxylic acids, carbonyls, alcohols, phenols, esters, amines, amides, and substituted amides, nitro compounds, unsaturated compounds, halogenated compounds, thiol compounds, determination of physical properties of organic compounds, literature survey, the naming of the identified compounds.

2. Test for protein and amino acids.

Course Objectives:

- To conduct experiments on the identification of organic compounds through systematic analysis.
- To provide the facility to carry out experiments related to the chemical analysis of leather samples.
- To improve students' capability for both individual and teamwork.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Demonstrate elemental analysis of organic compounds and leather samples.	C2, A2
CLO2	Manipulate the laboratory experiments on functional group analysis of organic compounds and leather samples.	C2, P2
CLO3	Determine melting and boiling point of organic compounds as well as conduct the systematic analysis of organic compounds.	C3, A2
CLO4	Perform and analyze laboratory experiments on quantitative analysis of amino acids, and proteins through specific tests as individual and/or teamwork.	C3, C4, P3, A3
CLO5	Prepare laboratory reports based on experimental data without resorting to plagiarism.	C5, A4

Mapping of CLOs with PLOs

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO 1	3	2	-	-	-	-	-	-	1	-	-	-
CLO 2	3	2	-	-	-	-	-	-	2	-	-	-
CLO 3	3	2	-	-	2	-	-	-	2	-	-	-
CLO 4	2	2	2	-	-	-	-	-	3	-	-	-
CLO 5	2	2	-	-	-	-	-	2	3	2	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
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CLO1	Interactive Lectures, Group Discussions, Demonstrations, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO2	Lecture, Demonstration, and Group work	Quiz, Report evaluation, Final Exam
CLO3	Lecture, Demonstration, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO4	Lecture, Demonstration, Hands-on practice, and Group work	Quiz, Report evaluation, Viva voce
CLO5	Interactive Lectures, Demonstration	Report Evaluation, Viva voce

Learning Materials

i. Recommended Readings

- a) Oliver Kamm- Qualitative organic analysis; an elementary course in the identification of organic compounds
- b) Ralph L. Shriner- The Systematic Identification of Organic Compounds

ii. Supplementary Readings

- a) Vogel A. I. - Text Book of Quantitative Chemical Analysis
- b) P. K. Sarker - Analytical Chemistry for Leather Manufacture.

iii. Others: Lecture notes and Laboratory procedure provide by the course teachers.

Course Code: 0723-LE-2101

Course Title: Leather Processing-II

Credits: 3.0

Rationale of the Course: This course is intended to introduce students to different mineral elements (especially transition metals) and their salt's potentiality in leather tanning through different theories and mechanisms. This course also covers the whole periodic table element discussions based on tanning potency and compares it to available mineral tanning salt. This course also improves the student's thinking ability to discover new kinds of tanning agents.

Course Contents

Theory and behavior of group elements: Relevance of Werners co-ordination theory in tanning, behavior of group elements, chromium, aluminium, zirconium, iron, titanium, difference between salts of these elements.

Tanning: Basic concept, theoretical background, tanning potentials of various metals, non-metals, natural and synthetic materials, tanning characteristics, hydrothermal stability and shrinkage temperatures of various tanning materials.

Chrome tanning: Chromium complexes and their structures, study on the phenomena of hydrolysis, olation, oxolation, polymerisation of chrome complexes, masking, principle of masking, effect of masking on chrome tannage, method of chrome tannage, preparation of chrome liquors and powders, influence of reducing agent on nature of chrome complexes mechanism of chrome tanning, variable parameters of chrome tanning.

Environmental impact of chrome tanning: Emissions and environmental impact, chrome balance in leather manufacturing, optimization of the process parameters- high exhaustion-

modification of the tanning process, direct chrome recycling, chrome recovery and reuse, recovery without reuse, chrome-free leather, wet-white concept, chrome free leather-other mineral tannages.

Aluminium tanning: Tanning behaviour of salts of aluminium, study on phenomena of ololation, oxolation and masking in aluminium salts, mechanism of aluminium tannage.

Zirconium tanning: Tanning behaviour of salts of zirconium, factors affecting zirconium tannage, mechanism of zirconium tannage, tanning behaviour of salts of iron and titanium, tannages involving the use of sodium silicate and poly phosphates.

Other tanning operations: Titanium tanning and iron tanning.

Course Objectives:

- a) To introduce the different mechanisms of mineral tanning and their suitable applications in leather making to make them understand the basic mechanisms of related leather engineering.
- b) To understand the importance of different kinds of mineral tanning salts and their application stages of tanning and comprehend the chemistry and mechanism of tanning through the method of tanning process.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Define and describe various tanning principles.	C1, A1
CLO2	Apply the different kinds of mineral tanning salts according to their tanning potency and the numeric change of the tanned leather will be understood.	C3, A4
CLO3	Investigate different tanning potential of different tanning agents in leather manufacturing.	C4
CLO4	Justify and formulate the different tanning processes of leather making through the various salts in mineral tannage to produce quality leather.	C5

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	3										
CLO2	3	3	2									
CLO3	3	3	3		1							
CLO 4	3	3	3	2								

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, Assignment	In-course Exam, Final Exam
CLO-2	Lecture, Assignment, Presentation	Group Presentation, In-course Exam, Final Exam
CLO-3	Lecture, Hands-on Demonstration	Group Presentation, In-course Exam, Final Exam
CLO-4	Lecture, Assignment, Presentation	In-course Exam, Final Exam

Learning Materials

i. Recommended Readings

- a) Theory and Practice of Leather Manufacture- K.T. Sarkar
- b) Tanning Chemistry, The Science of Leather-Anthony D Covington
- c) Possible Defects in Leather Production-Gerhard John
- d) Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edn. I. L. T. A., Calcutta.

ii. Supplementary Readings

- a) Chemistry and Technology of Leather-Roddy, O` Flaherty and Lollar, Vol. 2 and 3. Robert E. Kreiger Publishing Co., N. Y.
- b) Chemistry of Tanning Processes – K. H. Gustavson, Academic Press N. Y.
- c) Leather Technician`s Handbook –J. H. Sharpouse, Vernon Lock Ltd., 125 High Holborn, London W-C1.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-2102 **Course Title:** Leather Processing-II Lab **Credits:** 1.5

Rational of the Course: The aim of the course is to give practical knowledge of different tanning materials and improve the skills in leather manufacturing. This course will provide students with the post-tanning operation and the practical experience of producing crust leather.

Course Contents:

1. Manufacturing of fur skin from goatskin and sheep skin.
2. Manufacturing of chrome tanned wet blue leather.
3. Effect of basification with different basifying agent in chrome tanning.
4. Effect of masking with different masking agent in chrome tanning.
5. Effect of chromium absorption due to low float, pH, time, temperature and mechanical agitation.
6. Manufacturing of full chrome shoe upper dyed crust leather.
7. Manufacturing of semi chrome crust leather.
8. Manufacturing of combination (chrome and other mineral tannage) tanned leather.
9. Manufacturing wet white natural crust leather.

10. Manufacturing of chrome free combination tanned leather.

Course Objectives:

- a) To introduce students to different leather processing techniques.
- b) To enhance the student's ability to analyze and evaluate the issues of practicality in the area of leather manufacturing.
- c) To enhance the knowledge and skills of students for designing and conducting post-tanning operations for the production of crust leather.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning level
CLO1	Recall the basic knowledge of crust leather production	C1, A1
CLO2	Interpret practical efficiency in critical thinking by presenting and evaluating arguments in an academic fashion.	C3
CLO3	Explain the manufacturing process using several tanning methods	C4, A3
CLO4	Modify several techniques for the development of leather processing	C3, C4

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	3	2							2			
CLO2	3	2		2					2			
CLO3	3	3		2					2			
CLO4	3	3		2	2				2			

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, Demonstration, Hands-on practice and Group work	Lab Performance, Report, Final Exam
CLO-2	Lecture, Demonstration, Hands-on practice and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO-3	Lecture, Demonstration, Hands-on practice and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO-4	Lecture, Demonstration, Hands-on practice, Group work and Assignment	Lab Performance, Viva, Final Exam

Learning Materials

i. Recommended Readings

- a) Theory and Practice of Leather Manufacture- K.T. Sarkar
- b) Tanning Chemistry: The Science of Leather-Anthony D Covington
- c) Possible Defects in Leather Production-Gerhard John.

ii. Supplementary Readings

- a) Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edition.
- b) Theory and Practice of Leather Manufacture–K. T. Sarkar, Macmillan India Press, Madras
- c) Leather Technician`s Handbook–J. H. Sharphouse, Vernon Lock Ltd., 125 High Holborn, London W-C1

iii. Others: Lab procedures/lecture material provided by the course teacher

Course Code: 0723-LE-2103 **Course Title:** Leather Biotechnology **Credits:** 3.0

Rationale of the Course: This course provides an in-depth understanding of biotechnology, its historical development, and its scope. It covers the classifications of bacteria, basic concepts of mycology, classifications of moulds, and fungal problems in the leather industry. It also covers general principles of microbial control and microbial fermentation; the basic concepts of enzymology and the histology of hides, skins, and leather.

Course Content

Introduction to biotechnology: Historical development, scope of biotechnology, biotechnology in leather processing.

Bacteriology: Bacteria and its morphology classification, bacterial classifications: morphological, mode of nutrition, temperature and pH; structure, nutritional requirements, bacterial culture media, bacterial interaction, bacterial staining and microscopy: simple staining, Gram staining, right field microscopy, dark field microscopy, fluorescence microscopy and electron microscopy.

Mycology: Introduction, spores and its types, classification of moulds, morphology of moulds, biochemistry of moulds, laboratory techniques for the study of mould, fungal problems in leather industry and their remedies.

Control of microorganism: General principles of microbial control, control of undesirable microorganisms by physical means, chemical disinfectants and their uses, sterilization and its kinds, method and means of sterilization, merits and demerits of different methods of sterilization, causes of sterilization failure, pasteurization, control of microorganism in leather industry: applications of bactericides, fungicides and insecticides in leather industry.

Microbial fermentation: Introduction to fermentation: bacterial growth phases, types of fermentations, fermentation equipment, preparation of media, preparation of inoculums, control and measurement of products, function of pH, temperature and O₂ concentration.

Enzymology: Basic concepts of enzymes—characteristics, classification, catalytic properties, lowering of activation energy, prosthetic group, coenzyme, cofactor, concept of specificity of enzyme, effect of substrate concentration, temperature and pH on enzyme activity; activity unit, specific activity, turnover number, Michaelis–Menten equation, K_m and V_{max} determination and their significance; enzyme inhibition—reversible and irreversible, different methods for enzyme assay, conventional leather processing, application of enzymes in curing, soaking, dehairing, bating, degreasing, tanning.

Histology of hides, skins and leather: Introduction to histology, scope of histology in leather processing, preparation of specimen for sectioning, different method of sectioning, methods for staining, quick test for defects identification.

Course Objectives:

- a) To provide students with an understanding of the historical development and scope of biotechnology in leather industry.
- b) To introduce students to the morphology and classification of bacteria.
- c) To familiarize students with the basic concepts of mycology, and fungal problems in the leather industry.
- d) To teach students about general principles of microbial control and explore physical and chemical disinfectants, sterilization methods, and pasteurization.
- e) To familiarize students with the basic concepts of enzymology, histology of hides, skins, and leather.

Course Learning Outcomes (CLOs): After completing this course, students will be able to

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the historical development and scope of biotechnology in the leather industry.	C1, A1
CLO2	Illustrate the process of bacterial classification, culture, and identification using different staining and microscopy techniques.	C2
CLO3	Explain the biochemistry of different spores and molds and use laboratory techniques for their study.	C3, C4
CLO4	Explain the methods of histology of hides, skins, enzymology and enzymes of application in leather manufacturing.	C4,
CLO5	Contrast the concepts of physical and chemical disinfectants and sterilization methods to control microorganisms in the leather industry.	C5, A4

Mapping of CLO with PLO

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
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CLO1	3				2	1						
CLO2	3	2		3	3							
CLO3	3		2	2	3							
CLO4	3	2		3	3							
CLO5	3	3		2	3		2					

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive Lecture, Lecture, Slide presentation, Audio-visual presentation	In-course Exam; Final Exam
CLO2	Interactive Lecture, Slide presentation	Assignment, In-course Exam; Final Exam
CLO3	Interactive Lecture, Slide presentation	In-course Exam; Final Exam
CLO4	Interactive Lecture, Slide presentation	Assignment, In-course Exam; Final Exam
CLO5	Interactive Lecture, Slide presentation, Hands on Demonstration	Assignment, In-course Exam; Final Exam

Learning Materials

i. Recommended Readings

- Srivastava S. and Singhal V.-Fundamentals of Microbiology
- Lechniger -Biochemistry: The Molecular Basis of Cell Structure and Function, 2nd edition, Kalyani Publishers, Ludhjana, 1978.
- R.Puvararishnan, Susil C. Dhar- Enzyme Technology In Beamhouse Practice.

ii. Supplementary Readings

- Stanbury P.F. and Whitaker A. - Principles of Fermentation Technology, Pergamon Press, 1984.
- Wiseman A.-Topics in Enzyme and Fermentation Biotechnology' (Several volumes). Vol.2.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-2104 **Course Title:** Leather Biotechnology Lab **Credits:** 1.5

Rationale of the Course: Students will receive an immersive introduction to fundamental microbiological techniques employed in the leather industry. They will master the art of preparing and sterilizing diverse media, isolating bacteria, and executing various staining and microscopy techniques. Through extensive training, students will acquire the skills to identify

and enumerate bacteria and to produce crude enzymes and measure their enzyme activity. Finally, this course will cover demonstration of histological techniques used for studying the internal structure of hides, skins, and leather.

Course Content

1. Microscopy: Observing the constituent parts of a compound microscope; studying depth of focus and field of view and estimating the apparent size of an object.
2. Microscopic study of leather defects due to moulds/ insect/bacteria/fungi Preparation, sterilization and dispensing of different bacterial media.
3. Preparation of bacterial pure culture by streak plate techniques and inoculation on different nutrient bacterial media for biochemical characterization.
4. Observation of cultural characteristics of bacteria on various media.
5. Simple staining and Gram staining of different bacterial species.
6. Enumeration of bacteria by spread plate techniques
7. Section cutting, staining, mounting of samples and observing under microscope.
8. Isolation and identification of enzyme producing bacteria from different environmental sources.
9. Production and characterization of enzyme from the isolated bacteria and comparison of the enzyme activity of commercial enzymes.
10. Determination of the enzyme activity of crude proteolytic enzymes extracted from isolated proteolytic bacteria.

Course Objectives:

- a) To introduce students to the principles and practices of microbiology, including bacterial cultivation and identification.
- b) To provide students with hands-on experience in the preparation, sterilization, and dispensing of different types of media used in bacterial cultivation and identification.
- c) To teach students the techniques for preparing bacterial pure cultures using streak plate techniques and inoculating media for biochemical characterization.
- d) To familiarize students with the different types of staining techniques used in bacterial microscopy, including simple and gram staining.
- e) To equip students with the skills necessary for the isolation and identification of moulds in pelts, wet-blue, and vegetable tanned and finished leathers, stored leather, and shoe and leather goods.

Course Learning Outcomes (CLOs): After completing this course, students will be able to

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Demonstrate mastery of using a compound microscope to identify and classify microorganisms.	C3, A3, P2
CLO2	Conduct a comparative microscopic study of hides and skins at different stages of processing.	C4, P3

CLO3	Prepare and inoculate various types of bacterial media, and evaluate the cultural characteristics of bacterial colonies.	C3, C4, P3
CLO4	Apply sectioning and staining techniques to prepare samples for microscopic observation.	C3, P3
CLO5	Perform isolation and identification of bacteria and mold species in leather wastes and leather products.	C3, P3
CLO6	Determine the enzyme activity of enzymes and explain their applications in leather processing.	C3, P3

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	2		2	3				3	3		
CLO2	3	2			3				3	3		
CLO3	3				3				3	3		
CLO4	3			1	2				3	3		
CLO5	3	2			3				3	3		
CLO6	3	2		2	3				3	3		

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture on theoretical background, Slide presentation, Hands on demonstration, and Group Discussion	Lab Performance, Continuous assessment: Viva, Report, and Final Exam
CLO2	Hands on demonstration, Group Discussion	Lab Performance, Continuous assessment: Viva, Report, and Final Exam
CLO3	Slide presentation, Hands on demonstration, and Group Discussion	Lab Performance, Continuous assessment: Viva, Report, and Final Exam
CLO4	Lecture on theoretical background, Hands on demonstration, and Group Discussion, and Slide presentation	Lab Performance, Continuous assessment: Viva, Report, and Final Exam
CLO5	Lecture on theoretical background, Hands on demonstration, and Group Discussion, and Slide presentation	Lab Performance, Continuous assessment: Viva, Report, and Final Exam

CLO6	Hands on demonstration, and Group Discussion, and Slide presentation	Lab Performance, Continuous assessment: Viva, Report, and Final Exam
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Learning Materials

i. Recommended Readings

- a) Stanbury P.F. and Whitaker A. - Principles of Fermentation Technology, Pergamon Press, 1984.
- b) Lechniger -Biochemistry: The Molecular Basis of Cell Structure and Function, 2nd edition, Kalyani Publishers, Ludhjana, 1978.
- c) R.Puvararishnan, Susil C. Dhar- Enzyme Technology In Beamhouse Practice.

ii. Supplementary Readings

- a) Srivastava S. and Singhal V.-Fundamentals of Microbiology.
- b) J. Nicklin [et al]-Microbiology.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: LE 2105 **Course Title:** Dyeing and Finishing-I **Credits:** 3.0

Rationale of the Course: This course provides an in-depth understanding of color concepts, color production, and dyeing techniques. Students will become familiar with a broad range of topics such as colorimetry, color space, different types of dyes, and their behavior in solutions for leather finishing. This course includes different thermodynamics properties, and behavior of dye in leather finishing.

Course Content

Color and constitution: Color concept; types of color and colorants, theory of color production, different primaries and intermediates, unit process for primaries and intermediates preparation.

Color and Vision: Theories of color vision, attributes of color, color space, method of investigating the perception of color, color appearance phenomena.

Colorimetry and Color System: Principle of additive and subtractive color mixing, different color system, color specification system, CMC method of color matching, color matching booth, different fastness properties.

Dyes: Classification of dyes, structure of natural and synthetic dyes, preparation of dyes and their interaction with leather, azo dyes preparation, reaction mechanism between dyes and fiber; metal complex dyes: chemistry, mechanism, selection of leather dyes; properties of leather dyes; leather dyes in Color Index (CI).

Behavior of Dyes in Solution: Nature of dye solution, aggregation of dyes, determination of aggregation number- Nernst-Husckel equation, Fick's law of diffusion, factors affecting diffusibility, measurement of diffusion coefficient, affinity of dyes.

Thermodynamics of Dyeing: Thermodynamic laws, activity of dyes, standard affinities of dyes for fibers, equilibrium state on affinity, adsorption isotherms, adsorption at surface and dye bath-fiber interfaces, dyeing equilibrium, half-time, entropy and enthalpy of dyeing.

Pigments: Properties of pigments, classification, organic and inorganic pigments, opacity, particle size, resistance to solvent, heat, light and color matching, pigment dyeing: advantages and limitation.

Course Objectives:

- a) To provide knowledge about the principles of color production, color space, color mixing, and colorants.
- b) To familiarize students with widely used dyes and pigment and their mechanisms with leather.
- c) To enable students to improve the finished leather appearance by applying various finishing techniques, and methods.

Course Learning Outcomes (CLOs): After completing this course, students will be able to-

CLOs	Course Learning Outcomes	Learning Level
CLO1	State the principle of different color concepts, the behavior of dyes in solution, and their interaction with leather	C1, A1
CLO2	Explain different types of dyes and their applications in leather dyeing	C2
CLO3	Apply the suitability of dyes, pigments and their properties to ensure quality leather manufacturing.	C3, A2
CLO4	Analyze the thermodynamics of dyeing, including adsorption isotherms and electrical effects	C4
CLO5	Interpret various colors and thermodynamics in leather finishing.	C5

Mapping of Course Learning Outcomes (CLOs) with Programs Learning Outcomes (PLOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO 1	3	2			2							
CLO 2	3	2			2							
CLO 3	3	3	2	1								
CLO 4	3	3	3	3								
CLO 5	3	3	3	2								

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation, and problem-based exercises	Group Presentation, In-course Exam; Final Exam, quiz, assignment, case study, oral presentation
CLO2	Lecture, group discussion and problem-based exercises, literature review.	Group Presentation, quiz In-course Exam; Final Exam
CLO3	Lecture, and problem-based learning: Identifying the problem to be solved	Assignment, Group Presentation, oral presentation, In-course Exam, and Final Exam
CLO4	Lecture, multimedia presentation, literature review, and problem-based exercises	Group Presentation, assignment In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) Eco-Friendly Textile Dyeing and Finishing. Edited by: Melih Günay Advances in the Dyeing and Finishing of Technical Textiles Edited by: M. L. Gulrajani.
- b) Charles Hugh Giles-A Laboratory Course in Dyeing
- c) Lubs H. A. - The Chemistry of Synthetic Dyes and Pigments
- d) Kurt Nassau-The Physics and Chemistry of Colour
- e) Venkata Raman K. - The Chemistry of Synthetics Dyes
- f) Allen R.L.M. - Colour Chemistry

ii. Supplementary Readings

- a) Handbook for Shoe and Leather Processing - Leathers, Tanning, Fatliquoring, Finishing, Oiling, Waterproofing, Spotting, Dyeing, Cleaning, Polishing, - by Anon

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-2106 **Course Title:** Dyeing and Finishing-I Lab **Credits:** 1.5

Rational of the Course: This course aims to deliver practical in-depth knowledge on physical and chemical properties of dyed leather such as the fastness properties, hard water resistance, fastness to acid and alkali, and the co-efficient of various dyes used in leather finishing. Students will be able to comprehend the problems that arise in the leather industry through this course.

Course Content

1. Determination of extinction coefficient of Acid/Direct/Basic/Metal complex/Sulphur dyes used for leather dyeing.
2. Determination of colour fastness of dye solutions to acids and alkali using IUF 202 method.
3. Determination of colour fastness of dye solutions to formaldehyde using IUF 224 method.
4. Determination of stability dye solutions to hard water using IUF 205 method.
5. Determination of colour fastness of leather to day light using IUF 401 method.
6. Determination of colour fastness of leather to water spotting using IUF 420 method.
7. Determination of wash fastness of dyed crust leather/finished leather.
8. Determination of dry-cleaning fastness of clothing leather.
9. Determination of perspiration fastness of garment /clothing leather.
10. Determination of wet and dry rubfastness fastness of finished leather
11. Determination of dry and wet adhesion of a finish coat of the leather using IUF 470 method.

Course Objectives

- a) To provide comprehensive practical knowledge on different fastness properties of dyes as well as finished leathers.
- b) To enhance analytical thinking of influencing chemical and physical parameters of dyeing.
- c) To make competent in determining the fastness properties of any given dyes.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Narrate various Compatibility tests of dyes for leather finishing.	C1, A1
CLO2	Demonstrate different fastness properties for the crust and finished leather.	C2
CLO3	Perform and manipulate techniques for determining different fastness properties of finished leather.	C3, P2
CLO4	Critically analyze comfort tests for the crust and finished leather through different methods.	C4
CLO5	Interpret and evaluate different test results for ensuring finished leather quality.	C3, C4

Mapping of CLOs with PLOs

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	3		3					2			
CLO2	3	2			2				2	2		
CLO3	3	2	3						2			
CLO4	3	2	2						2			
CLO5	3	2	1						3			

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Demonstration and problem-based exercises.	Viva, assignment, report evaluation, and final exam
CLO-2	Group discussion, demonstration of problem-based exercises	viva, report evaluation final exam
CLO-3	Demonstration, identifying the problem to be solved	Assignment, group presentation, quiz, class test, and final exam
CLO-4	Multimedia presentations, group discussions, demonstrations, and problem-based exercises	Group presentation, viva report evaluation, and final exam
CLO-5	Group discussion, demonstration.	Group presentation, assignment, quiz, viva, class test, and final exam

Learning Materials

i. Recommended Reading:

- a) Reed R. (Ed.) - Science for Students of Leather Technology.
- b) Handbook for Shoe and Leather Processing - Leathers, Tanning, Fatliquoring, Finishing, Oiling, Waterproofing, Spotting, Dyeing, Cleaning, Polishing, Chemicals and Dyes, Cements and Glues - by Anon.

ii. Supplementary Reading:

- a) Heidemann E. - Fundamentals of Leather Making.

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0723-LE-2107 **Course Title:** Leather Products Manufacturing **Credits:** 3.0

Rational of the Course: This course is designed to impart fundamental knowledge on leather products design and manufacturing. The course equips students with the familiarization of the production technology of leather products. At the end of the course, students will be able to design and manufacture of basic leather products.

Course Content

Introduction: History of leather products, leather products as apparel and types of leather products, classification of leather goods, terms used in leather goods, tools and machinery, accessories and lining materials, edge construction and finishing, unit operations for leather goods.

Pattern making: Introduction, classification of pattern, indication of pattern, copied pattern, transferring the pattern, material consumption, and costing.

Fabrication technology of leather products: Introduction, preparatory process, bench operations, creasing, edge dyeing or staining, punching, riveting, eyeleting, cementing, edge folding, marking, stamping, embossing, printing, construction method, and assembling.

Shaping techniques: Introduction, types, dart, pleat, lining, interlining, fusing: constructions, advantages, process, requirements, equipment, and quality control.

Body proportion and measurement: Basic concepts, division into eight golden sections, application, and construction, construction of golden rectangle, classification of body type with features, body measurement for garments manufacturing.

Jacket and Waist Coat: Introduction, classification, measurements, designing, pattern making, block making, and manufacturing, finishing of jacket, sleeve, collar, pocket for jacket manufacturing.

Money bag and photo frame: Introduction, types, raw materials, perspective drawing, list of components, measurement instruction, total pattern making, leather consumption, splitting and skiving instruction, construction and assembling.

Course Objectives

- a) To provide fundamental knowledge on leather products manufacturing.
- b) To enhance the skills on leather goods pattern-making process.
- c) To understand the unit operations for leather goods and garments manufacturing.
- d) To equip the students with modern techniques for body proportion and measurement systems in leather garments manufacturing.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	State the fundamental concepts about leather goods and garments.	C1, A1
CLO2	Explain the concepts of unit operations involved in leather goods and garments manufacturing.	C2, A2
CLO3	Prepare and modify different types of patterns involved in leather goods and leather garments manufacturing.	C3, A2
CLO4	Illustrate the measurement techniques of body proportion and relates to the manufacturing process.	C4, C5, A3

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	-	-	-	-	-	-	-	-
CLO2	3	-	3	-	-	-	-	-	-	-	-	-
CLO3	3	2	3	-	-	-	-	-	-	-	-	-
CLO4	3	2	2	-	-	-	-	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation and Literature review	In-course Exam; Final Exam
CLO2	Lecture, group discussion and problem-based exercises, Literature review	Group Presentation, In-course Exam; Final Exam
CLO3	Lecture, problem-based learning (PBL), demonstration.	Assignment, In-course Exam, and Final Exam
CLO4	Lecture, multimedia presentation, group discussion, demonstration, and problem-based exercises	Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended readings

- a) Carrand Latham, The Technology of Clothing Manufacture.
- b) Francesca Sterlacei, Leather Apparel Design.
- c) Moseley, G.C., Leather Goods Manufacture.

ii. Supplementary Readings

- a) Batsford, Fashion with Leather.
- b) Hamlyn, Leatherwork –A step by step Guide.

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0723 LE 2108 **Course Title:** Leather Products Manufacturing Lab

Credit Value: 1.5

Rational of the Course: This course contains details about the leather products manufacture through cutting, Pre-assembling, assembling, bench operations, sewing and finishing operations. The course will also equip the students with knowledge and understanding of production technology of leather goods and garments manufacturing which includes knowledge in pattern construction, designing and styling development and production.

Course Contents

1. **Tooling technique and Pattern making:** Introduction of tools and their uses and tooling technique. Introduction of pattern cutting technique, basic and working pattern making.
2. **Manufacturing of waist belts:** Designing, pattern making, cutting, splitting, skiving, assembling, stitching, final preparation, finishing, costing
3. **Manufacturing of card holder:** Designing, pattern making, cutting, splitting, skiving, assembling, stitching, final preparation, finishing, costing.
4. **Manufacturing of Wallet:** Designing, pattern making, cutting, splitting, skiving, assembling, stitching, final preparation, finishing, costing.
5. **Manufacturing of Ladies purse:** Designing, pattern making, cutting, splitting, skiving, assembling, stitching, final preparation, finishing, costing.
6. **Manufacturing of ladies bag:** Designing, pattern making, cutting, splitting, skiving, assembling, stitching, final preparation, finishing, costing.
7. **Manufacturing of waist coat:** Construction of basic block, pattern making, grading, cutting, splitting, skiving, assembling, stitching, final preparation, finishing, costing:
8. **Manufacturing of skirt:** Construction of basic block, pattern making, grading, cutting, splitting, skiving, assembling, stitching, final preparation, finishing, costing

Course Objectives: The objectives of this course are:

- a. To familiarize students with the various practical aspects of Leather products manufacturing.
- b. To foster an understanding of the importance of pattern engineering.
- c. To enable the students to apply various techniques of design in making leather goods and garments.
- d. To make the students competent in the field of pattern drafting and grading.
- e. To provide comprehensive knowledge about the organization and management of leather goods and garments manufacturing.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Recognize various tools and tooling techniques.	C1, A1, P1
CLO2	Explain the concepts of pattern making for leather goods and leather garments.	C2, A2, P2
CLO3	Use various machineries involved in leather products manufacturing.	C3, A2, P2
CLO4	Assemble different types leather goods and garments.	C3, A2, P3
CLO5	Evaluate different quality parameter of leather goods and leather garments.	C4, A2, P3

Mapping of CLOs with Program Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	2	-	-	-	-	-	-	-
CLO2	3	-	3	-	-	-	-	-	-	-	-	-
CLO3	2	-	-	-	3	-	-	-	-	-	-	-
CLO4	2	-	3	-	2	-	-	-	-	-	2	1
CLO5	2	3	-	-	-	2	-	-	-	-	-	3

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO2	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO3	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO4	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO5	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam

Learning materials

- i. Recommended readings**
 - a) Martin M. Shoben, Pattern Cutting and Making up
 - b) Francesca Sterlacci, Leather Apparel Design .
 - c) Europa Lehrmittel, Clothing Technology
- ii. Supplementary Readings**
 - a) Hamlyn, Leatherwork –A step-by-step Guide.
 - b) Jongensen, Making Leather Clothes.
- iii. Others:** Handout/lecture material provided by the course teacher

Course Code: 0541-Math-2109 **Course Title:** Differential Equations and Numerical Methods
Credits: 3.0

Rationale of the Course: This course is a study of mathematical techniques used to model engineering systems. Differential equations and numerical methods are covered in this course as an introduction. This course deals with the different differential equations, numerical problems, and their real-life applications.

Course Content

Ordinary Differential Equations: Definition of Differential Equation, Order and Degree; Classification of Differential Equations; Formulation; Solution of first order differential equation by various methods; Solutions of general linear equations of second and higher order with constant co-efficient; Solutions of homogeneous linear equation.

Modeling with First Order Differential Equations: Construction of differential equations as mathematical models (exponential growth and decay, heating and cooling, mixture of solutions, series circuit, logistic growth, chemical reaction, falling bodies). Model solutions and interpretation of results.

Modeling with Second Order Differential Equations: Vibration of a mass on a spring, free and undamped motion; free and damped motion; forced motion; electric circuit problems.

Partial Differential Equations: Formation of partial differential equations, solution of standard types of first order equation and Lagrange’s equation, classification of second order partial differential equations, linear partial differential equations of second order and higher order with constant coefficients.

Solution of Equations and Eigenvalue Problems: Solution of algebraic and transcendental equations – Bisection method - Fixed point iteration method – Newton Raphson method – Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method - Eigenvalues of a matrix by Power method.

Interpolation and Approximation: Interpolation with unequal intervals – Lagrange's interpolation – Newton’s divided difference interpolation – Newton’s forward and backward difference formulae.

Numerical Differentiation and Integration: Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's rule – Evaluation of double integrals by Trapezoidal and Simpson's rules.

Initial and Boundary Value Problems for Differential Equations: Runge-Kutta method for solving first-order equations, Milne's and Adams-Bashforth predictor corrector methods for solving first order equations.

Course Objectives: The aims of this course are:

- To introduce the basics of differential equations and terminologies regarding them.
- To solve different types of ordinary differential equations and partial differential equations analytically using well-known techniques.
- To explore the utility of differential equations in modeling numerous physical and biological systems.
- To demonstrate the importance of selecting the right numerical technique for a particular application and carefully analyzing and interpreting the obtained results.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Formulate differential equations by removing arbitrary constants from algebraic relations and draw solutions curves using direction field.	C5, A4
CLO2	Classify first-order differential equations as separable, homogeneous, linear, exact, Bernoulli's, etc. and solve them using appropriate methods.	C2, C3, A2
CLO3	Derive higher order differential equations, classify and solve them using appropriate methods.	C3, A2
CLO4	Find numerical approximations to the roots of an equation by Newton method, Bisection Method, Secant Method, etc.	C3, A2
CLO5	Demonstrate the use of interpolation methods to find intermediate values for any given set of points.	C3, A2

Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	3	-	1	-	-	-	-	-	-	-	-
CLO2	3	3	-	1	-	-	-	-	-	-	-	-
CLO3	3	3	-	1	-	-	-	-	-	-	-	-
CLO4	3	3	-	1	-	-	-	-	-	-	-	-
CLO5	3	3	-	1	-	-	-	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion, problem-based learning (PBL): Identifying the problem to be solved	Assignment, In-course Exam, and Final Exam
CLO2	Lecture, group discussion and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO3	Lecture, group discussion and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO4	Lecture, group discussion, and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO5	Lecture, group discussion, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) S. L. Ross, Differential Equation.
- b) D. G. Zill, A First Course in Differential Equations with Applications.
- c) H.J.H. Piaggio, An Elementary Treatise on Differential Equations.

ii. Supplementary Readings

- a) Chapra. S.C., and Canale. R. P., “Numerical Methods for Engineers”, Tata, McGraw-Hill, New Delhi, 5th Edition, 2007.
- b) Brian Bradie, “A Friendly Introduction to Numerical Analysis”, Pearson Education, Asia, New Delhi, 2007.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-2201 **Course Title:** Leather Processing-III **Credits:** 3.0

Rationale of the Course: The course is designed to share with students to develop knowledge on different types of non-mineral tanning materials and tanning processes. The knowledge of chemistry of vegetable extracts with tanning power, their tanning mechanism, interaction with collagen, biosynthesis and preparation for specific non-mineral tanning are covered in this course.

Course Content

Vegetable tannins: Vegetable tannins: Classification, and physico-chemical properties; vegetable tanning materials and their properties, leaching of vegetable tanning and general methods of tannin extract preparation.

Hydrolysable tannins: Chemistry of poly phenolic tannins present in major hydrolysable tanning material; methods of separation of poly phenolic substance from tanning extracts; structure of galotannins and ellagitannins.

Condensed tannins: Chemistry of flavonoid tannins present in major condensed tanning materials; methods of separation of monomeric flavonoid compounds from tanning extracts; structure of leucoanthocynaidin catchins and polymeric flavonoid tannins.

Biosynthesis of plant polyphenols: Path ways for biosynthesis of gallotannins and ellagitannins in plant, biosynthesis of flavonoids and condensed tannins.

Vegetable tanning: Vegetable tanning: mechanism, principle, sources, supply, affecting factors, process, manufacturing process of different types, pollution load, and cleaner method.

Synthetic tannins: Introduction; classification; general chemistry; general methods of manufacture; properties and use of different types of syntans in leather manufacture; mechanism of tanning with syntans; collagen-syntan interaction; effect of syntans on dyeing and retanning auxiliaries; environmental aspects; cleaner processing.

Resin and polymeric tannages: Different methylol compounds of nitrogen basis and polymeric compounds used in leather manufacture.

Aldehyde tannage: Aldehyde tanning: concepts, mechanism, factors, environmental aspects, cleaner processing; different aldehydes used for tanning; properties of leather tanned with different aldehydes.

Oil tanning: Objectives; theory of oil tanning; application of oil tanning for the production of chamois leather; conditions for oil tanning; environmental aspects; and cleaner processing.

Course Objectives:

- a. To understand and explain the basics of organic tannage.
- b. To familiarize with different tanning agents for organic tannage.
- c. To develop knowledge about the mechanism of vegetable tanning.
- d. To understand and explain the chemistry of syntans and the process of synthetic tanning.
- e. To learn the details of oil tanning and aldehyde tanning.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify and describe vegetable tannins and synthetic tannins, their properties, extract preparation and chemistry.	C1, A1
CLO2	Illustrate the concept of hydrolysable tannin and condensed tannin.	C2
CLO3	Explain the structure of leucoanthocynaidin catchins and polymeric flavonoid tannins in leather processing.	C3, A3
CLO4	Analyze and apply the pathways of biosynthesis of gallotannins and ellagitannins in plant, biosynthesis of flavonoids and condensed tannins.	C3, A4
CLO5	Depict the mechanism of tanning with syntans.	C4, A5
CLO6	Apply and manipulate oil tanning for the production of chamois leather.	C3, C4

Mapping of CLO with PLO

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2										
CLO2	3											
CLO3	3	3	3									
CLO4	3	3		3								
CLO5	3	3	3									
CLO6	3	3	3									

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, Multimedia presentation, and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO-2	Lecture, group discussion and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO-3	Lecture, guided reading and problem-based learning (PBL): Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam, and Final Exam
CLO-4	Lecture, multimedia presentation, group discussion, literature review, and problem-based exercises	Group Presentation, In-course Exam, and Final Exam
CLO-5	Lecture, group discussion, literature review, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) Sarkar, K.T., Theory and Practice of Leather Manufacture.
- b) Anthony D. Covington- Tanning Chemistry: The Science of Leather.
- c) Dutta. S.S., An Introduction to the Principles of Leather Manufacture.

ii. Supplementary Readings

- a) Wilson, J. A., The chemistry of Leather Manufactures Vol. II.
- b) Gustavson, K. H., The Chemistry of Tanning Process.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-2202 **Course Title:** Leather Processing-III Lab **Credits:** 1.5

Rationale of the Course: The purpose of the course is to provide the students practical knowledge and improved skills in leather manufacturing. In this course students will learn to produce leather from raw hide and skins using different mineral and non-mineral tanning materials. The knowledge of crust leather manufacture from tanned leathers with variety of post tanning processes is covered in this course. Students will learn to develop a manufacturing procedure and frame the manufacturing problem with the correct methodology.

Course Content

1. Manufacture of full vegetable (only one vegetable tanning agent) tanned natural crust leather
2. Manufacture of full vegetable (mixed vegetable tanning agent) tanned natural crust leather
3. Manufacture of shoe upper crust leather by combination of chromium and vegetable tanning
4. Manufacture of shoe upper crust leather by combination of aluminum and vegetable tanning agents
5. Manufacturing of shrunken grain crust leather.
6. Manufacturing of screen/block printed crust leather.
7. Manufacturing of lining leather.
8. Effect of different neutralizing agent in post tanning operation.
9. Effect of rate of dye absorption due to pH, time, temperature
10. Effect of different fat liquoring agent on chemical softening of leather in post tanning operation.
11. Compare the filling properties of different types of syntans during retanning.
12. Manufacture of glutaraldehyde tanned leather.
13. Effect of glutaraldehyde during the processing of softy shoe upper/garments leather.

Course Objectives

- a) To introduce students with different leather processing techniques.
- b) To enhance the students' ability to analyze and critically evaluate the issues of leather manufacturing.
- c) To enhance knowledge and skills of students for designing and conducting an academic practical independently.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Exhibit familiarity with a broad array of methods and approaches that are used within the industry.	C1, C2
CLO2	Demonstrate practical competence in conventional and advanced leather Engineering	C3
CLO3	Develop a manufacturing hypothesis and frame the manufacturing problem with the correct methodology.	C3

CLO4	Formulate recipe using mixed methods to evaluate leather final quality.	C3
CLO5	Apply practical methodological tools and techniques for conducting research and development in the areas of leather engineering.	C4

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	2	1						2			
CLO2	3	2	1				1		2			
CLO3	3	2	1		1		1		1			
CLO4	3	2					1		2			
CLO5	3	3	2		1	2	2		3			1

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, multimedia presentation, demonstration, group discussion, teamwork, problem-based practical	Group Presentation, Assignment; Final Exam
CLO-2	Lecture, group discussion, teamwork, practical and problem-based practical	Group Presentation, Assignment; Final Exam
CLO-3	Lecture, guided reading and problem-based learning (PBL): Identifying the problem to be solved, group discussion, teamwork, practical	Assignment, Group Presentation, Assignment, viva voce and Final Exam
CLO-4	Lecture, multimedia presentation, group discussion, demonstration, and problem-based practical	Group Presentation, Assignment, Quiz and Final Exam
CLO-5	Lecture, group discussion, presentation, and problem-based practical	Group Presentation, Assignment, Quiz, and Final Exam

Learning Materials

i. Recommended Readings

- a) Theory and Practice of Leather Manufacture-K.T. Sarkar.
- b) Tanning Chemistry: The Science of Leather-Anthony D Covington.

ii. Supplementary Readings

- a) Possible Defects in Leather Production-Gerhard John.
- b) Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edn. I. L. T. A., Calcutta.

- c) Chemistry and Technology of Leather-Roddy, O` Flaherty and Lollar, Vol. 2 and 3. Robert E. Kreiger Publishing Co.,N. Y.
- d) Fundamentals of Leather Manufacture-Eckhart Hidemann.
- e) Theory and Practice of Leather Manufacture-K. T. Sarkar, Macmillan India Press, Madras.

iii. **Others:** Handout/lecture material provided by the course teacher.

Course Code: 0531-Chem-2203 **Course Title:** Polymer Science and Engineering **Credits:** 3.0 credits

Rationale of the Course: This course is designed to impart the fundamentals of polymers and their derivatives, bonds, structures, and properties. The course also introduces the knowledge of various polymerization techniques along with associated technologies and emphasizes various environmental aspects.

Course Content

Polymer structure: Concept of polymer, oligomer and macromolecule, classifications of polymer, tacticity, degree of polymerization, contour length, functionality of monomer, molecular forces and chemical bonding in polymers.

Polymerization: Step-reaction (condensation) polymerization: mechanism, polycondensation; Radical chain (addition) polymerization: mechanism-initiation, propagation, termination, kinetics and chain transfer; Ionic polymerization: cationic and anionic polymerization, polymerization by transition metal catalysts, ring opening polymerization; Polymerization technique: Solution, bulk, suspension, emulsion.

Polymer solution: Criteria for solubility, heat of dissolution and solubility parameters, conformation of polymer chains in solutions, nature of polymer molecules in solution, size and shape of macromolecules in solution, effect of molecular weight on solubility, solubility of crystalline and amorphous polymers, viscosity of dilute polymer solutions.

Structure and properties of polymers: Chemical and geometrical structure of polymer molecules, Glass transition temperature (T_g): Free volume theory, factors affecting on T_g , melting point, mechanical properties of crystalline polymers.

Molecular weight and size of polymers: Number average, molecular weight average, Z-average and viscosity average molecular weight; distribution of molecular weight; contour length, molecular weight determination methods.

Polymer technology: Polymer compounding and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization.

Environmental considerations: Polymer degradation: Definition, types, factors affecting polymer degradation, preventions, recycling, remoulding, depolymerisation, incineration, biodegradable polymers, green synthetic approach of polymer.

Course Objectives

- To provide knowledge and understanding of polymers, structures, properties and synthetic routes of various polymers.
- To disseminate knowledge on polymerization techniques, mechanism, and processing.
- To impart comprehensive knowledge on polymer additives, ultimate applications and environmental aspects.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Define and classify polymers, their structures, and configurations.	C1, C2, A1
CLO2	Illustrate different types of polymerization techniques, technological aspects and mechanisms.	C2, A2
CLO3	Correlate different polymer properties with their structure and molecular weight.	C3, A3
CLO4	Compare various determination methods of polymer molecular weight with their pros and cons.	C4, A3
CLO5	Assess the environmental impacts of polymers in real-life applications.	C5, A4

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	2	-	-	-	-	-	-	-	-	-
CLO2	3	2	3	1	-	-	-	-	-	-	-	-
CLO3	3	2	1	2	1	-	1	-	-	-	-	-
CLO4	3	2	2	1	2	-	-	-	-	-	-	-
CLO5	3	2	2	2		2	2	-	-	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, demonstration and problem-based exercises	Group Presentation, In-course Exam, Quiz, Assignment, Final Exam
CLO2	Lecture, multimedia presentation, video presentation, demonstration, group discussion	Group Presentation, In-course Exam; quiz, assignment, case study, Final Exam
CLO3	Lecture, multimedia presentation, literature review, group discussion	Assignment, Quiz, Group Presentation, In-course Exam, and Final Exam

CLO4	Lecture, multimedia presentation, group discussion, literature review, video presentation, demonstration, and problem-based exercises	Quiz, Assessment, Group Presentation, In-course Exam, and Final Exam
CLO5	Lecture, multimedia presentation, group discussion, literature review, video presentation, demonstration, and problem-based learning	Assignment, Quiz, Group presentation, Oral presentation, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) Charles E. Carraher Jr- Carraher's Polymer Chemistry 8th Edition
- b) Gowrikar V. R., Viswanathan N.V. and JayadevSreedhar, "Polymer Science", New Age Publication, New Delhi 2003.
- c) Gupta V. B. and Kothari V. K., "Manufacture Fibre Technology", Chapman and Hall Publication, UK 1997.

ii. Supplementary Readings

- a) Billmeyer F. M., "Text Book of Polymer science", Wiley Inter Science, New York, 2002.
- b) Odion G., "Principles of Polymerization", John Wiley, UK, 2002.

iii. Others: Handout/lecture materials provided by the course teacher

Course Code: 0531-Chem-2204 **Course Title:** Polymer Science and Engineering Lab

Credits: 1.5 credits

Rationale of the Course: This course is based on the theoretical knowledge of polymer science and engineering. The course is designed to provide practical knowledge while working in a polymer chemistry laboratory, developing skills in using lab apparatus and equipment mostly used in qualitative and quantitative analysis of polymeric substances.

Course Content

1. Identification of different polymeric materials in footwear.
2. Determination of relative viscosity of polymeric substances.
3. Determination of molecular weight of different polymers.
4. Synthesis and characterization of resins from the precursors.
5. Preparation of polystyrene /PMMA by suspension polymerization method.
6. Determination of chemical compositions of selected polymers.
7. Determination of solvent stability and ionic character of selected polymers and surfactants.
8. Determination of film hardness of acrylic, polyurethane, butadiene binders.

9. Determination of tensile strength and elongation of the finish film formation by acrylic, polyurethane, butadiene binders
10. Determination of ironing effect of acrylic, polyurethane, butadiene binders.

Course Objectives

- a. To familiarize in-depth practical knowledge in the synthesis and characterization of polymeric materials.
- b. To develop skills on the determination techniques of polymer molecular weight and kinetics.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify different types of polymeric materials using physical and chemical methods.	C2, A2, P2
CLO2	Prepare and characterize different types of polymeric materials.	C3, A2, P3
CLO3	Determine molecular weights of polymers applying different methods.	C3, A2, P3
CLO4	Manipulate and analyze the conventional experimental methods to produce polymer derivatives.	C4, A4, P3
CLO5	Generate reports based on the results practicing the ethical acknowledgement of used sources or avoiding copying from other written sources.	C5, A4, P5

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO 1	3	2	2						2			
CLO 2	3	2	1		2							
CLO 3	3	2	1									
CLO 4	3	3	2		2				2			
CLO 5	3		2					2		2		2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Demonstration, Group work	Lab Performance, Quiz test, Continuous Assessment, Report evaluation, Viva, Final Exam
CLO2	Literature review, Demonstration, Video presentation, Hands-on practice, Group work	Lab Performance, Quiz test, Assignment, Report evaluation, Viva, Final Exam
CLO3	Literature review, Video presentation, Group work	Lab Performance, Continuous Assessment, Quiz test, Viva, Report evaluation, Final Exam
CLO4	Demonstration, Hands-on practice, Presentation, Group work, Problem based exercises	Lab Performance, Continuous Assessment, Case study, Report evaluation, Final Exam
CLO5	Discussion, Multimedia presentation, Lecture Group work	Report evaluation, Final Exam

Learning Materials

i. Recommended Readings

- a) Billmeyer F.W. Jr. - Text Book of Polymer Science.
- b) Ralph L. Shriner- The Systematic Identification of Organic Compounds
- c) Gowariker V. R. -Polymer Science.

ii. Supplementary Readings

- a) Arora M.G. & Singh M. - Polymer Chemistry.
- b) Charles E. Carraher Jr- Carraher's *Polymer Chemistry* 8th Edition

iii. Others: Lab Procedures /lecture material provided by the course teacher

Course Code: 0531-Chem-2205 **Course Title:** Analytical chemistry **Credits:** 3.0

Rationale of the Course: The aim of the course is to introduce a broad range of modern and classic techniques that are useful in analytical chemistry. The interdisciplinary nature of chemical analysis makes analytical chemistry a vital tool in science, industrial, government, and academic laboratories throughout the world. This course is also helping students to develop an in-depth theoretical understanding to carry out research.

Course Contents

Statistical analysis of data: Evaluation of analytical results, uncertainty in measurement, accuracy and precision, significant figures, sensitivity, selectivity and specificity of chemical reaction, repeatability, reproducibility, errors, rejection of data: the Q test and Grubb's test.

Gravimetric and complexometric methods: Principles of gravimetric methods, conditions for precipitation co-precipitation and post-precipitation, precipitation from homogeneous solution, complexometric titration, metallochromic indicator, buffer solution in EDTA titration.

Chromatographic techniques: Introduction, classification of chromatographic methods, partition and adsorption chromatography, R_f value, illustration of paper, thin layer chromatography (TLC) and column chromatography; ion exchange chromatography: Introduction, exchangers, characteristics, and its applications.

Ultraviolet-Visible spectrometry: Introduction, principle, broad nature of spectrum, instrumentation, Beer-Lambert law, absorption spectrum, and λ_{\max} , shifting of λ_{\max} : Conjugation, solvent polarity, pH; Woodward-Fieser rules for λ_{\max} calculation, analysis of heavy metals and other pollutants.

Atomic absorption spectrometry: Introduction, basic principles, instrumentation, hollow cathode lamp, sample preparation, type of techniques, flame, and types of flame, electrothermal analyzer, different interferences, recent developments, applications.

Environmental analysis: Sampling of wastewater, Analysis of tannery wastewater sample: alkalinity, acidity, Different types of solids, hardness of water, banned amines; Analysis of chrome-tanned leather.

Safety practice in laboratory: Introduction, safety rules, MAK values of working material that involved health hazards, list of harmful materials, emission protection law, prevention of accidents, and first aid in laboratory.

Course Objectives

- To provide fundamental knowledge on the accuracy, precision, and errors of experimental results by applying statistical methods.
- To give an overview of the use of selected classical and instrumental qualitative and quantitative analytical methods.
- To equip students with skills to solve analytical problems by selecting appropriate analytical tools.

Course Learning Outcomes (CLOs): After completing this course, students will be able to

CLOs	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the fundamental statistical analysis and its utilization in calculating statistical parameters.	C1, A1
CLO2	Explain the basics of different analytical methods, their applications, and safety practices in the laboratory.	C2, A2
CLO3	Apply gravimetric, chromatographic, and spectroscopic techniques in qualitative and quantitative analysis.	C3, A2

CLO4	Analyze and compare different qualitative and quantitative results of analytical techniques for authentication.	C4, A3
CLO5	Correlate the analytical techniques for the analysis of finished leather, wastewater, and other environmental contaminants.	C5, A4

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	-	-	-	-	1	-	-	-	-	-
CLO2	3	2	-	-	2	-	3	-	-	-	-	-
CLO3	3	2	-	-	-	-	2	-	-	-	-	-
CLO4	3	3	-	3	-	-	2	-	-	-	-	-
CLO5	3	3	-	2	-	-	3	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive lecture with whiteboard illustration, Problem practice.	In-course and Final Exam
CLO2	Interactive lecture with whiteboard illustration, Slide presentation, Problem practice.	Quiz and Final Exam
CLO3	Interactive lecture with whiteboard illustration, Slide presentation.	Assignment and Final Exam
CLO4	Interactive lecture with whiteboard illustration, Problem practice, Displaying UV instrument.	In-course and Final Exam
CLO5	Interactive lecture with whiteboard illustration, Case study.	In-course and Final Exam

Learning Materials

i. Recommended Readings

- Gary D. Christian- Analytical Chemistry.
- Skoog, West and Holler- Fundamental of Analytical Chemistry.

ii. Supplementary Readings

- David Harvey- Modern Analytical chemistry.
- Bryan m. Ham and Aihui Maham-Analytical chemistry.
- Séamus Higson- Analytical chemistry.

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0531-Chem-2206

Course Title: Analytical Chemistry Lab

Credits: 1.5

Rationale of the course: The course is designed to provide practical knowledge related to safety during working in an analytical laboratory, development of skills for the use of lab apparatus and equipment's using mainly advanced titration methods, and quantitate analysis by spectrophotometric method.

Course content

Determination of hardness (complexometry), sulphite (iodometry), sulphide(iodimetry), chloride (Volhard method), Ammonium(titrimetry), gravimetric determination of metal like lead, calcium, aluminum, Determination of total organic carbon in soil sample, Spectrophotometric determination of Fe(II), ammonium and sulphate from the supplied sample solution, Determination of Calcium(II) in a calcium compound/tablet; Analysis of fat, oil, and soap.

Course Objectives:

- a) To introduce the fundamental knowledge and skill of different laboratory experiments based on titration, gravimetry, and spectrophotometry.
- b) To determine toxic metals and other toxic chemicals both in leather and tannery effluents.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Explain the theoretical principles of classical analytical methods within titration, and various techniques within gravimetric and spectroscopic methods.	C2, A3
CLO2	Apply the volumetric and gravimetric and spectroscopic methods to carry out laboratory scale experiments and environmental analysis based on manipulation ability and understanding.	C3, P2, A2
CLO3	Demonstrate the analysis of fat, oil, and soap. Articulate laboratory measurements and data, including units, significant figures, precision, and accuracy.	C3, P3, A3
CLO4	Demonstrate knowledge of good laboratory practices, professionalism, ethical behavior, and teamwork by turning in required reports and completing laboratory work in a regular basis.	C3, P3, A3

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	-	-	1	-	-	-	-	-	-	-
CLO2	3	2	2	-	2	-	2	-	-	-	-	-
CLO3	3	2	-	-	-	-	-	-	-	-	-	-
CLO4	2	2	-	-	-	-	-	2	2	2	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive Lecture, Group Discussion, Demonstration, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO2	Lecture, Demonstration, Hands-on practice, and Group work	Presentation, Report evaluation, Final Exam
CLO3	Lecture, Demonstration, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO4	Lecture, Demonstration, Hands-on practice, and Group work	Report evaluation, Final Exam

Learning materials

i. Recommended readings

- a) Gary D. Christian- Analytical Chemistry.
- b) John Kenkel- Analytical Chemistry for Technicians.
- c) Vogel A. I. - Text Book of Quantitative Chemical Analysis.

ii. Supplementary Readings

- c) P. K. Sarker - Analytical Chemistry for Leather Manufacture.
- d) Fifield and Haines-Environmental Analytical Chemistry.

iii. Others: Lecture notes and Lab procedure provided by the course teachers.

Course Code: 0717-ME-2207 **Course Title:** Fundamentals of Mechanical Engineering

Credits: 3.0

Rationale of the Course: This course is designed with different basic mechanical theories of rigid bodies, solids, thermodynamics, heat transfer, fluid mechanics, welding, and their mechanisms. After completing the course, students will be able to possess an understanding of different mechanical operations along with their potential application in the leather industry.

Course Content

Engineering statics: General principles of statics, Vectors, Statics of particles, Equilibrium of rigid bodies, Internal forces and moments, Friction, Centroids and Moments of inertia.

Engineering dynamics: Kinematics of Particles, Rectilinear and curvilinear motion of particles, position vector, velocity and acceleration, derivative of vector functions, Newton's second law of motion- dynamic equilibrium

Mechanics of solid: Introduction to mechanical response of materials and stress-strain relationships, Modulus of elasticity and modulus of rigidity, Shear stress, axial stress in composites, Centrifugal and Thermal stresses; Statically indeterminate members, Stresses in thin-walled and thick-wall members, torsion, column theory.

Thermodynamics: Fundamental concepts and definitions, laws of thermodynamics, thermodynamic processes and cycles, introduction to steam generator units, detail study of

boiler, vapor power cycles-rankine, reheat, internal combustion engines, steam turbines, compressor, measurements and automatic control mechanism.

Heat transfer: Different modes of heat transfer-conduction, convection, and radiation, one dimensional steady state conduction of heat in solid plane wall, radiation heat transfer, the laws of black-body radiation, sources of energy.

Fluid mechanics and Pumps: Hydraulics properties of fluids, surface tension and capillary tubes, basic hydrostatic equation, pressure head of a liquid, pressure gauges, flow of fluids, Bernoulli's equation, and equation of continuity. laminar flow and turbulent flow, head loss due to friction in a pipe, fluid flow measurements, pump types, Characteristics and applications of reciprocating and centrifugal pumps.

Welding: Gas welding: principle, equipment used, gas storage and safety measures. Gas cutting. Arc welding: principle, equipment used; AC and DC arc welding, electrodes, shielded arc welding: TIG, MIG and plasma arc welding; electrical resistance welding. Lathe machine and accessories.

Learning Objectives

- a) To provide the fundamental knowledge of different mechanical theories associated with leather and footwear industries.
- b) To introduce the students to the statics, dynamics, mechanics, and weldings of solids.
- c) To develop the basic understanding of thermodynamics as well as fluid mechanics.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	State the basic concepts of different mechanical theories including statics, dynamics, thermal, solid, and fluid mechanics.	C1, A1
CLO2	Explain the mechanisms behind engineering statics, dynamics, heat transfer, pump, and welding along with thermodynamics, solid, and fluid mechanics.	C2, A2
CLO3	Apply the mechanical theories in real-life problem solving.	C3, A2
CLO4	Relate the concepts of mechanics in different areas of leather manufacturing machinery.	C4, A3

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	-	-	-	-	-	-	-	-
CLO2	3	1	-	-	1	-	-	-	-	-	-	-
CLO3	3	2	2	3	2	-	-	-	-	-	-	2
CLO4	3	2	3	3	2	-	-	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, multimedia presentation, literature review and problem-based exercises	Group Presentation, Assignment, oral presentation, In-course Exam and Final Exam
CLO2	Lecture, group discussion and problem-based exercises, literature review.	Group Presentation, In-course Exam and Final Exam
CLO3	Lecture, multimedia presentation and problem-based learning: Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam and Final Exam
CLO4	Lecture, multimedia presentation, group discussion, demonstration, and problem-based exercises	Group Presentation, Case study, Assignment, In-course Exam and Final Exam

Learning Materials

i. Recommended Readings

- a) Khurmi R.S., and Gupta J.K., (2020), "Thermal Engineering", S. Chand and Company Limited, New Delhi.
- b) Holman J.P., (2004) "Heat Transfer", 9th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- c) Rogers G.F.C., and Mahew Y.R., (1967), "Engineering Thermodynamics: Work and Heat Transfer", 4th Edition (Reprinted), Longman Pub Group.
- d) Khurmi R.S., (2001), "A Text Book of Hydraulics, Fluid Mechanics and Hydraulic Machines", 1st Edition (Reprinted), S. Chand and Company Limited, New Delhi.
- e) Khurmi R.S., (1993), "A Text Book of Engineering Machines", 1st Edition (Reprinted), S. Chand and Company Limited, New Delhi.

ii. Supplementary Readings

- a) Ferdinand P. Beer., and E. Russell Johnston, Jr. (2016), “Vector Mechanics for Engineers Statics and Dynamics”, Eleventh Edition, McGraw-Hill Education.

iii. **Others:** Hand notes/Lecture materials will provide by the course teacher.

Course Code: 0717-ME-2208 **Course Title:** Mechanical Workshop **Credits:** 1.5

Rationale of the Course: This course is based on 0715-ME-2208 to make students competent to know and practice different types of machinery, gas and arc welding, different types of fitting works, study and practice on pumps, power generators, engines and turbines.

Course Content

1. Use of Hand Tools and Machine Tools
2. Prepare cutting press knives using knife cutting and bending machine
3. Work on lathe machine
4. Work on milling machine
5. Practice with drilling machine
6. Practice with shaper and grinding machine
7. Perform on gas welding machine
8. Perform on arc welding machine and TIG welding
9. Study on pump and its accessories
10. Study on power generating engines.

Course Objectives

- a. To introduce students to different cutting knife preparations.
- b. To familiarize students with pumps, compressors, power generators, and engines.
- c. To provide skills in gas, arc, and TIG welding.
- d. To develop skills on lathe, shaper, milling, drilling, and grinding machines.

Course Learning Outcomes (CLOs): Upon successful completion of this course, students will be able to

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Demonstrate different basic tools, equipment, and machines.	C2, A1, P1
CLO2	Illustrate the operating principles and techniques of different machinery like lathe, drilling, milling, shaper, etc.	C3, A2, P2
CLO3	Manipulate and operate different mechanical machinery in real-life practices.	C3, P3, A3
CLO4	Correlate those mechanical operations in leather and footwear machinery.	C4, A3, P3
CLO5	Solve any technical issues while operating those machinery.	C5, A4, P4

Mapping of Course Learning Outcomes (CLOs) with Programs Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	-	-	-	-	-	-	-	-
CLO2	3	2	2	-	-	-	-	-	-	-	-	-
CLO3	3	2	2	1	3	-	-	-	2	-	-	3
CLO4	2	1	-	1	-	-	-	-	-	-	-	2
CLO5	3	2	3	2	2	-	-	-	2	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Demonstration and problem-based exercises presentation.	Viva, report evaluation, and final exam
CLO2	Group discussion, demonstration of problem-based exercises, multimedia presentation	Viva, report evaluation, and final exam
CLO3	Demonstration, identifying the problem to be solved	Group presentation, quiz, report evaluation and final exam
CLO4	Multimedia presentations, group discussions, demonstrations and problem-based exercises	Group presentation, viva, report evaluation, quiz, and final exam

Learning Materials

- i. **Recommended Readings**
 - a) Khurmi R.S. and Gupta J.K. "A Text Book of Work Shop Technology", 1st Edition (Reprinted 1981), S. Chand and Company Limited, New Delhi.
- ii. **Supplimentary Readings**
 - a) Chapman, W.A.J., "Workshop Technology Part 1", 5th Edition (1972)
- iii. **Others:** Handout/lecture material provided by the course teacher

Course Code: 0723-LE-2210 **Course Title:** Field Tour-II **Credit Value:** 1.0

Rationale of the Course: This course is designed to offer first-hand exposure to the business operations and processes that are usually performed in the workplace. Industrial visits will provide the students with a practical perspective of the concepts and theories that are taught to them. It will also help to keep the students up-to-date with knowing about the prevalent technologies and significant changes happening in the market.

Course Content

In 2nd Year 2nd Semester, students will visit a reputed footwear industry.

Discuss with the company supervisor about any project or assignment/task. Try to understand the systems in your workplace – Processes, Organization, and Administrative. Record all the work done or knowledge gained. Maintain logbook and give feedback to guide teacher.

Course Objectives

- To build a learning intervention that is intertwined with practical, hands-on skill enhancement knowledge to ensure that student's learning is not focused solely on theoretic approaches.
- To make a good relationship with various footwear companies and increase their networking opportunities.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Provide a description of the operations, workstations, plants, machines, assembly lines, and management involved in the footwear industry and engage in discussions with knowledgeable professionals.	C2, A3, P2
CLO2	Improve abilities in collaborating effectively with others, expressing ideas clearly and concisely, and working efficiently in a group setting.	C2, A3
CLO3	Prepare technical documents and give verbal presentations on completed industrial tour work.	C3, C4, A4

Mapping course learning outcomes (CLOs) with program learning outcomes (PLOs)

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	3	-	-	-	-	3	-	2
CLO2	2	-	-	-	-	-	-	-	2	2	-	2
CLO3	2	-	-	-	-	-	-	-	-	3	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Class Lecture, Display and Demonstration	Presentation and viva, Report Evaluation
CLO2	Class Lecture, Display and Demonstration,	Presentation and viva, Report Evaluation
CLO3	Discussion, Discussion and Motivation, Self-study	Presentation and viva, Report Evaluation

Learning Materials

i. Recommended Readings

- i. Writing the Winning Thesis or Dissertation: A Step-by-Step Guide - By Allan A. Glatthorn, Randy L. Joyner.
- ii. Relevant books, handbooks, patents and manuals.

Course Code: 0723-LE-3101 **Course Title:** Leather Processing-IV **Credits:** 3.0

Rationale of the Course: The course provides the knowledge of sequential post tanning processes including retanning, dyeing and fat-liquoring. Working mechanism of different machines/instruments are also covered in this course. Students will learn the use and reaction mechanism of different absolute chemicals for the best manufacturing of crust leather.

Course Contents

Mechanical operations prior to wet finishing: Sammying, splitting, shaving, trimming and weighting.

Wetback and washing: Objectives, use of surface-active agents, acidification, rinsing.

Bleaching: Different methods of leather bleaching, factors affecting bleaching, bleaching of vegetable and chrome-tanned leather, effect of bleaching on leather quality.

Re-chroming: Objectives, use of basic chrome sulphate, chrome syntan, chrome stable fat liquor, glutaraldehyde, etc. in re-chroming, controls during re-chroming.

Neutralization: Objectives, iso-electrical points and neutralization, principles of neutralization for chrome tanned leather, factors affecting neutralization, selection of proper neutralizing agents, controls of neutralization, test for neutralization, neutralization and its impact on subsequent leather processing.

Re-tanning and combination tannage: Introduction, objectives of re-tanning, types of materials used in re-tanning and semi-chroming, chemistry and mechanism of re-tanning, combination tannage, advantages and disadvantages of retanning and combination tannage, factors affecting retanning and combination tannage, influence of retanning materials on physical and dyeing properties of leather, mode of application of retanning materials, quality control during retanning and combination tannage, lubricating retanning agents.

Dyeing: Leather dyes and their application, practical aspect of dyeing effect; preparation of tanned leather for dyeing; factors influencing dyeing process; dyeing auxiliaries; levelness; fixation of dyes; color measurement; color different and color matching; dyeing defect and their remedies.

Fat-liquoring: Objectives, classification of fat liquor, natural and synthetic fatliquors, theory and mechanism of fatliquors, theory and behavior of emulsions, emulsifiers, stability of emulsion, application of fat liquors, factors affecting fatliquoring, distribution of fat and oils in leather, controls of fat liquoring, effects of fatliquors on physical properties, fatliquors used in water repellent leather, modern trends in fatliquoring, curring and stuffing using fats and oils.

Mechanical and manual operations of re-tanned leather: Objectives of setting out, vacuum drying, tunnel/overhead drying, vibrating staking, toggle drying, trimming, dry vacuum.

Drying of leather: Definition, water content in leather, theory of drying of solids, equilibrium and non-equilibrium state of leather; methods of drying, defects in drying, remedies.

Course Objectives: Make the students enable:

- a) To know about the stages involved in post-tanning.
- b) To get idea about mechanical operation before wet finishing.
- c) To comprehend the re-tanning and combination tannage.
- d) To learn the process of dyeing and fat-liquoring.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the necessity of post-tanning processes.	C1, A1
CLO2	State the mechanical operations before wet finishing	C3, A2
CLO3	Evaluate and manipulate tanning and combination tannage.	C6, A3
CLO4	Explain the process of dyeing and fat-liquoring and their controls.	P2, A5
CLO5	Discuss the mechanism of different mechanical and manual operations of retanned leather.	C3, A5

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	3	2									
CLO2	3				3	3	3		3			
CLO3	3	3		3	3				3			
CLO4	3				3	3	3		3			
CLO5	3				3	3			3	3		2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation, demonstration and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO2	Lecture, group discussion and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO3	Lecture, guided reading and problem-based learning (PBL): Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam, and Final Exam
CLO4	Lecture, multimedia presentation, group discussion, literature review, demonstration, and problem-based exercises	Group Presentation, In-course Exam, and Final Exam
CLO5	Lecture, group discussion, literature review, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) Anthony D. Covington- Tanning Chemistry- The Science of Leather.
- b) Dutta S.S.-An introduction to the Principles of Leather Manufacture.
- c) Flaharty, Roddy, Lollar-The chemistry and Technology of Leather (vol-2 and 3).

ii. Supplementary Readings

- a) Sarpouse J.H.-Leather Technicians Handbook.
- b) Sarkar K.T.-Theory and Practice of Leather Manufacture.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-3102 **Course Title:** Leather Processing-IV Lab **Credits:** 1.5

Rationale of the Course: The purpose of the course is to provide the students practical knowledge and improved skills in leather manufacturing. In this course students will learn to produce leather from raw hide and skins using different specialty manufacturing processes. This course also covers knowledge of crust leather manufacture from tanned leathers with variety of post tanning processes. Students will become capable of developing a manufacturing hypothesis and frame the manufacturing problem with the correct methodology.

Course Content

1. Manufacture of chamois leather.
2. Manufacture of sole/ insole leather.
3. Manufacture of book binding leather.
4. Manufacture of garments/clothing/gloving leather.
5. Manufacture of football leather.
6. Manufacture of upholstery leather.
7. Manufacture of glace kid/ corrected grain/aniline finish leather.
8. Manufacture of army boot leather.
9. Manufacture of screen/block/boutique printed leather.

Course Objectives:

- a) To introduce students with different control parameters in crust leather processing.
- b) To enhance the students' ability to analyze and critically evaluate the issues of practical in the realm of special leather manufacturing.
- c) To enhance knowledge and skills of students for designing and conducting an academic practical independently.

Course Learning Outcomes (CLOs): After completing this course, students will be able to

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	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Exhibit correlation with a broad array of methods and techniques that are used in leather manufacturing.	C1, C2
CLO2	Demonstrate practical competence in conventional leather making.	C3
CLO3	Develop a manufacturing process and analyze the cause and remedy of the manufacturing problems.	C3, C4
CLO 4	Explain and justify the diversify leather manufacturing process.	C4

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	2	2		1	1	2		1	2		
CLO2	3		2		2	1	2		1			
CLO3	3	3	2		2	2	2		2	2		
CLO 4	3	3	2						2	3		

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, demonstration, group discussion, teamwork.	Lab Performance, Report, Final Exam
CLO-2	Lecture, group discussion, teamwork and practical	Lab Performance, Report, Final Exam
CLO-3	Lecture, group discussion, teamwork, practical	Lab Performance, Report, Viva voce and Final Exam
CLO 4	Lecture, group discussion, hand on practice.	Quiz, report evaluation, final exam.

Learning Materials

i. Recommended Readings

- a) Theory and Practice of Leather Manufacture-K.T. Sarkar.
- b) Tanning Chemistry: The Science of Leather-Anthony D Covington.
- c) Possible Defects in Leather Production-Gerhard John.

d) Chemistry and Technology of Leather-Roddy, O` Flaherty and Lollar, Vol. 2 and 3. Robert E. Kreiger Publishing Co.,N. Y.

ii. Supplementary Readings

a) Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edn. I. L. T. A., Calcutta.

b) Chemistry of Tanning Processes-K. H. Gustavson, Academic Press N. Y.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0531-Chem-3103 **Course Title:** Instrumental Analysis **Credits:** 3.0

Rationale of the Course: This course covers in-depth knowledge of design, operational techniques, principles, and practical applications of modern instrumental methods used in chemical analysis. Using a combination of chromatographic and spectroscopic problem-based learning approaches, the critical thinking and analytical skills of the student will be improved and will assist them in developing their theoretical knowledge to do advanced research.

Course Contents

Gas chromatography: Introduction, classification, principles of gas-liquid chromatography, gas-solid chromatography, techniques of gas-liquid chromatography, phases, oven, columns, detectors: types of detectors, application of GC in chemical analysis.

High-Performance liquid chromatography: Basic concept, instrumentation of HPLC, stationary phases: Normal and reversed-phase, mobile phase, sample injector, selection of column, UV-visible and RI detectors, Peak tailing and fronting, effect of temperature in HPLC, comparison of HPLC with GLC, application of HPLC.

Infrared spectrometry: Basic principle, types of vibration modes, selection rule, parameters determining the position and intensity of bands, characteristic absorption bands of functional groups, influence of substituent, polarity and hydrogen bonding on IR peaks, application of IR spectrum for chemical and leather analysis.

Nuclear Magnetic Resonance Spectroscopy: Fundamental theory, NMR active nucleus, solvents, chemical shift and factors affecting chemical shift, shielding and de-shielding effect, application of ¹H-NMR spectrum in organic compounds and leather chemicals analysis.

Mass Spectrometry: Introduction, principle, isotopic peaks, ionization methods: EI, ESI, CI, fragmentation pattern of simple molecules, applications.

Thermal analysis: Thermogravimetric analysis (TGA): Introduction, objectives, instrumentation, classification, interpretation of TGA curve, factors affecting TGA curve, application in leather science; basic principle of differential thermal analysis (DTA) and differential scanning calorimetry (DSC).

Characterization of collagen: Chromatographic properties, electrophoretic properties, microscopy and spectroscopy techniques for collagen morphology, X-ray diffraction studies of

collagen, non-invasive methods of liquid and solid imaging of biological specimens and their relevance to location of defects in hides/skins.

Course Objectives:

- a) To improve the analytical knowledge on purification, identification and quantification of the chemical components from their mixture or impurities.
- b) To develop the ability to analyze organic and other chemicals by the combination of spectroscopic data such as infrared spectroscopy, nuclear magnetic resonance spectroscopy, and mass spectrometry.
- c) To provide in-depth knowledge on the thermal stability of leather, synthetic polymers, and footwear materials using TGA and DSC.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the physical laws and working principles, instrumentation, and applications of HPLC and GC as well as compare the different aspects of HPLC and GC.	C2, C4, A2
CLO2	Analyze and interpret IR, NMR, and Mass spectrum of different compounds and elucidate the structure of unknown compounds.	C4, C5, A3
CLO3	Relate the basic principles and significance of TGA, DTA, and DSC techniques and compare the related curves.	C4, A3
CLO4	Characterize collagen through the study of FT-IR, X-ray diffraction, and mechanical and optical properties of collagen fibers.	C4, A3

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	3	1	-	1	3	-	-	-	-	-	-	-
CLO2	3	2	-	2	3	-	-	-	-	-	-	-
CLO3	3	2	2	2	3	-	-	-	-	-	-	-
CLO4	2	3	2	3	3	-	-	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, multimedia presentation, demonstration and problem-based exercises.	In-course Exam; Final Exam
CLO2	Lecture, group discussion and problem-based exercises on instrumental analysis.	In-course Exam; Final Exam

CLO3	Lecture, showing sophisticated instruments, Identifying the problems to be solved.	In-course Exam, Final Exam
CLO4	Lecture, audiovisual presentation, multimedia presentation, group discussion, demonstration, and problem-based exercises.	Quiz, Final Exam

Learning Materials

i. Recommended Readings

- a) Gary D. Christian- Analytical Chemistry.
- b) John Kenkel- Analytical Chemistry for Technicians.
- c) Sharma B. K. - Instrumental Methods of Chemical Analysis.

ii. Supplementary Readings

- a) Sarker P. K. - Analytical Chemistry for Leather Manufacture.
- b) Williams D. H. and Ian Fleming- Spectroscopic methods in Organic chemistry.

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0531-Chem-3104 **Course Title:** Chemical Analysis of Leather and Leather Products Lab **Credits:** 1.5

Rationale of the Course: This practical course is based on theoretical knowledge of analytical chemistry and instrumental methods of analysis. The course is designed to provide essential knowledge related to safety during working in an advanced analytical laboratory, and the development of skills for the use of sophisticated instruments and equipment in different chemical analysis. The course is also designed to develop instrumental and analytical skills to conduct research work.

Course Contents

Analysis of Leather: Sulphated ash, fat content, chromic oxide content, Cr⁶⁺ and other trace metals content, formaldehyde, moisture, nitrogen content, and shrinkage temperature of the leather sample; Extraction of collagen and characterization.

Analysis of Chrome liquor: Chromic oxide, sulphate, hydroxide content.

FT-IR and TGA analysis of sole materials.

Course Objectives: The learning objectives of this course are:

- a) To introduce the essential experimental knowledge and skills of different tests to determine moisture content, nitrogen content, thermal stability of leather, and synthetic tanning materials, and total fat in leather samples.
- b) To apply practical knowledge in analytical chemistry in the leather and allied engineering field.
- c) To determine toxic metals like total chromium, lead, and cadmium by atomic absorption spectroscopy (AAS) and chromium (VI) by UV-VIS spectrophotometer.

Course Learning Outcomes (CLOs): After completing this course, students will be able to

CLOs	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Perform different physical and chemical tests to determine pH, fat content, moisture content, ash content, and shrinkage temperature of leather samples.	C3, P3, A3
CLO2	Apply the titrimetric method (IUC-8) to determine the chromic oxide content in finished leather and chrome liquor samples and determine nitrogen in leather by Kjeldahl method.	C3, P3, A4
CLO3	Demonstrate complexometric and gravimetric methods to determine sulphate from chrome liquor and utilize thermogravimetry and FT-IR to analyze the leather and different synthetic sole materials.	C3, P3, A3
CLO4	Estimate the concentration of total Cr, Pb, Cd and Cr (VI) in leather and effluent samples by spectroscopic method.	C5, P4, A4
CLO5	Write laboratory reports that integrate mathematical, tabular, and graphical representations of data which compare and contrast theoretical predictions and experimental measurements and draw pertinent conclusions.	C4, P3, A4

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 0	PLO 1	PLO 2
CLO1	3	2	2	-	-	-	-	-	-	-	-	-
CLO2	3	3	2	2	-	-	-	-	-	-	-	-
CLO3	3	2	1	3	2	-	-	-	-	-	-	-
CLO4	3	2	2	2	2	2	2	-	-	-	-	-
CLO5	3	2	-	-	-	-	-	-	-	2	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive lecture, Group discussion, Demonstration, Hands-on practice, and Group work	Quiz, Viva voce, Report evaluation, Final Exam
CLO2	Lecture, Demonstration, Hands-on practice, and Group work	Presentation, Report evaluation, Final Exam
CLO3	Lecture, Demonstration, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO4	Lecture, Demonstration, Hands-on practice, and Group work	Report evaluation, Final Exam
CLO5	Lecture and whiteboard illustration	Report evaluation

Learning Materials

i. Recommended Readings

- a) Gary D. Christian- Analytical Chemistry.
- b) John Kenkel- Analytical Chemistry for Technicians.

ii. Supplementary Readings

- a) Sarker P. K. - Analytical Chemistry for Leather Manufacture.

iii. Others: Handout/lab procedure manual provided by the course teacher

Course Code: 0723-LE-3105 **Course Title:** Environmental Science and Engineering

Credits: 3.0

Rationale of the Course: Environmental Science and Engineering is a fundamental course for undergraduate engineering students which gives stresses real-time knowledge and skills on the environment. The course will help to deal with various environmental pollutions and their mitigations.

Course Content

Concept of Environment: Definition and concept of environment, types and components of environment, Biodiversity, man-environment relationships.

Air Pollution: Introduction, composition of air, sinks of atmospheric gases, chemical reactions occur in different spheres, smog formation in air, major sources of air pollution and impact on the environment, greenhouse effect, acid rain and its effect, air pollutant and their characteristics, hazardous air pollutants (HAPs).

Soil Pollution: Introduction, sources of soil pollution, detrimental effects of soil pollutants, disease caused by soil pollution, treatment of soil pollutants, control of soil pollution.

Leather and Leather Products Industry and Environment: Manufacturing process sequences and their environmental implications, major chemical inputs and wastes in cutting, sewing, assembling, and finishing.

Waste Management: definition of waste, integrated waste management, transformation of solid waste, Recovery of residues of effluents, organic materials, dissolved salts, energy; recycling of lime/sulphide liquors, dehair; high chrome exhaustion techniques in chrome tanning, chrome recovery and recycling, oil and grease recovery, disposal of effluents.

Environmental Management System (EMS), Policies and Legislation: Concept and certification process of EMS, Environmental legislation in Bangladesh, Environment Conservation/Protection Act and Rules.

Course Objectives

- a. To introduce the students to basic concepts of the environment, environmental pollution, and environmental management system.
- b. To identify the impacts of different natural and anthropogenic activities on the environment and their remediation.
- c. To impart knowledge on industry-specific solid waste management practices and energy recovery approaches.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the basic concepts of the environment, environmental pollution, integrated waste management, and environmental management system.	C1, A1
CLO2	Explain the causes and effects of environmental pollution and their remediation.	C2, A2
CLO3	Compare and analyze different techniques to ensure proper waste management approaches in footwear and related industries.	C3, C4, A3

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	1	-	-	-	3	3	2	-	-	-	2
CLO2	3	3	2	-	2	3	3	2	-	-	-	3
CLO3	3	3	3	1	2	3	3	-	-	-	-	3

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course-Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation, white board illustration, problem-based exercises, group discussion	Quiz, In-course exam; Final Exam
CLO2	Lecture, multimedia presentation, problem-based Learning (PBL): Identifying the problems to be solved	Assignment, Group presentation, In-course exam, Final exam
CLO3	Lecture, multimedia presentation, group discussion, analyze and compare through various case-studies	Assignment, In-course Exam, Final Exam

Learning Materials

i. Recommended Readings

- a) Fifield & Haines. -Environmental Analytical Chemistry.
- b) Gilbert Masters and Wendell Ela – Introduction to Environmental Engineering and Science.
- c) Roy M. Harrison-Pollution causes, Effects, and Control.

ii. Supplementary readings

- a) DE A.K. - Environmental chemistry.

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0717-ME-3107 **Course Title:** Materials Science and Engineering **Credits:** 3.0

Rationale of the Course: This course intends to introduce students to the behavior of materials directly linked to their fundamental structures, and how structures and properties may be altered through processing. It will help the students understand the structure of solids, the mechanical, thermal, electrical, magnetic, and optical properties of materials, and the characterization technique.

Course Content

Materials: Basic concept, classification of materials, smart and intelligent materials, nanotechnology, and recent developments.

Structure of crystalline solids: Introduction, unit cells, metallic crystal structures, density computations, polymorphism and allotropy, crystal systems; crystallographic points, directions, and planes: point coordinates, crystallographic directions, crystallographic planes, linear and planar densities, close-packed crystal structures; crystalline and noncrystalline materials, polycrystalline materials, anisotropy, noncrystalline solids.

Mechanical properties: Tensile strength, plastic deformation, true stress and strain, elastic recovery after plastic deformation, compressive, hardness, variability of material properties,

design/safety factors, dislocation, characteristics of dislocations, slip and slip systems, generalized creep behavior, stress and temperature effect, viscoelastic deformation.

Thermal and electrical properties: Heat capacity, thermal expansion, materials of importance invar and other low expansion alloys, thermal conductivity and thermal stresses, electrical conduction, semiconductivity, semiconductor devices, electrical conduction in ionic ceramics and in polymers, dielectric behavior, capacitance, field vectors and polarization, types of polarization, phonons, frequency dependence of the dielectric constant, dielectric strength, dielectric materials, ferroelectricity, piezoelectricity.

Magnetic properties: Basic concepts, diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism and ferrimagnetism. Influence of temperature on magnetic behavior, domains and hysteresis, magnetic anisotropy, soft and hard magnetic materials, magnetic storage, superconductivity.

Optical properties: Light interactions with solids, atomic and electronic interactions, optical properties of metals, optical properties of nonmetals, refraction, reflection, absorption, transmission, color, opacity, and translucency in insulators, applications of optical phenomena, luminescence, materials of importance-light emitting diodes (LED), photoconductivity, LASERS, optical fibers in communications.

Characterization techniques: X-ray diffraction, structure determination from powder patterns, influence of crystal symmetry and multiplicities on powder pattern, neutron diffraction, SEM, EDX, TEM, XPS, AFM, and VSM.

Composite materials: Particle-reinforced composites: large-particle composites, dispersion-strengthened composites, fiber-reinforced composites, influence of fiber length, influence of fiber orientation and concentration, the fiber phase, the matrix phase, polymer-matrix composites, metal-matrix composites, glass material, phase transition, carbon-carbon composites, processing of fiber-reinforced composites, hybrid composites, structural composites, laminar composites, sandwich panels, materials of importance-nano and biocomposites.

Course Objectives: The objectives of this course are as follows:

- a) To provide the students with the fundamental characteristics of materials and their applications in the respective fields.
- b) To introduce various concepts of characterization techniques for different types of materials.
- c) To provide in-depth knowledge on the design, development, and fabrication of diversified materials.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Define and explain the fundamental structures of solid materials.	C1, C2, A1
CLO2	Correlate the structures with the physico-mechanical and electromagnetic properties of materials.	C3, A2
CLO3	Apply the knowledge of materials science to enhance and radically improve existing and future technology.	C3, A2
CLO4	Analyze and interpret the results obtained from different characterization techniques of materials.	C4, C5, A3

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	-	-	-	-	-	-	-	-	-	-	-
CLO2	3	-	-	-	-	-	-	-	-	-	-	-
CLO3	3	3	2	3	-	2	-	-	-	-	-	-
CLO4	3	3	2	3	3	2	1	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive discussion, lecture discussion with multimedia, and whiteboard illustration	In-course Exam and Final Exam
CLO2	Interactive discussion, lecture-discussion with multimedia, and whiteboard illustration	In-course Exam and Final Exam
CLO3	Lecture discussion with multimedia, white board illustration, and problem-based learning (PBL): Identifying the problem to be solved	Assignment, In-course Exam, and Final Exam
CLO4	Lecture discussion with multimedia, group discussion, literature review, demonstration, and problem-based exercises	Assignment, Group Presentation, In-course Exam, and Final Exam

Learning Materials

i Recommended Readings

- a) Materials Science and Engineering-An Introduction -W. D. Callister Jr.
- b) The Science and Engineering of Materials -D. R. Askeland, P. Phulé.
- c) Foundations of Materials Science and Engineering -W. F. Smith.

ii Supplementary Readings

- a) Introduction to Physical Metallurgy, Avner.

- b) Strength of Materials, Andrew Pytel, Ferdin and L. Singer.
- iii **Others:** Handout/lecture material provided by the course teacher.

Course Code: 0314-Hum-3109

Course Title: Industrial Sociology

Credits: 2.0

Rationale of the Course: This course provides the students with a basic understanding of the role of social processes, social institutions, and social interactions in their lives and integrates the knowledge drawn from their own degree backgrounds. Industrial sociology concerns the production of goods and services in society and the nature of the social relations involved in this production process.

Course Content

Introduction to Sociology: Definition, Nature, Scope, Importance, Social Interactions, Social Groups, Social Institutions.

Culture and Related Concepts: Types, Elements, Role of Culture in Organization, Socialization and Personality, Work Behavior, Work Environment, Work Ethics and Work Culture.

Interpersonal Relations: Interpersonal Behavior, Formation of Personal Attitudes, Language and Communication, Motivations and Emotions, Public Opinion.

Social Stratification: Factors of Social Stratification, Caste and Class, Power, Prestige, and Authority, Social Mobility, Migration.

Human Ecology: Ecological Processes, Ecosystem, and Energy, Ecosystem and Physical Environment, Solid Waste Disposal, Pollution.

Population Dynamics: World Population Growth and Distribution, Population Dynamics in Bangladesh, Causes and Consequences of Urbanization, Population Policy in Bangladesh.

Community Development: Scope and Subject Matter of Community Development, Processes of Community Development, Community Development Programs in Bangladesh, Community Organization and Related Services.

Deviance and Crime: Crime as a Social and Cultural Phenomenon, Crime and Social Organization, Organized Crime, Culture Based Crime, Economics of Crime.

Sociology of Change and Development: Social Change and Development, Dynamics of Social Change, Role of NGOs in Development, World System and Development, Gender and Development.

Course Objectives

- a) To describe the basic sociological concepts, theories, and methods to analyze societal phenomena.
- b) To introduce students to basic social processes of society, social institutions, and patterns of social behavior.
- c) To impart sociological knowledge of core areas and substantive topics and the ability to critically think about them.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify and connect the basic ideas and terminology in the study of sociology, human ecology and apply the knowledge in real-life.	C1, C2, A2
CLO2	Explain the major methods and concepts used in the systematic study of society.	C3, A2
CLO3	Relate work culture, work ethics, and ethical behavior in real-life.	C4, A3
CLO4	Critically analyze society, its phenomena using sociological theories, and social problems and their impacts on individuals.	C5, A3

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	2	1	-	1	-	2	-	2	2	-	-	3
CLO2	2	2	-	1	-	2	-	2	2	2	-	3
CLO3	2	2	-	2	-	2	-	3	2	2	-	3
CLO4	3	3	-	2	-	3	-	3	2	2	-	3

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, interactive discussion, audio-visuals	In-course Exam, Final Exam
CLO2	Lecture, group discussion, case study, audio-visuals	Assignment, In-course Exam, Final Exam
CLO3	Lecture, audio-visual lectures	Assignment, Case Study, In-course Exam, Final Exam
CLO4	Audio-visual lecture, multimedia presentation, and group discussion	Quiz, Group Presentation, In-course Exam, Final Exam
CLO5	Lecture, multimedia presentation	In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- Schaefer, R. T. (2009). *Sociology: A Brief Introduction* (10th ed.). McGraw-Hill.
- Ian Glover-Engineers in Britain: A Sociological Study of the Engineering Dimension.
- Stewart, E. W. and Glynn, J. A. (1979). *Introduction to Sociology* (3rd Ed). McGraw-Hill.

ii. Supplementary Readings

- a) Gerald G Marten-Human Ecology: Basic Concepts for Sustainable Development.
 - b) Dealey, James Quayle and Ward, Lester, Frank-A Text Book of Sociology.
- iii. **Others:** Other materials or notes will be provided by the course teacher.

Course Code: 0723-LE-3111

Course Title: Footwear Manufacturing

Credits: 3

Rationale of the Course: Footwear Manufacturing is a core course for leather products engineers to manufacture footwear as a leather product. After completion of this course, students will be able to gather basic concepts of foot, last, and footwear as well as comprehensive theoretical knowledge to manufacture footwear with appropriate materials, proper size, and fit for different styles and requirements.

Course Contents

Foot and Last: Foot anatomy, importance of foot anatomy, foot arch, foot comfort, characteristic features of infant, children, and adult foot, biometry of human foot, types of foot, foot dynamics- weight-bearing foot, walking foot, running foot, common defects of foot and their remedy; last definition, types, and specification, the relationship between foot and last.

Types of Footwear: Oxford, derby, court, moccasin, sandal, casual, boot, sports, mule, clogs, safety footwear, occupational footwear, fashion footwear, etc.; bespoke footwear- meaning, advantages, and customer; properties of comfortable footwear.

Parts of Footwear: Upper - vamp, quarter, toe cap, apron, tongue, counter, backstraps, fastenings, toe puff, stiffener, eyelets, trims/ornaments; parts of lining; bottom parts- insole, insock, welt, rand, bottom filler, midsole, runner, sole, heel, shank piece, parts of sandals.

Shoe Sizing and Fitting: Principle of shoe sizing, history of shoe sizing, length size, shoe size classification- UK shoe sizing, Paris point, American shoe sizing, Centimeter scale, mondo point, comparison among different shoe sizing systems, conversion of sizes from one scale to another, standardize shoe sizes; fitting- definition and principles and different fitting systems.

Design and Pattern Making: Concept of design and pattern making, 2D-3D concept, marking, mean forme, standard forme, sectional pattern of different styles.

Cutting and Closing: Introduction, qualities required for clicker, materials, characteristics and variations in leather, methods of cutting, leather measurement systems; closing preparation, top line and edge treatments, stitch formations, type of seam, finishing off, punching, eyeleting and perforation.

Pre-lasting and Lasting: Pre-lasting operation- Definition, backpart molding, toe-puff attaching, insole molding, insole attaching, upper conditioning; lasting operation-Definition, principle of lasting, different techniques of lasting, shape retention, the need of machine lasting, upper preparation for machine lasting, adjustment of machine, machine parts and function and its parameters setting, problems finding in machine lasting and remedies, detail controlling of forepart, seat, and side lasting operation for different types of footwear, procedure for flat

lasting and force lasting, string lasting, slip lasting, operational sequence in lasting line for oxford, derby, court shoe and sandal.

Bottom preparation and Finishing: Preparation of sole, heel, and top-piece attaching, sole press, aims and objectives of finishing and their utility, the relationship between heel pairing and heel scouring, edge trimming and setting, characteristics of bottom finishes, edge and heel finishes, upper leather dressing, cleaning and shoe lacing, heel attaching and top piece attaching by hand and machine, different types of edge trimming, forepart and waist trimming, heel scouring, heel front buffing, bottom finishing, upper leather cleaning and dressing, fitting the sock, shoe lacing.

Learning Objectives: The objectives of this course are to provide:

- a) To introduce the students to the anatomy, types, and defects of human foot, and different footwear and lasts with their parts.
- b) To provide students with the concept of different shoe sizing systems along with their comparison, conversion, and fittings.
- c) To comprehend the designing and pattern-making processes for different styles of footwear
- d) To explore different aspects of footwear manufacturing from designing to finishing.

Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

CLOs: Upon completion of this course, students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Outline the anatomy of human foot and recall the basic knowledge of foot, last, footwear, shoe sizing and fitting, and required operations of footwear manufacturing.	C1, A1
CLO2	Explain different shoe sizing and fittings and the basic operations of footwear manufacturing from designing to finishing.	C2, A2
CLO3	Apply different shoe sizing systems in shoe manufacturing from designing to finishing followed by different closing treatments, lasting operations, and constructions.	C3, A3
CLO4	Compare the advanced manufacturing process with the traditional one to upgrade the techniques.	C4, A4
CLO5	Relate different aspects of footwear manufacturing techniques according to the requirements.	C5, A4

Mapping of CLO with PLO

CLOs	PLO 1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	-	-	-	-	-	-	-	-
CLO2	3	2	-	-	-	-	-	-	-	-	-	-
CLO3	3	2	3	2	2	-	-	-	-	-	-	-

CLO4	3	2	3	3	2	-	-	-	-	-	-	-
CLO5	2	3	3	3	-	-	-	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, multimedia presentation, whiteboard illustration, interactive discussion, group discussion	Assignment, In-course Exam; Final Exam
CLO2	Lecture, multimedia presentation, video presentation, whiteboard illustration	Assignment, In-course Exam; Final Exam
CLO3	Lecture, multimedia presentation, group discussion, interactive discussion, problem-based exercise	Group presentation, In-course Exam; Final Exam
CLO4	Lecture, multimedia presentation, interactive discussion, whiteboard illustration, case study	Assignment, Group presentation, In-course Exam; Final Exam
CLO5	interactive discussion, multimedia presentation, whiteboard illustration	Final Exam

Learning Materials

i. Recommended Readings

- a) Venkatappaiah B.- Introduction to The Modern Footwear Technology.
- b) Miller R. G. (Editor)- Manual of Shoe Making.
- c) Korn J. (Editor) -Boot and Shoe Production.

ii. Supplementary Readings

- a) Ruth Spencer Crookenden -K Shoes -The first 150 years 1842-199
- b) Ruth Thomson -Making Shoes.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-3112

Course Title: Footwear Manufacturing Lab

Credits: 1.5

Rationale of the Course: This course is designed to provide practical knowledge to the students about the manufacturing of different types of footwear. After completion of the course, students will be able to learn the complete manufacturing process practically for various types of footwear.

Course Contents

1. Identification of bones, nerves, and muscles from skeleton and model.
2. Foot measurement and foot impression-taking techniques.
3. Identification of various types of footwear and their different parts and components.
4. Handling and introduction of working tools of footwear.
5. **Court Shoe Manufacturing:** Preparation, OSH, mean and standard forme, sectional and bottom components pattern, cutting, closing, lasting, sole attaching, finishing, defects identification and remedy plan, and materials consumption.
6. **Oxford Shoe Manufacturing:** Preparation, OSH, mean and standard forme, sectional and bottom components pattern, cutting, closing, lasting, sole attaching, finishing, defects identification and remedy plan, and materials consumption.
7. **Derby Shoe Manufacturing:** Preparation, OSH, mean and standard forme, sectional and bottom components pattern, cutting, closing, lasting, sole attaching, finishing, defects identification and remedy plan, and materials consumption.
8. **Sandal Manufacturing:** Preparation, OSH, mean and standard forme, sectional and bottom components pattern, cutting, closing, lasting, sole attaching, finishing, defects identification and remedy plan, and materials consumption.
9. **Moccasin Shoe Manufacturing:** Preparation, OSH, mean and standard forme, sectional and bottom components pattern, cutting, closing, lasting, sole attaching, finishing, defects identification, and remedy plan and materials consumption.

Course Objectives: The learning objectives of this course are:

- a) To identify the different materials and components used in footwear production.
- b) To introduce the essential experimental knowledge and skills of different processes of footwear manufacturing
- c) To apply theoretical knowledge practically in the field of footwear industries and develop the sector technically as well as economically.

Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

CLOs: Upon completion of this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Outline the detailed pattern-making and manufacturing knowledge for different types of shoes and understand the structure of human foot, last and footwear.	C2.A1, P2
CLO2	Identify the machinery, equipment, and associated risk in footwear manufacturing.	C2, A2, P2
CLO3	Apply advanced technology and construction method for particular styles in manufacturing.	C3, A3, P3
CLO4	Discover the identified defects from its practical knowledge during pattern-making and manufacturing	C4, A4, P4
CLO5	Prepare a defect remedy plan to modify the existing process from	C5, A4, P4

	footwear designing to manufacturing.	
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Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	-	-	-	2	-	-	-	3	-	-	-
CLO2	3	2	-	-	3	-	-	-	3	-	-	-
CLO3	3	3	2	-	3	-	-	-	2	-	-	-
CLO4	3	3	3	2	3	-	-	-	2	-	-	-
CLO5	3	3	3	3	3	-	-	-	2	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Demonstration, Panel-Discussion, Practical	Lab Performance, Final Exam
CLO2	Lecture, Demonstration, Panel-Discussion, Practical, Practical Problem-solving	Lab Performance, Final Exam
CLO3	Lecture, Demonstration, Group Discussion, Practical, Cooperative Learning, Practical Problem-solving, Videotapes, Debate	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO4	Lecture, Demonstration, Video presentation, Problem-based group discussion, Case studies, Problem-solving, Cooperative Learning.	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO5	Lecture, Demonstration, Video presentation, Problem-based group discussion, Problem-solving, Cooperative Learning.	Lab Performance, Continuous assessment: Viva, Report, Final Exam

Learning Materials

i. Recommended Readings

- a) Venkatappaiah B.- Introduction to The Modern Footwear Technology.
- b) Miller R. G. (Editor)- Manual of Shoe Making.
- c) Korn J. (Editor) -Boot and Shoe Production.

ii. Supplementary Readings

- a) Swayam Siddha -Product Knowledge.
- b) Thornton J. H. -Text Book of Footwear Materials.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-3201 **Course Title:** Eco-Friendly Leather Processing **Credits:** 2.0

Rationale of the Course: The course is designed to develop knowledge on environmentally friendly leather processing. The purpose of this course is to provide students with exposure to environment friendly leather processing technologies. Students will be introduced to cleaner methods of pre-tanning, tanning and post tanning processing techniques. It will also cover knowledge about the modern eco-friendly developments based on the latest research developments.

Course Content

Introduction to Eco-Friendly Leather Processing: Importance of eco-friendly leather processing, Overview of the environmental impacts of traditional leather processing, Historical and cultural perspectives on eco-friendly leather processing

Beamhouse: Eco-friendly process technologies: salt free curing options, sulphide free unhairing systems, enzymatic unhairing- advantages and control, ammonia - free deliming, prevention of H₂S gas emission; salt free pickling systems, solvent free degreasing systems.

Tanning: Less chrome and chrome-free tanning systems; chrome-free leather; wet-white concept, chrome free leather-other mineral tannages. Emissions from chrome tanning, environmental impact of chrome tanning, high exhaustion-modification of the tanning process, chrome recycling, recovery, and reuse.

Post Tanning: Formaldehyde, phenol, AOX free post tanning systems, latest concepts and trends in leather processing, cleaner processing based on eco-labelling, integrated strategies to achieve permissible BOD, COD and TDS standards of tannery effluents.

Finishing: Finishing equipment in cleaner perspective, techniques for newer and novel finishing systems viz. aqueous finishing concepts and formulation, solvent-free finishing systems, etc.

Manufacture of different types of leather: Physical and chemical requirements, classification, methodology, optimization of process, and troubleshooting- eco-friendly shoe upper, garments, upholstery, gloving, technical leather,

Policy and Regulatory Frameworks in Leather Industry

Compliance with national and international regulations and standards for leather manufacturing; the role of environmental management systems, such as iso 14001; the impact of trade agreements and environmental policies; eco-labels and certification programs for leather products, such as the leather working group certification and the global recycled standard; collaborative efforts between governments, industry associations, and other stakeholders.

Course Objectives: Make the students able:

- a) To impart knowledge on drying of leather.
- b) To acquaint the students with different machineries and products used in leather finishing.
- c) To enable the students to apply various techniques of cleaner processing of leather.
- d) To make the students competent in different leather manufacturing processes.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify, and describe cleaner process technology of leather.	C1, A1
CLO2	Depict the comprehensive knowledge of national and international regulations and standards, including compliance requirements.	C2
CLO3	Explain the cleaner process technology during beam house, tanning and post tanning process.	C3, A3
CLO4	Formulate eco-friendly manufacturing process and solve troubleshooting of different types of leather.	C5, A4

Mapping of CLO with PLO

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	2		3	3						
CLO2	3		2		3	3						
CLO3						3	3					2
CLO4	3	3	2			3	2	2				

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, Multimedia presentation, demonstration and assignments	Group Presentation, In-course Exam; Final Exam
CLO-2	Lecture, Multimedia presentation, and demonstration	Group Presentation, In-course Exam; Final Exam
CLO-3	Lecture, Multimedia presentation, and group discussion	In-course Exam, and Final Exam
CLO-4	Lecture, multimedia presentation, demonstration, group discussion, Problem Based Learning (PBL) and assignments	Group Presentation, In-course Exam, and Final Exam
CLO-5	Lecture, multimedia presentation	Group Presentation, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) Jakov BULJAN, Raw Hide, Trade and Preservation, xxm Congress of the International Union of Leather Technologists and Chemists Societies (IULTCS), 1995.

- b) Jakov Buljan, Ivan Král', The framework for sustainable leather manufacture, United Nations Industrial Development Organization, 2019.
- c) P.S. Briggs, Gloving, Clothing and Special Leather Products Institute, London, 1981.

ii. Supplementary Readings

- a) Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edition.
 - b) Leather Technician`s Handbook–J. H. Sharphouse, Vernon Lock Ltd., 125 High Holborn, London W-C1
- iii. **Others:** Handout/lecture material provided by the course teacher

Course Code: 0723-LE-3202 **Course Title:** Eco-Friendly Leather Processing Lab **Credits:** 1.5

Rationale of the Course: This course is designed to provide practical knowledge and skills of eco-friendly leather processing. Students will be able to apply cleaner methods of pre-tanning, tanning and post tanning processing techniques. This course will also cover practical knowledge about the modern eco-friendly developments based on the latest research developments.

Course Content

1. Application of salt less curing of freshly flayed cow hides and its effect on water content at different time interval.
2. Application of salt less curing of freshly flayed goat skins and its effect on water content at different time interval.
3. Application of enzyme in soaking of cured hides/skins.
4. Application of enzyme in lime and sodium sulfide free unhairing of hides/skin.
5. Application of enzyme in unhairing of hides/skins with reduced amount of lime.
6. Application of enzyme in unhairing of hides/skins with reduced amount of sodium sulfide.
7. Application of chrome free tanning of hides and skins.
8. Application of enzyme in chrome tanning and its effect on chromium uptake.

Course Objectives: Make the students able:

- a) To impart practical knowledge on eco-friendly options for leather processing.
- b) To acquaint the students with different machineries involved in leather making.
- c) To enable the students to apply various techniques in making eco-friendly leather.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Apply the process of eco-friendly curing	C3, C4, P3, A2
CLO2	Assess enzyme usage in soaking process of cured hides/skins.	C3, P3, A2
CLO3	Apply enzyme in lime and sodium sulfide free unhairing of hides/skins.	C3, P3, A2
CLO4	Compare and evaluate the effectiveness of enzymatic unhairing.	C4, P4, A3
CLO5	Evaluate the use of enzyme in chrome tanning and demonstrate its effect on chromium uptake.	C4, P4, A3

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	3	2		2		3		3	3		
CLO2	3	3	2		2		3		3	3		
CLO3	3	3	3		3	2	3		3	3		
CLO4	3	3	3		2	3	3		3	3		
CLO5	3	3	3	3	2	2	3		3	3		

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, and Final Exam
CLO-2	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, and Final Exam
CLO-3	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, and Final Exam
CLO-4	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment, Viva, Report, Final Exam
CLO-5	Lecture, Demonstration, Video presentation and Problem-based group discussion	Demonstration, Lab Performance, Continuous assessment, Group presentation

Learning Materials

i. Recommended Readings

- a) Jakov BULJAN, Raw Hide, Trade and Preservation, xxm Congress of the International Union of Leather Technologists and Chemists Societies (IULTCS), 1995.
- b) Jakov Buljan, Ivan Král', The framework for sustainable leather manufacture, United Nations Industrial Development Organization, 2019.
- c) J.H. Sharphouse, Leather Technicians Hand Book, Leather Producers Association, Northampton NN3 1JD, Reprinted 1995.

ii. Supplementary Readings

- a) Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edn. I. L. T. A., Calcutta.
- b) Tanning Chemistry, The Science of Leather-Anthony D Covington.
- c) Fundamentals of Leather Manufacture – Eckhart Heidemann.

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0723-LE-3203 **Course Title:** Testing of Leather and Allied Materials **Credit Value:** 3.0

Rationale of the Course:

This course is designed to provide the basic concepts of thumb tests and laboratory tests for upper, lining, garments and sole leather. This course emphasizes on the quality assessment of different physical characteristics of leather, footwear, and allied materials. It imparts a comprehensive knowledge on different physical testing methods related to crust and finished leather. It also covers the knowledge and skills to assess different properties for upper and lining, sole, insole leather, and other allied materials. Upon completion of the course, students will be able to attain thorough knowledge of quality control in leather production.

Course Contents

Introduction: Objectives of carrying out physical testing of leather, few popular thumb tests for different leather, disadvantages of thumb tests, physical testing methods.

Sampling: Introduction, statistical aspects of sampling, determination of sample size, selection of a sampling location, hide to hide variability for various tests, sampling positions for full hide and skins, bends or butts, shoulder, belly.

Strength and stretch of leather: Tensile strength and percentage of elongation at break, stitch tearing strength, tearing strength, tongue tearing strength, buckle tear strength, split tear strength, distension and strength of grain by the ball burst test, relationship between different strength, puncture resistance, measurement of the initial strain energy of leather.

Important tests of comfortable properties: Essential comfortable properties for leather, footwear and leather products, principles and methods of different physical tests such as flexing endurance test, vamp flexing, water vapor permeability, water proofness, apparent and real densities, scuffing and abrasive resistance, absorption of water, water penetration, resistance to cracking of grain and crack index, perspiration resistance of leather, leather softness, fogging tendency of leather.

Important tests for specific types of leather: Upper leather, lining leather, sole leather, clothing leather, upholstery leather, belting leather, car automotive leather, chamois leather, football leather, book binding leather, glace kid leather, glove leather, varnished leather, oil-pull up leather, aniline, semi aniline and pigment finished leather, etc.

Tests for finish film: Introduction, bond strength between the leather surface and the finish film, resistance to heat, cold crack, light fastness, wet and dry rub fastness, test for bleeding, water fastness, elasticity of finish film, resistance to solvent, washing and cleaning agents, dressing agents, water stains, plasticizer, moisture fastness, resistance to buffing of suede leather, resistance to ageing.

Tests for sole leather: Apparent and real densities, abrasion resistance, absorption of water, resistance to cracking of grain crack index, flexing test - SATRA BATA flexing test, Ross flex, Bennewart flex, adhesion test, oil swelling resistance test, compression set resistance test.

Test for insole leather: Flexing index, tensile strength and extension at break, tear strength, Laminar strength, adhesion strength.

Course Objectives: Objectives of this course are:

- a) To familiarize students with various theoretical aspects of physical characteristic of Leather and allied materials.
- b) To describe processing steps involved in physical testing of leather and allied materials.
- c) To make the students competent in the field of quality assessment in leather industry.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Explain different thumb tests of various upper leather, collection of samples for lab tests and sampling positions.	C1, C2, A1
CLO2	Describe different tests according to standard procedures for upper and lining leather, footwear and allied materials.	C2, A2
CLO3	Compare and select quality leather, and other materials for particular footwear manufacturing.	C3, A2
CLO4	Analyze and compare different quality parameters of different leather and allied materials for specialized shoe.	C4, A3
CLO5	Justify and follow the standard quality of different footwear.	C5, A3

Mapping of CLOs with Program Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	-	-	-	-	-	-	-	-	-	-
CLO2	3	2	-	-	-	-	-	-	-	-	-	-
CLO3	3	2	-	-	-	-	-	-	-	-	-	1
CLO4	3	3	2	3	-	-	-	-	-	-	-	2
CLO5	3	3	2	3	-	-	-	-	-	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, Multimedia presentation, demonstration and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO-2	Lecture, group discussion and Multimedia presentation	Group Presentation, In-course Exam; Final Exam
CLO-3	Lecture, guided reading and problem-based learning (PBL): Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam, and Final Exam
CLO-4	Lecture, group discussion, literature review, and problem-based exercises (PBE)	Group Presentation, In-course Exam, and Final Exam
CLO-5	Lecture, group discussion, multimedia presentation literature review, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

Learning materials

i. Recommended readings

- a) An Introduction to the Principles of Physical testing of Leather.-Dutta S.S.
- b) Society of Leather Technologists and Chemists-Official Methods of Analysis- 1996.
- c) Testing and Quality Assessment of footwear and Footwear Materials- B. Venkatappiah, CLRI 1999

ii. Supplementary Readings

- a) SATRA Owner's manual
- b) Lecture Notes on Leather- P.S. Venkatachalam

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0723-LE-3204 **Course Title:** Testing of Leather and Allied Materials lab
Credit Value: 1.5

Rationale of the Course: This course is designed to provide the practical knowledge of thumb tests and laboratory tests for upper, lining, garments and sole leather. The course also demonstrates and conducts different tests to assess different properties (strength, comfort and aesthetic appeal) for upper and lining leather, sole, insole and other allied materials. Learners will be able to identify the suitable finished leather for footwear and leather products industry and will be competent to control quality of various leather.

Course Contents

1. Determination of Tensile strength and % Elongation at break of upper leather.
2. Determination of Tear strength/Stitch tear strength/ Tongue tear strength/ Split tear Strength of upper leather
3. Determination of Distension and strength of grain.
4. Determination of Flexing Endurance (Vamp flexing/ Bally flexing).
5. Determination of Water vapour permeability of upper and lining leather.
6. Determination of resistance to water penetration.
7. Determination of scuff resistance of leather.
8. Determination of softness of garments leather.
9. Determination of colour fastness to circular rubbing.
10. Determination of heat resistance of finish film.
11. Determination of light fastness of finish film.
12. Determination of break/ pipiness/ wrinkle of leather.
13. Determination of bond strength in between leather and finish film.
14. Determination of perspiration resistance for upper materials used in products.
15. Determination of abrasion resistance of sole leather.
16. Determination of water absorption and % of Swelling.
17. Determination of resistance to bending.
18. Determination of flexing index of insole leather.
19. Determination of stiffness/ Shape retention of leather.

Course Objectives: The objectives of this course are:

- a) To familiarize students with the various practical aspects of physical characteristic of leather and allied materials.
- b) To demonstrate various standard operation procedures involved in physical testing of leather, and allied materials.
- c) To acquaint the students with different machineries involved in physical testing of leather and allied materials.
- d) To enhance the students' ability to analyze and critically evaluate different finished leather with realistic international standard quality parameters for specific leather products industries.
- e) To enable students competent in the field of leather and allied materials testing.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the quality testing using SOPs for upper and lining leather, sole, insole, and other allied materials.	C1, A1, P1
CLO2	Demonstrate and perform different tests according to SOPs for upper leather, lining leather, sole, insole, and allied materials.	C2, C3, A2, P2
CLO3	Compare and identify the best leather and other raw materials for different leather goods and footwear.	C4, A3, P3
CLO4	Evaluate shoe upper, lining, sole leather, garments, bag leathers with standard quality parameters.	C5, A3, P3
CLO5	Interpret and measure the standard quality of complete crust and finished leather.	C5, A4, P4

Mapping of CLOs with Program Learning Outcomes (PLOs)

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	3	3	-	-	1	-	-	-	2	-	-	-
CLO2	3	3	-	-	2	-	-	-	2	-	-	-
CLO3	3	3	-	3	3	-	-	-	2	-	-	-
CLO4	3	3	2	2	3	-	-	-	2	-	-	2
CLO5	3	2	2	2	3	-	-	-	2	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Report, Final Exam
CLO2	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO3	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO4	Lecture, Demonstration, Hands-on practice, and Group work	Lab Performance, Continuous assessment: Viva, Report, Final Exam
CLO5	Lecture, Demonstration, Video presentation and Problem-based group discussion	Demonstration, Continuous assessment: Group presentation

Learning Materials

i. Recommended readings

- a) An Introduction to the Principles of Physical testing of Leather.-Dutta S.S.
- b) Society of Leather Technologists and Chemists-Official Methods of Analysis- 1996.
- c) Testing and Quality Assessment of footwear and Footwear Materials- B. Venkatappiah, CLRI 1999

ii. Supplementary Readings

- a) SATRA Owner's manual
- b) Lecture Notes on Leather- P.S. Venkatachalam

iii. Others: Handout material provided by the course teacher.

Course Code: 0723-LE-3205

Course Title: Dyeing and Finishing-II

Credits: 3

Rationale of the Course: This course is intended to acquaint students with comprehensive knowledge about different color systems, mechanisms of dyeing, and analysis of the rheological processes of coatings for leather finishing. This course is essential to comprehend the advanced dyeing practice used in the leather industry. At the end of the course, students will be able to solve different leather dyeing and finishing problems that may arise in real life.

Course Content

Behavior of Dyes in Solution: Nature of dye solution, Fick's law of diffusion, activation energies of diffusion, factors affecting diffusibility, measurement of diffusion coefficient, affinity of dyes, determination of affinity in dyeing system, influencing factors of affinity.

Thermodynamics of Dyeing: Thermodynamic laws, equilibrium state on affinity, adsorption isotherms, adsorption at surface and dye bath-fibre interfaces, dyeing equilibrium, half-time, heat, entropy and enthalpy of dyeing.

Color and Vision: Theories of color vision, various color attributes; color space, method of investigating the perception of color, color appearance phenomena.

Colorimetry and Color System: Principle of additive and subtractive color mixing; different color system, color specification system, color difference and evaluation, properties and sources of artificial light, visual color matching; different fastness properties.

Rheology and Performance Properties of Coatings: Concept of rheology, rheological measurements and processes, low VOC coatings- flow problems and solutions.

Finishing operations: Application of finishes-padding, spraying; curtain coating, printing and laminating, plating, glazing, polishing.

Formulation of leather finishes: Glazing finish, wax finish, typical pigment finish, pigment finish from dry powdered pigments, colorless lacquers, titanium white, zinc oxide castor oil barkite, concentrated white liquor, false grain finish, side leather finish for corrected leathers, finish for glazed lining leather, semi-anili finish, clothing and gloving gloss finish, suede leather finishes, patent and wet look leathers, antique finish, silver finish, gold finishing effect.

Physics of Film Formation: Introduction, solutions of cross-linking polymers, solventless cross linking systems, disperse phase systems.

Course Objectives

- a) To introduce students to different types of film-forming materials and their applications in dyeing and finishing.
- b) To be familiar with a broad array of methods and approaches that are used within the industry.
- c) To acquaint students with techniques to develop conventional leather finishing processes.
- d) To provide knowledge of modern machines involved in dyeing and finishing.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

CLOs	Course learning outcomes (CLO)	Learning level
CLO-1	Recall and describe the color, color specification, and color mixing systems for leather finishing.	C1, C2
CLO-2	Interpret the dyeing mechanisms in leather processing within the tannery.	C3,
CLO-3	Analyze rheology and performance properties measurement for the solution of flow problems, and aging processes.	C3,
CLO-4	Applying techniques to formulate conventional and special finishing effects for leather finishing.	C4
CLO-5	Contrast and evaluate various dyeing behaviors in leather finishing.	C4

Mapping of Course Learning Outcomes (CLOs) with Programs Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1	3	2							3	2		
CLO 2	3	2							2	2		
CLO 3	3		2						2			
CLO 4	3	3			3				2			
CLO 5	3	3		3					3			

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation, and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO2	Lecture, group discussion and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO3	Lecture, guided reading and problem-based learning (PBL): Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam, and Final Exam
CLO4	Lecture, multimedia presentation, group discussion, literature review, and problem-based exercises	Group Presentation, In-course Exam, and Final Exam
CLO5	Lecture, group discussion, literature review, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) Eco-Friendly Textile Dyeing and Finishing. Edited by: Melih Günay -Advances in the Dyeing and Finishing of Technical Textiles Edited by: M. L. Gulrajani
- b) Handbook for Shoe and Leather Processing - Leathers, Tanning, Fatliquoring, Finishing, Oiling, Waterproofing, Spotting, Dyeing, Cleaning, Polishing By – Anon, Publisher: Rossetti Press

ii. Supplementary Readings:

- a) Prepared to Dye: Dyeing Techniques for Fiber Artists by Shepherd, Gene

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0723-LE-3206 **Course Title:** Dyeing and Finishing-II Lab **Credits:** 1.5

Rational of the Course

This course is outlined in a way to provide practical knowledge of both conventional and modern finishing methods and approaches that are used in the leather industry. This lab course will facilitate the students to acquaint with different types of methods, machinery, and materials involved in leather finishing.

Course Content

1. Manufacturing of aniline finished leather
2. Manufacturing of semi-aniline finished leather
3. Manufacturing of corrected grain finished leather.
4. Manufacturing of glaze/plate finished leather.
5. Manufacturing of embossed finished leather.
6. Manufacturing of resin finished leather.
7. Manufacturing of nappa/shoe upper finished leather.
8. Manufacturing of pull-up/garments finished leather.
9. Manufacture of water patent/matt patent finished leather.
10. Manufacture of two-tone/gold/silver/copper effect finished leather.
11. Manufacture of tipping embossed finished leather.

Course Objectives

- a) To identify different types of film-forming materials and their applications.
- b) To compare the characteristics of the finished film and different layers in the finished coat.
- c) To carry out various finishing techniques involved in leather manufacturing.
- d) To prepare diversified finishing effects as per recent trends.

Course Learning Outcomes (CLOs): After completing this course, students will be able to

	Course Learning Outcomes (CLOs)	Learning Level
CLO-1	State and identify suitable finishing chemicals for specific leather coating.	C1, A1
CLO-2	Comprehend different finishing formulations individually.	C2
CLO-3	Analyze the suitability of conventional and advanced leather finishing for the particular article.	C3, A2
CLO-4	Apply practical knowledge to develop new finishing formulations for different finishing effects.	C3, C4
CLO-5	Correlate finishing methods and approaches that are used within the industry.	C5

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO-1	3			2					2			
CLO-2	3		2						2	3		
CLO-3	3			2	2							
CLO-4	3	2	3	2						2		
CLO-5	3	3	2	1					3	2		

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy CLOs

CLO	Teaching-Learning Strategy	Assessment Strategy
CLO1	Demonstration and problem-based exercises presentation.	Viva, assignment, report evaluation, and final exam
CLO2	Group discussion, demonstration of problem-based exercises	viva, report evaluation final exam
CLO3	Demonstration, identifying the problem to be solved	Assignment, group presentation, quiz, class test, and final exam
CLO4	Multimedia presentations, group discussions, demonstrations, and problem-based exercises	Group presentation, viva report evaluation, and final exam
CLO5	Group discussion, demonstration.	Group presentation, assignment, quiz, viva, class test, and final exam

Learning Materials

i. Recommended Readings

- a) Anthony D. Covington- Tanning Chemistry- The Science of Leather.
- b) Dutta S.S.-An introduction to the Principles of Leather Manufacture.
- c) Krystof Bienkieuicz - Physical Chemistry of Leather Making.
- d) Flaharty , Roddy , Lollar-The Chemistry and Technology of Leather (vol-2 and 3) .
- e) Sarkar K.T.-Theory and Practice of Leather Manufacture.
- f) Reed R. -Science for Students of Leather Technology.

ii. Supplementary Reading

- a. BASF Manual -Pocket Book for the Leather Technologist.
- b. Sarpouse J.H.-Leather Technicians Handbook.
- c. Heidenmann Eckhart - Fundamentals of Leather Manufacture.
- d. Procter H.R.-The Principle of Leather Manufacture.

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0723-LE-3207

Course Title: Supply Chain Management

Credits: 3.0

Rationale of the Course: This course is designed as a core course to deliver SCM related knowledge to the students. It comprises understanding the basic structure of the leather and footwear industry's supply chain, supply chain performance drivers, designing an agile supply chain network, demand forecasting, outsourcing decisions and lead time management.

Course Contents

Understanding the Supply Chain: Supply chain, supply chain 4.0, types of supply chains and examples, strategic, tactical, and operational decisions in supply chains, process view of a supply chain, the importance of supply chain flows, structure of supply chain in the leather and footwear industry.

Supply Chain Performance and Drivers: Competitive and supply chain strategies, achieving strategic fit, expanding strategic scope, a framework for structuring drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing, Obstacles to achieving fit.

Demand Forecasting in a Supply Chain: The role of forecasting in a supply chain, Characteristics of forecasts, Components of forecasts and forecasting methods, Basic approach to demand forecasting, Time series forecasting methods, Measures of forecast error.

Sourcing Decisions in a Supply Chain: The Role of Sourcing in a Supply Chain, Supplier Scoring and Assessment, Supplier Selection and Contracts, Design Collaboration, The Procurement Process, Sourcing Planning and Analysis, Making Sourcing Decisions in Practice.

Strategic Lead Time Management: Time-based competition, time-based process mapping, logistics pipeline management, lean thinking.

Designing the Distribution Network Design in the Supply Chain: The role of distribution in the supply chain, Factors influencing distribution network design, Design options for a distribution network, E-business and the distribution network, distribution networks in practice, a strategic framework for facility location, Multi-echelon networks, Gravity methods for location, Plant location models, Supply Chain Decisions Under Uncertainty in Practice.

JIT and Quick Response Logistics: The philosophy, logistics implication, Vendor Managed Inventory.

Agility and Agile Supply Chain: The concept of market winner and market qualifier, How to combine lean and agile mindsets (pareto curve, decoupling point).

Managing the Global Pipeline: The tradeoffs among the logistics costs, concepts of centralization, focused factories and postponement.

Advanced Planning and Scheduling in Supply Chain Management: Understanding and solving logistics and supply chain problems, advanced planner and scheduler.

Course Objectives: The objectives of this course are as follows:

- a) To describe the fundamentals of SCM including its role in an organization and integrating firms in a supply chain.
- b) To explain the various concepts in SCM like coordination, planning for uncertainty, supply contracts, logistics management, outsourcing and procurement management.
- c) To demonstrate various analytical methods and tools so that students can be able to measure and evaluate various facets of supply chain performance.
- d) To understand the practices in SCM that differentiate successful firms from others.
- e) To explore the challenges in SCM through a real industry project.

Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

CLOs: Upon completion of this course, students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify and state the basic structure and functions of supply chain management for the leather industry.	C1, A1
CLO2	State and describe the supply chain activities and their performance drivers for the leather industry.	C1, C2, A2
CLO3	Apply different mathematical models along with modern tools for demand forecasting, sourcing decisions, lead time management, and overall planning in the supply chain and compare their results.	C3, C4, A3
CLO4	Design distribution network and agile supply chain network to manage the global pipeline.	C5, A3

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO 1	3	-	-	-	-	-	-	-	-	-	-	-
CLO 2	3	1	-	-	-	-	-	-	-	-	-	-
CLO 3	3	3	-	3	3	-	-	-	-	-	-	-
CLO 4	3	3	3	3	-	-	-	-	-	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive discussion, lecture-discussion with multimedia, and whiteboard illustration	In-course Exam and Final Exam
CLO2	Interactive discussion, lecture-discussion with multimedia, and whiteboard illustration	Assignment, In-course Exam, and Final Exam
CLO3	Lecture discussion with multimedia, whiteboard illustration, and problem-based learning (PBL)	In-course Exam, and Final Exam
CLO4	Lecture discussion with multimedia, group discussion, literature review, demonstration, and problem-based exercises	Assignment, Group Presentation, and Final Exam

Learning Materials

i. Recommended Reading

- a) K. Shridhra Bhat, "Logistics and Supply Chain Management".
- b) S. Chopra and Mendil, "Supply chain management, strategy, planning and operation", Pearson Education, Asia, 2/2004.
- c) B.S. Sahay, "Supply Chain Management, for Global Competitiveness", Macmillan Bangladesh Limited, 1999.

ii. Supplementary Readings

- a) G. Raguram and N. Rangarajan, "Logistics and Supply Chain Management-Cases and concept", Macmillan
- b) M. Hugos, Essentials of Supply Chain Management, Wiley.

iii. **Others:** Hand notes/Lecture materials will be provided by the course teacher.

Course Code: 0417-Hum-3208 **Course Title:** Employability Skills-II **Credits:** 1.5

Rationale of the Course:

This course is designed to help students identify the knowledge and skills required for obtaining and keeping employment. Upon successful completion of the course, students are expected to have employability skills that will allow them to do effective presentations, write properly, be career-oriented, and have the ability to work independently.

Course Contents

1. **Self-management skills:** Basics of self-management, stress management, ability to work independently, emotional intelligence, role play on avoiding a stressful situation, self-reflection, strength and weakness analysis, self-motivation, goal setting, and time management.

2. **Teamwork:** Working across different ages irrespective of gender, race, religion or political persuasion, working as an individual and as a member of a team, knowing how to define a role as part of the team, applying teamwork to a range of situations e.g., futures planning, crisis problem solving, identifying the strengths of the team members, coaching and mentoring skills including giving feedback.
3. **Problem-solving:** Developing creative, innovative and practical solutions, identifying problems and solving them, solving problems in teams, applying a range of strategies to problem-solving, using mathematics including budgeting and financial management to solve problems, applying problem-solving strategies across a range of areas, resolving customer concerns in relation to complex projects issues.
4. **Entrepreneurial skills:** Presenting the power of entrepreneurship, exercise on interviewing an entrepreneur, and self-assessment of entrepreneurial qualities.
5. **Writing concept note (CN) and proposal of a business plan:** Prepare the contents of a CN and proposal, set scoring criteria for the CN and proposal, and prepare CNs and proposals for various types of leather and leather products.
6. **Writing business plan:** Basic business plan guidelines, writing business plans for various types of leather and leather products, break-even analysis, preparation of budget template, project work plan, and measurable project performance indicators.
7. **Writing a technical and financial project proposal:** Basic guidelines for technical and financial project proposal, write a technical and financial project proposal for different technical aspects of the leather industry of Bangladesh.
8. **Presentation skill development:** Presentation and public speaking, rules for effective speaking, improving skills in non-verbal and verbal communication, the beauty of rhythm and voice modulation, presentation techniques, preparing the contents, tips for preparing attractive and powerful PowerPoint presentation, main challenges or barriers of presentation and public speaking, methods for overcoming the fear and obstacles during presentation, importance of rehearsals, common mistakes in presentation and public speaking, tips for smart speech, discussions on world-famous public speech with the audio-visual record, making interactive presentation slides and presenting the business plan/project proposal and self-assessment.

Course Objectives: The learning objectives of this course are:

- a) To develop an ability to gain key strategies and expressions for communicating with professionals and non-specialists.
- b) To enhance interpersonal and soft skills for professional development.
- c) To develop essential skills required to increase productivity, efficiency, and effectiveness.
- d) To develop problem-solving, confidence-building, organizational, team working skills.
- e) To prepare the students with all the employability skills as per the demand of the job market.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe professionalism and self-management skills required to opt appropriately in the working environment.	C1
CLO2	Explain the interpersonal and soft skills required for professional development.	C2
CLO3	Coordinate and carry out teamwork and problem-solving activities to develop enhanced productivity, efficiency, and effectiveness.	C3, P2, P3
CLO4	Compare and execute different types of communication and other essential interpersonal soft skills.	C4, P4, A3
CLO5	Design and review project proposals for leather/footwear/leather products manufacturing industries.	C5

Mapping of CLO with PLO

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	-	-	-	-	1	-	-	-	3	3	-	3
CLO2	-	-	-	-	1	-	-	-	3	3	-	3
CLO3	-	3	3	-	1	-	-	-	3	3	-	3
CLO4	-	-	-	-	1	-	-	-	3	3	2	3
CLO5	-	3	3	2	1	-	-	-	3	-	3	3

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive discussion, lecture discussion with multimedia, and Group work.	Continuous Assessment, Group Presentation, and Final Exam
CLO2	Interactive discussion, lecture discussion with multimedia, white board/ flip chart illustration, metaplan, and Group work.	Continuous Assessment, Group Presentation, Viva, and Final Exam
CLO3	Interactive discussion, lecture discussion with multimedia, and Group work.	Continuous Assessment, Group Presentation, and Final Exam
CLO4	Interactive discussion, lecture discussion with multimedia, white board/ flip chart illustration, metaplan, and Group work.	Continuous Assessment, Group Presentation, Viva, and Final Exam
CLO5	Interactive discussion, lecture discussion with multimedia, and Group work.	Continuous Assessment, Assignment, Group Presentation, and Final Exam

Learning Materials

i. Recommended Readings

- a) An Introduction to Employability Skills-Arvind M Nawale, Mahesh M Nivargi, Manisha B Gahelot.
- b) The Complete Book of Business Plan- Secrets to Writing Powerful Business Plans- Joseph A. Covello and Brian J. Hazelgren.
- c) The Complete Presentation Skills Handbook-Suzy Siddons.

ii. Supplementary Readings

- a) The Journey-Book on Secrets of Employability Skills-Dr. Hari Prasad. N, Dr. Soundria. S. M
- b) Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds-Carmine Gallo.

iii. **Others:** Handout/lecture material provided by the course teacher.

Course Code: 0542-Math-3209

Course Title: Probability and Statistics

Credits:

3.0

Rationale of the Course: This course is designed to introduce students to the fundamental ideas and logic behind statistical reasoning. In addition, students will be guided through the process of developing an understanding of the subject's significance to the sectors in which they choose to further their education.

Course Content

Introduction: Historical development of the subject, collection of data-primary data, and secondary data.

Frequency distribution: Grouped frequency distribution and their presentation in the form of frequency polygon and histogram.

Measures of central tendency: (i) Mean: (a) Arithmetic Mean (b) Geometric Mean (c) Harmonic Mean (ii) Median (iii) Mode, their definitions, computations, advantages, disadvantages and uses.

Measures of dispersion: Absolute measure, (a) Range (b) Mean deviation (c) Quartile deviation (d) Standard deviation, Relative measure, Coefficient of variation, their definitions, computations and uses.

Moment, skewness and kurtosis: Their definitions, computations and uses.

Correlation and regression: Correlation-Ideas of correlation, measurement of correlation. Pearsonian correlation co-efficient, and spearman's rank correlation co-efficient. Multiple correlations, Regression-Ideas about simple regression, equation of the regression line, estimation of the parameters of the regression line.

Probability: Simple idea of probability, different definitions related to probability, addition law of probability for mutually exclusive and not mutually exclusive events, multiplication law of

probabilities for dependent and independent events, discrete and continuous random variables, mathematical expectation, conditional probability, probability distribution: (i) Binomial, (ii) Poisson, Simple idea about normal distribution and its probability curve.

Test of significance: Some definitions related to the test of significance.

T-test: (a) Comparison of a sample mean with a known population mean when S.D. is known and when S.D. is not known. (b) Comparison of means of two samples when S.D. is known and also when it is unknown, (c) Paired t-test, its practical use in Leather/Footwear/Leather Product Industry. χ^2 -test: simple application and its practical use in industry.

Sampling: Definition of population, sample, parameter, census, etc. simple random sampling, stratified random sampling, their definitions, computations, uses, advantages and disadvantages.

Design of experiment: Basic principles of experimental design, ideas about CRD, RBD.

Course Objectives:

- a) To provide the basic foundations of statistics with applications in real life.
- b) To provide knowledge on descriptive statistics, correlation, regression, probability, and probability distributions for both continuous and discrete random variables.
- c) To discuss the theory and its applications for real-life problem-solving and inquiry.
- d) To provide students with hands-on experience in using statistical theory and methods to perform different statistical analyses and interpret results.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	State the fundamental concepts of different terminologies related to statistics.	C1, A1
CLO2	Describe the theories and methods to perform different statistical analyses.	C2, A2
CLO3	Calculate, interpret, and communicate the correlation coefficient and simple linear regression model.	C3, A2
CLO4	Analyze the data related to correlation, regression, probability, and probability distributions for both continuous and discrete random variables.	C4, A3
CLO5	Justify the appropriate statistical data based on experiment conditions and assumptions.	C5, A3

Mapping of CLOs with PLOs

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	3	2	-	-	-	-	-	-	-	-	-	-
CLO2	3	3	-	-	-	-	-	-	-	-	-	-
CLO3	3	3	-	-	-	-	-	-	-	-	-	1
CLO4	3	3	2	3	-	-	-	-	-	-	-	2
CLO5	3	3	2	3	-	-	-	-	-	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO2	Lecture, group discussion and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO3	Lecture, guided reading and problem-based learning (PBL): Identifying the problem to be solved	Assignment, In-course Exam, and Final Exam
CLO4	Lecture, group discussion, and problem-based exercises	Assignment, In-course Exam, and Final Exam
CLO5	Lecture, group discussion, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) An introduction to Statistics and Probability, Dr. Nurul Islam.
- b) Research Methodology (Methods and Techniques), C.R. Kothar.

ii. Supplementary Readings

- Business Statistics (Fourteenth Edition), Dr. S.P. Gupta and Dr. M.P. Gupta.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-3210

Course Title: Field Tour-III

Credit Value: 1.0

Rationale of the Course: The course offers students an invaluable opportunity to gain practical experience and insights into the operations of a reputed tannery industry. This course aims to bridge the gap between classroom learning and real-world application by facilitating a hands-on visit to an operational tannery. This course will provide the students with a practical perspective of the concepts and theories that are taught to them. It will also introduce students with knowledge about modern technology, and machinery used in the leather industry.

Course Content

In 3rd Year 2nd Semester, students will visit a reputed tannery industry.

1. **Practical Understanding:** Students will meticulously comprehend the intricate systems in place within the tannery workplace, including processes, organizational structures, and administrative protocols. This first-hand exposure will help them grasp the complexities of the industry and witness how theoretical concepts are put into practice.

2. **Logbook Documentation:** Throughout the visit, students are required to maintain a diligently maintained logbook. This logbook will serve as a comprehensive record of all activities performed and knowledge acquired during the immersion
3. **Analyze and Evaluate:** Upon completing the tannery visit, students are expected to analyze their experiences and observations critically. They will be encouraged to identify strengths, weaknesses, and potential areas of improvement within the tannery's processes or operations.
4. **Feedback and Reflection:** Students are encouraged to provide constructive feedback to their guiding teacher based on their observations and experiences gained during the visit. This reflection process will help students consolidate their learning, gain valuable insights, and foster a culture of continuous improvement.
5. **Discuss with the company supervisor** about any project or assignment/tasks. Try to understand the systems in your work place – Processes, Organization, Administrative. Record all the work done or knowledge gained. Maintain logbook and give feedback to guide teacher.

Course Objectives

- a) To build a learning intervention that is intertwined with practical, hands-on skill enhancement knowledge to ensure that student's learning is not focused solely on theoretic approaches.
- b) To make a good relationship with various leather companies and increase their networking opportunities.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Provide a description of the operations, workstations, plants, machines, assembly lines, and management involved in the leather industry and engage in discussions with knowledgeable professionals.	C2, A3, P2
CLO2	Improve abilities in collaborating effectively with others, expressing ideas clearly and concisely, and working efficiently in a group setting.	C2, A3
CLO3	Prepare technical documents and give verbal presentations on completed industrial tour work.	C3, C4, A4

Mapping course learning outcomes (CLOs) with program learning outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	3	-	-	-	-	3	-	2
CLO2	2	-	-	-	-	-	-	-	2	2	-	2
CLO3	2	-	-	-	-	-	-	-	-	3	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Class Lecture, Display and Demonstration	Presentation and viva, Report Evaluation
CLO2	Class Lecture, Display and Demonstration,	Presentation and viva, Report Evaluation
CLO3	Discussion, Discussion and Motivation, Self-study	Presentation and viva, Report Evaluation

Learning Materials

i. Recommended Readings

- a) Writing the Winning Thesis or Dissertation: A Step-by-Step Guide - By Allan A. Glatthorn, Randy L. Joyner.
- b) Relevant books, handbooks, patents and manuals.

Course Code: 0723-LE-4101

Course Title: Tannery Wastewater Management

Credits: 3.0

Rational of the Course: Mismanagement of different wastes especially wastewater produced by tanning processes has caused severe environmental problems and ultimately impaired human health, as a result processing and manufacturing of leather and leather goods are facing challenging phase of existence. The course is intended to describe different methods of existing and advanced tannery wastewater treatment facilities for meeting discharge standard and resource recovery from the effluent. The catalogue description of the course is here:

Course Content

Principal industries attributed for water pollution: Types of water pollution– physical, chemical and biological pollution, hazardous effects of water pollution on land, ground water, surface water, aquatic life and sea, ecological system and water pollution; Current Status of the Leather and Leather Products Industry; Water Use and Wastewater Ratios in Leather Industry; Leather Working Group (LWG) and Their Approaches on Water Use

Types of tannery effluent: Effluent from beam house operations, tan yard processes and finishing processes, their nature, most toxic ingredients in tannery waste water.

Tannery effluents: Source of liquid wastes in tanneries, characterization and assessment of critical environmental parameters, chemistry and characteristics of environmental parameters- total solids, total dissolved solids, volatile matters, BOD₅, COD, TOC, TDS, ammonia, nitrogen, protein content, chlorides, alkalinity, pH, sulphide, DO, total coliform count, polyphenol, metal content; Current Practices for Reducing Water Use.

Processes for the treatment of industrial wastewater: Principles of physical treatment: screening, mixing, equalization, sedimentation, filtration. Principles of chemical treatment:

coagulation, flocculation, precipitation, ion exchange, use of alkali, CaO, neutralization, flotation, oxidation/reduction, distillation, objectives of biological wastewater treatment and various processes.

Primary treatment: Main objectives of primary treatment- primary treatment units- collection system of discharged waste water in tanneries, screening, equalisation of waste water.

Secondary treatment: Principles of secondary treatment, different processes involved in secondary treatment system, lagoon treatment, aeration system, trickling filter, systematic design of these systems, bio-technology in effluent treatment.

Tertiary treatment: UV treatment, ozonolysis, chlorination, reverse osmosis. concept of CETP, disposal of sludge.

Principle of biological treatment: Derivation of bacterial growth kinetics. Process design and operation of attached growth, suspended growth and hybrid process: activated sludge process - its modifications, trickling filter, RBC, oxidation ditch, aerated lagoon, biofilter, anaerobic baffled reactor, UASB reactor, waste stabilization pond, design and operation of biological nitrification, de-nitrification system, floating aquatic plant system.

In-plant management for pollution reduction: House-keeping, segregation of waste streams, reduction of water use, chemical use, recycling and reuse of chemicals and water, water foot print.

Course Objectives

- a) To inculcate the basic concepts of tannery waste water treatment, its design and management.
- b) To inform the basic methodology for wastewater treatment and methods employed for water reuse, wastewater reclamation, reuse, resource recovery.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	State basics water parameters, biological principles and design practice of tannery wastewater treatment and prepare for designing wastewater treatment systems.	C1, C2
CLO2	Apply fundamental concepts to primary, secondary and tertiary wastewater treatment systems for tannery effluent after conceptualizing different characteristics and types of tannery effluent.	C3
CLO3	Analyze the efficiency of different wastewater treatment systems and correlate the principles of biological wastewater treatment, nutrient removal and resource recovery from tannery wastewater	C4, A4

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3		3		2				3			
CLO2	3	3	3	2		3						
CLO3	3	3		3			2	3	3		2	3

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course-Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, Multimedia presentation, white board illustration, problem-based exercises, group discussion	Quiz, In- course exam; Final Exam
CLO-2	Lecture, multimedia presentation, Problem based Learning (PBL): Identifying the problems to be solved	Assignment, Group presentation, In-course exam, Final exam
CLO-3	Lecture, multimedia presentation, group discussion, analyze and compare through various case-studies	Assignment, In-course Exam, Final Exam

i. Recommended Readings

- a) Metcalf and Eddy, H. Tchobanoglous, G. and Burton, F.L. (Ed), Waste water Engineering, treatment, disposal and reuse”, 3rd edn. Tata-McGraw Hill Publishing, New Delhi 1991.
- b) Metcalf and Eddy, “Wastewater Engineering, Treatment and Reuse”, Tata McGraw Hill, New Delhi, 2003.
- c) Gilbert M. Masters, “Introduction to Environmental Engineering and Science”, 2nd edition, Pearson Education (2004)
- d) Faisal I. Hai, Kazuo Yamamoto and Chungg-Hak Lee (2014) ; “Membrane BiologicalReactors: Theory, Modeling, Design, Management and Applications to Wastewater Reuse”

ii. Supplementary Readings

- a) Besselievie, B.E. and Schwartz, M. “The Treatment of Industrial wastes”, 2nd edn., McGraw Hill.
- b) Infogate, GTZ, “Treatment of Tannery Waste Water”, GmbH, Frankfurt, Germany, 2002.

iii. **Others:** Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-4102 **Course Title:** Wastewater Treatment Lab **Credits:** 1.5

Rationale of the course: This course is designed to complement the theoretical course on tannery wastewater management. This course develops skills for treatability studies of wastewater using lab-scale models and explores the relationship between common environmental experiments and industrial wastewater treatment. It also enhances technical and instrumental skills in environmental analysis for research purposes.

Course Contents

1. Determination of pH, conductivity and turbidity of wastewater
2. Determination of chlorine content of tannery wastewater/ soaking liquor
3. Determination of Iron content of water.
4. Determination of dissolved oxygen in water.
5. Determination of biological oxygen demand of industrial wastewater.
6. Determination of chemical oxygen demand industrial wastewater.
7. Determination of optimum dose of coagulants for wastewater treatment.
8. Determination of total nitrogen and phosphorus in water.
9. Experimental study on material corrosion
10. Determination of total dissolved solid in wastewater.
11. Determination of total suspended solids, total volatile suspended, and fixed suspended solids in wastewater
12. Determination of sulfide content in composite tannery wastewater/ liming liquor
13. Determination of calcium content in tannery wastewater.

Course Objectives

- a) To enhance students' ability to analyze industrial wastewater, they will be better equipped to implement the appropriate wastewater treatment facilities in industrial settings.
- b) To improve students' analysis of heavy metals and solids (suspended, dissolved) enhances their understanding of how these materials move within the ecosystem, fostering ecological awareness.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

CLOs	Course Learning Outcomes	Learning Level
CLO1	Explain the theoretical backgrounds, principles and environmental significance of carrying out laboratory scale experiments.	C2, A3
CLO2	Use and apply analytical balance, TDS meter, pH meter, BOD meter, COD meter, conductivity meter, and turbidimeter for carrying out experiments.	C3, A2
CLO3	Perform experiments related to environmental remediation and conduct an individual research project within the laboratory of other appropriate settings.	C3, A2
CLO4	Develop and use technical and analytical skills to quantify the level of xenobiotics in environmental compartments.	C5, A4
CLO5	Interprets experimental results and theoretical knowledge related to experimental study through oral presentations, demonstrations, and written technical report format.	C5, A4

Mapping of CLO with PLO

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3		3		3							
CLO2	3	2	3				2		3			
CLO3	3	3	2		3				3			
CLO4	3		3		3	1			3			
CLO5	3	3	3	2	3				3	3		

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Assignment
CLO2	Hands on demonstration, Problem based teaching methods	Presentation, Class Test
CLO3	Lecture, demonstration, Case study	Report Evaluation, Viva voce
CLO4	Lecture, hands on demonstration, Multimedia presentation, White board illustration,	Final Exam, Final Exam, Presentation

	Assignment	Report Evaluation, Class Test, Assignment
CLO5	Video presentation, Lecture and hands on demonstration.	Class Test, Report Evaluation, Viva Voce, Final Exam

Learning materials

i. Recommended readings

- a) Society of Leather Technologists and Chemists - Official Methods of Analysis
- b) Infogate, GTZ- Treatment of Tannery Wastewater- GmbH, Frankfurt, Germany, 2002.

ii. Supplementary Readings

- a) P. K. Sarker - Analytical Chemistry for Leather Manufacture.
- b) Fifield and Haines-Environmental Analytical Chemistry.

iii. Others: Lecture notes and Lab procedure provided by the course teachers.

Course Code: 0723-LE-4104 **Course Title:** Computer-Aided Design **Credits:** 1.5

Rationale of the Course:

The course will provide an overview of how computer-aided design and CAD software like Shoe master and Crispin can be applied to the traditional skills of pattern cutting, grading, fashion design and manufacturing. Student will learn to use various CAD/CAM software packages which include Shoe master and Crispin. The course also will help students how to use CAD software for designing and pattern making skills for footwear and allied industry.

Course Contents:

Computer Aided Design Techniques of the following items

1. Demonstrating and practice different types of tools used in CAD/CAM Software.
2. 2D scanning of mean for me and standard pattern and producing complete set of patterns for classic derby shoe.
3. 3D scanning of derby shoe last, making e-last and modification of the last.
4. Developing style lines, flattening and producing complete set of patterns for classic derby shoe.
5. Grading of upper, lining, bottom and component patterns for classic derby shoe.
6. Developing of complete set of patterns with size range for classic sports shoe.
7. Developing of complete set of patterns with size range for classic moccasin shoe.
8. Developing of complete set of patterns with size range for classic boot.
9. Preparation of a detailed Bill of Materials (BOM), consumption and costing for classic derby shoe.

Course Objectives

- To gather the essential experimental knowledge and skill of different process to design a footwear product using special software and computer.
- To practice pattern developments and grading by using latest shoe designing software like shoemaster and crispin.
- To apply theoretical knowledge practically in the field of footwear industries and develop the sector technically as well as economically.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Demonstrate the function of different tools used in CAD software including shoemaster and crispin.	C2, A1, P1
CLO2	Identify the machinery, equipment, and associated risk for specific types footwear pattern development.	C2, A2, P2
CLO3	Implement the practical knowledge for preparing complete set of pattern on different style by using CAD/CAM software.	C3, A3, P3
CLO4	Compare a set of pattern for a particular style using CAD/CAM software with manual pattern making and fix the defect.	C4, A4, P4
CLO5	Prepare remedy plan for pattern making defect and develop detailed Bill of Materials (BOM), consumption and costing for specific footwear.	C5, A5, P4

Mapping of CLO with PLO

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	2	-	-	-	2	-	-	-
CLO2	3	2	-	-	3	-	-	-	2	-	-	-
CLO3	3	3	2	-	3	-	-	-	2	-	-	-
CLO4	3	3	3	2	3	-	-	-	2	-	-	-
CLO5	2	2	3	3	3	-	-	-	2	-	-	-

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Demonstration, Practical	Class Test, Report, Direct Assessment, Final Exam
CLO2	Lecture, Demonstration, Panel-Discussion, Practical, Practical Problem-solving	Class Test, Report, Direct Assessment, Final Exam
CLO3	Lecture, Demonstration, Group Discussion, Practical, Cooperative Learning, Practical Problem-solving, Videotapes, Debate	Class Test, Report, Viva Voce, Indirect Assessment, Final Exam
CLO4	Lecture, Demonstration, Video presentation, Problem-based group discussion, Case studies, Problem-solving, Cooperative Learning.	Class Test, Report, Viva Voce, Indirect Assessment, Final Exam
CLO5	Lecture, Demonstration, Video presentation, Problem-based group discussion, Problem-solving, Cooperative Learning.	Class Test, Report, Viva Voce, Indirect Assessment, Final Exam

Learning Materials

i. Recommended Readings

- a) Pattern Cutting and Making up- Martin M. Shoben.
- b) Leather Apparel Design – Francesea Sterlacci.
- c) Clothing Technology- Europa Lehrmittel

ii. Supplementary Readings

- a) Metric Pattern Cutting for Children’s Wear and Baby Wear- Winifred Aldrich.
- b) Grading for the Fashion Industry- Taylon Shoben.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-4105 **Course Title:** Industrial Utility and Maintenance **Credits:** 3.0

Rational of the Course:

The course is designed to teach students the fundamentals of industrial utilities and issues with functionality caused by deposition, corrosion, and biofouling. This course will provide students with knowledge of the maintenance of various machinery of leather and footwear industries, total productive maintenance, and also laboratory safety and maintenance.

Course Content

Air conditioning, Psychometric chart and psychometric processes: Comfort condition, Principle of air conditioning, Application in Leather Product industry; Refrigeration equipment, Refrigerant; Air conditioning in tannery; Calculation of simple air conditioning system, Distribution system, Humidifier, De-humidifier, Cooling tower; Use of psychometric chart and psychometric process in leather drying.

Boiler: Boiler types, mountings, accessories, boiler efficiency; Use of boiler in tanneries.

Material handling equipment: Issues and importance of material handling, selection and classification of material handling equipment, various types of conveyors equipment- belt, screw, chain, flight, bucket elevator, pneumatic, hydraulic, cranes and forklifts; Application of material handling equipment in tanneries.

Machine erection, Lubrication and Maintenance: Floor preparation, foundation, machine fixation, leveling. Lubricant, types, general properties, functions, lubrication systems of tannery machineries, types of maintenance, planning and organizing maintenance, preparation of maintenance schedule.

Maintenance of various machineries of tannery: Leather drum, motor for leather drum, Fleshing machine, Sammying machine, splitting machine, Shaving machine, Setting machine, Vacuum machine, Tunnel dryer, Toggling machine, Stacking machine, Rotto press, Plating machine, Buffing machine, Spraying machine, spare parts replacement, and troubleshooting.

Total productive maintenance (TPM): Introduction, objectives of TPM, benefits of TPM, OEE (Overall Equipment Efficiency), six big losses analysis, 4M+E analyze, pillars of TPM, step by step to successful TPM, difficulties faced in TPM implementation, case studies on operational performance in leather and footwear industry of Bangladesh.

Laboratory safety and maintenance: Properties of safety and general rules of laboratories; Personal safety in the laboratory; Chemical safety in the laboratory; Laboratory safety; Risk management; Cleaning measures; Biosecurity; Radiation Safety; First aid in laboratory accidents; Waste management; Basic laboratory; supplies; Basic laboratory equipment; Basic measurement methods.

Course Objectives

- a) To introduce the different industrial utilities and their proper maintenance.
- b) To impart knowledge on different machine parts and their functions for leather and footwear production.
- c) To provide in-depth knowledge on the maintenance and their applications of leather and footwear machinery.

Course Learning Outcomes (CLOs): After completing this course, students will be able to

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Define different terms and state various principles used in industrial utility and maintenance	C1, A1
CLO2	Explain the field of industrial utility and maintenance and also describe its role in leather and leather manufacturing.	C2, A2
CLO3	Explain and apply various types of maintenance strategies and their purposes in various leather manufacturing machineries.	C3, A2
CLO4	Apply the most common techniques of machine tools and their maintenance in leather industry.	C3, A2
CLO5	Solve the routine maintenance problems of leather industries including inputs, outputs and safety considerations.	C4, A3

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	-	-	-	-	-	-	-	2	-	-	-
CLO2	3	-	-	-	-	-	-	-	2	-	-	-
CLO3	3	1	2	-	-	-	-	-	2	-	-	-
CLO4	3	2	3	-	2	3	-	-	2	-	-	1
CLO5	2	2	3	-	2	3	-	-	2	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lecture, multimedia presentation, literature review and problem-based exercises	Group Presentation, Assignment, oral presentation, In-course Exam and Final Exam
CLO-2	Lecture, group discussion and problem-based exercises, literature review.	Group Presentation, In-course Exam and Final Exam
CLO-3	Lecture, multimedia presentation and problem-based learning: Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam and Final Exam
CLO-4	Lecture, multimedia presentation, group discussion, demonstration, and problem-based exercises	Group Presentation, Case study, Assignment, In-course Exam and Final Exam
CLO-5	Lecture, multimedia presentation, group discussion, demonstration, and problem-based exercises	Group Presentation, Case study, Assignment, In-course Exam and Final Exam

Learning Materials

i. Recommended Readings

- a) G. R. Nagpal, G R. Khanna- Power Plant Engineering
- b) W.F. Stoecker and J.W. Jones-Air Conditioning and Refrigeration
- c) Sharphouse - Leather Technicians Hand books.

ii. Supplementary Readings

- a) Boothroyd G.- Assembly Automation and Product Design

iii. Others: Handout/lecture material provided by the course teacher

Course Code: 0723-LE-4106 **Course Title:** Industrial Utility and Maintenance Lab

Credits: 1.5

Rational of the Course:

This course is designed to provide students with practical knowledge of industrial utilities and maintenance of machinery used in leather and footwear industries. Students will become competent in comfortable working condition, material handling, understanding operating procedures of various machinery and their upkeep as well.

Course Content

1. Study the air conditioning and controlling system in the tunnel dryer for leather drying.
2. Study the control and maintenance of emergency power supply unit (Diesel power unit).
3. Study the use of different material handling equipment like belt-conveyor, wooden horses and forklifts, etc. in tannery setup.
4. Study the use of different lubricants and hydraulic oils which are directly used in tannery machineries
5. Check and fill the hydraulic oil up to the level of the machine plating machine.
6. Check and sharp the cutter knife of shaving machine
7. Check and adjust the operating thickness and pressure of shaving machine.
8. Check and adjust the operating pressure of Sammying machine.
9. Check and adjust the operating temperature and pressure of Rotto press or Kiss plate machine.
10. Check and sharp the band saw of the leather splitting machine.
11. Check and sharp the cutter knife of fleshing machine.
12. Check and adjust the operating pressure of setting machine.
13. Check the operating condition of central pneumatic compressor.

Course Objectives

- a) To demonstrate different types of materials handling equipment used in leather industry.
- b) To develop skills in the applications of different lubricants and hydraulic oils for different machinery.

- c) To generate skills in routine maintenance of different types of machinery used in leather manufacturing.
- d) To familiarize students with replacing the spare parts of different leather machinery.
- e) To check and follow-up the different leather machinery maintenance.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Demonstrate different types of materials handling equipment and the use of different lubricants and hydraulic oils.	C1, C2, P1
CLO2	Perform the operating and maintenance procedures of leather manufacturing machinery.	C3, A2, P2
CLO3	Analyze different problems and difficulties created in operating and maintaining leather machinery in production.	C4, A2, P3
CLO4	Solve the problems of different machinery to ensure the effective production output.	C4, A3, P3

Mapping of CLO with PLO

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	1	-	-	-	-	-	-	-
CLO2	3	-	-	1	2	-	-	-	2	-	-	-
CLO3	3	2	-	2	3	-	-	-	2	2	-	-
CLO4	3	3	-	2	3	-	-	-	3	2	-	1

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Demonstration and problem-based exercises presentation.	Viva, assignment, report evaluation, and final exam
CLO-2	Group discussion, demonstration of problem-based exercises, multimedia presentation	Viva, report evaluation and final exam
CLO-3	Demonstration, identifying the problem to be solved	Assignment, group presentation, quiz, report evaluation and final exam
CLO-4	Multimedia presentations, group discussions, demonstrations and problem-based exercises	Group presentation, viva, report evaluation, quiz and final exam

Learning Materials

i. Recommended Readings

- a) Sharphouse - Leather Technicians Hand books.
- b) Pivecka J. - Practical Handbook on Shoe Production.
- c) Boothroyd G.- Assembly Automation and Product Design.
- d) Miller R.G. (Editor) -Manual of Shoe Making.

ii. Others: Handout/lecture material provided by the course teacher

Course Code: 0411-Hum-4107 **Course Title:** Cost and Management Accounting **Credits:** 3.0

Rationale of the Course: This course provides knowledge of cost behavior and terminology, cost elements, accounting system, and costing techniques. The course emphasizes on analysis of cost behavior, evaluation performance and business economics. At the end of the course, students will have a thorough understanding of the areas of cost ascertainment, cost control and cost management in a complicated manufacturing environment of leather industry.

Course Contents

Cost Accounting

Introduction: Meaning, scope, objectives, advantages, financial accounting vs cost accounting, factors influencing the design of a cost, limitations, characteristics of an ideal cost accounting system, installation of costing system-steps, difficulties, measures to overcome the difficulties, cost unit, methods of costing types, development of cost accounting.

Cost Behavior and Terminology: Basic cost behavior patterns, economic, accounting and other cost patterns, product costing concept need for knowledge of cost behavior, methods of estimating cost relationship.

Cost Elements and Accounting System: Costing for materials, costing for labour, and costing for overheads; job order costing, contract costing and process costing.

Costing Techniques: Standard costing, costing of by-products and joint products, direct costing. Costing of leather products, material, labour, power and overhead expenses, foreign exchange mechanisms, exchange rates; foreign exchange exposure management – risks, strategies to reduce risk, budget: types of budgets, budgeting, and control in leather products industries.

Management Accounting

Introduction: Definition, difference between financial accounting and cost accounting, relationship with financial accounting, uses in planning and control.

Analysis of Cost Behaviour: Variable, fixed and mixed, cost-volume-profit analysis. Analysing cost for pricing and short-run decision: BEP analysis, cost for decision making, differential cost analysis.

Evaluation Performance: Variance analysis, financial statement, analysis, and interpretation.

Business Economics: The roles of engineers in business and corporation, time value of money, simple and compound interest, types of investment; Types of economic analysis: present, future and annual worth analysis, cost-benefit analysis, internal rate of return analysis; Incremental analysis depreciation: Straight line depreciation, declining balance method, MACRS, sum of years method etc., after tax cash flow analysis, inflation and its impact on economic decision, capital budgeting and rationing, sensitivity analysis.

Course Objectives: The objectives of this course are as follows:

- a) To know about terminology, cost elements, cost accounting, and behavior
- b) To impart adequate knowledge on cost accounting systems, costing techniques, and management accounting.
- c) To deliver the problem-solving know-how in the areas of cost and management accounting in a complicated manufacturing environment.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Outline and explain the different concepts of managerial accounting, cost accounting, and business economics.	C1, C2, A1
CLO2	Identify and explain different types of cost behavior, and costing techniques to control the product and related costs.	C2, C3, A2
CLO3	Analyze overhead costing according to nature, behavior, function and control, and methods of distribution of factory overhead to the production department.	C4, A3
CLO4	Evaluate cost-volume-profit analysis for pricing and short-run decision.	C5, A3
CLO5	Create a profit plan, standard costing, and relevant costs for decision-making.	C6, A4

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	-	-	-	-	-	-	-	-	-	-	-
CLO2	3	-	-	-	-	-	-	-	-	-	-	-
CLO3	3	2	-	2	1	-	-	-	-	-	2	-
CLO4	3	2	-	2	2	-	-	-	-	-	2	-
CLO5	3	3	2	3	1	-	-	-	-	-	3	-

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive discussion, lecture discussion with multimedia, and white board illustration	In-course Exam and Final Exam
CLO2	Interactive discussion, lecture discussion with multimedia, and white board illustration	In-course Exam and Final Exam
CLO3	Lecture discussion with multimedia, white Board illustration, and problem-based learning (PBL): Identifying the problem to be solved	Assignment, In-course Exam, and Final Exam
CLO4	Lecture discussion with multimedia, group discussion, literature review, demonstration, and problem-based exercises	Assignment, Group Presentation, In-course Exam, and Final Exam
CLO5	Lecture discussion with multimedia, group discussion, literature review, demonstration, and problem-based exercises	Assignment, Group Presentation, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) Accounting Principles, Kieso and Kimmel.
- b) Managerial accounting (Text Book) Garrison, R. H., & Noreen, E. W. (7th / Latest edition) Boston: Irwin/McGraw-Hill.
- c) Cost Accounting: A Managerial Emphasis, Horngren CT, 15th / Latest edition publisher Pearson.

ii. Supplementary Readings

- a) Cost Accounting (Text Book), S.P Iyengar, Latest Edition, 2017-2018, Sultan Chand & Sons
- b) Theory & Practice of Costing (Reference Book), Basu & Das, Latest, 2018-19

iii. **Others:** Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-4109

Course Title: Total Quality Management

Credits: 3.0

Rationale of the Course: This course emphasizes the TQM framework, barriers, and benefits resulting in beneficial effects on organizational development in the competitive business. After completion of the course, students will learn about strategic lead time management and quality systems and be able to lead a team, production line, and a business organization.

Course Contents

Introduction: Modern concept of quality and its measurement, quality redefined, identification of quality characteristics: quality of design conformance and performance, Deming's principles on quality and productivity, quality costs and their interpretations, basic concepts of TQM, TQM framework.

Statistical Quality Control: Control and measurement of quality, elementary SPC tools: Control charts, Process capability analysis, Design of experiments, Acceptance sampling plans: OC curves, single and double sampling plane, rectifying inspection, AOQ.

TQM Principles: Quality statements, Customer focus, Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Continuous process improvement, PDCA cycle, 5S, Kaizen, Supplier partnership, Partnering, Supplier selection, Supplier Rating.

TQM Tools and Techniques I: The seven traditional tools of quality, New management tools, Six-sigma: Concepts, methodology, applications in Leather/Footwear/Leather Products industries; Benchmarking, Benchmarking processes, FMEA, Stages, Types.

TQM Tools and Techniques II: Quality circles, Quality Function Deployment (QFD) Taguchi quality loss function, PM Concepts, improvement needs, Performance measures, BPR; application of TQM tools in Leather/Footwear/Leather Product industries, BSTI, ASTM.

Quality Systems: Need for ISO 9000- ISO 9000-2000 Quality System, Elements, Documentation, Quality auditing- QS 9000, ISO 14000 Concepts, Requirements and Benefits, Quality Council, Leadership, Employee involvement, Motivation, Empowerment, Team and Teamwork, Recognition and Reward.

Strategic Lead Time Management: Time based competition, time-based process mapping, logistics pipeline management. Lean thinking, Lean operations, Push-pull production concepts, KANBAN, Kaizen, Toyota approach, Seven elements of JIT system for planning and control.

Lean Manufacturing: Introduction, Stability of Lean System, Just in Time, JIDOKA (Automation with a Human Touch), Worker Involvement and Systematic Planning Methodology.

Course Objectives: The objectives of this course are as follows:

- a) To provide the fundamentals of total quality management related to leather industry.
- b) To develop core knowledge of various TQM principles, tools and techniques.
- c) To familiarize the concept of international quality standards and recognition in the leather industry.
- d) To introduce students with the basics of strategic lead time management and lean manufacturing techniques.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	State the different principles of quality management and statistical analysis with the help of various measuring principles.	C1, A1
CLO2	Explain different principles of TQM tools and their field of applications in leather manufacturing.	C2, A2
CLO3	Apply the TQM tools and standards to measure different quality parameters for leather and footwear.	C3, A3
CLO4	Solve the technical problems associated with quality using various TQM analysis tools.	C4, A3

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	3	-	-	-	-	-	-	-	-	-	-	-
CLO2	3	-	-	-	2	-	-	-	-	-	-	-
CLO3	3	2	-	1	3	-	-	-	-	-	-	1
CLO4	3	2	-	2	3	-	-	-	2	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation, demonstration and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO2	Lecture, group discussion and problem-based exercises	Group Presentation, In-course Exam; Final Exam
CLO3	Lecture, guided reading and problem-based learning (PBL): Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam, and Final Exam
CLO4	Lecture, multimedia presentation, group discussion, literature review, demonstration, and problem-based exercises	Group Presentation, In-course Exam, and Final Exam

Learning Materials

i. Recommended Readings

- a) Dale H. Besterfield, et al., "Total Quality Management", Pearson Education Asia, Third Edition, Indian Reprint, 2006.

- b) Suganthi, L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006.

ii. Supplementary Readings

- a) James R. Evans and William M. Lindsay, “The Management and Control of Quality”, (6th Edition), South-Western (Thomson Learning), 2005

Course Code: 0723-LE-4110 **Course Title:** Quality Management Lab **Credits:** 1.5

Rational of the Course: This course provides practical, focused education on requirements for quality management systems and how to prepare for lab inspections. In this course students will learn practically how to prepare different quality management activities like preparation of spec sheet, BOM sheet, MRP sheet etc. By ending of this course each student will be able to assure the proper quality of different leather and footwear products.

Course Content

Spec sheet development: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts, etc.

Computerized layout design: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts, etc.

BOM sheet development: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts, etc.

Production planning: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts, etc.

Production scheduling: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts, etc.

Resources allocation, machine loading and optimization: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts, etc.

Time study and motion study: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts, etc.

Development of MRP sheet: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts, etc.

Course Objectives:

- a) To develop specification sheet for various leather products.
- b) To design layout for various products using computer programming.
- c) To develop BOM sheets of various leather products.
- d) To allocate resources for various leather products.
- e) To develop production planning and scheduling using computer programs for various leather products.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Explain different aspects of production planning and quality control tools used in TQM.	C2, A2
CLO2	Operate the tools/software to measure and control the products quality.	C3, P2
CLO3	Analyze different problems and difficulties created in operating those tools in real world application.	C3, C4
CLO4	Solve those problems to ensure maximum quality of a product.	C3, A3

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3				2							
CLO2	1				3							
CLO3	1	3	1		2							
CLO4			2		2							1

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Demonstration and problem-based exercises presentation.	Viva, assignment, report evaluation, and final exam
CLO2	Group discussion, demonstration of problem-based exercises, multimedia presentation	Viva, report evaluation and final exam
CLO3	Demonstration, identifying the problem to be solved	Assignment, group presentation, quiz, report evaluation and final exam
CLO4	Multimedia presentations, group discussions, demonstrations and problem-based exercises	Group presentation, viva, report evaluation, lab performance and final exam

Learning Materials

i. Recommended Readings

- a) Dale H. Besterfiled, et al., "Total Quality Management", Pearson Education Asia, Third Edition, Indian Reprint, 2006.

- b) Suganthi, L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006.

ii. Supplementary Readings

- b) James R. Evans and William M. Lindsay, “The Management and Control of Quality”, (6th Edition), South-Western (Thomson Learning), 2005

- iii. Others:** Handout/lecture material provided by the course teacher.

Course Code: 0723-LE-4111 **Course Title:** Leather Processing Chemicals **Credits:** 2.0

Rationale of the Course: This course explores the chemistry, manufacture and application of leather chemicals, including beamhouse chemicals, tanning agents, syntans, fat liquors, binders, dyes, pigments, and topcoats. Students gain the knowledge and skills to make decisions, contributing to the production of high-quality and environmentally friendly leather chemicals for the sustainability.

Course Contents

Beamhouse chemicals: Basic concepts of biochemicals (Enzyme Technology in beamhouse) in beamhouse, biocides, wetting agents, unhairing agents, delimiting agent, bating agents, basic chromium sulfate.

Tanning chemicals: Chemistry, manufacturing, and technology of chrome alternative tanning, vegetable tanning, process control and application.

Syntans: Chemistry and technology for the manufacture of synthetic tanning agents based on phenol, formaldehyde, urea-formaldehyde, melamine-formaldehyde, sulphones, metal-complex, polymeric retentions like acrylic, amino aldehyde resin.

Dyes: Principle of dye manufacture, Characteristics of dyestuff, Acid, Basic, Direct, Mordant, Metal complex dye, etc., properties of arylamines and health hazards.

Fat liquors: General chemistry and technology for the manufacture of fat liquors based on natural and synthetic oils, sulphated/sulphited oils and fats, paraffin sulphonic acid/hydroxyethane sulphonic ester-type fatliquor, multi charge fatliquor etc.

Binders: Technology for the manufacture of casein binders, casein-wax binders and cationic protein binders, emulsion binders based on acrylates (batch /one shot/semi batch/core shell) and urethanes, physical properties and performance levels of binders and adhesives.

Pigments: Surfactant demand - pigments manufacture of pigments dispersions with and without casein, use of ball mill, triple roll mill and bead mill in the manufacture of pigment dispersions, cationic pigment dispersions and their role in leather finishing.

Topcoats: Manufacture of nitro-based lacquers and lacquer emulsions, manufacture of nitro free lacquers and lacquer emulsions, and role of solvents in manufacturing lacquers and lacquer emulsions.

Course Objectives:

- To introduce the different mechanisms of tanning chemicals and their manufacturing technology through suitable applications in leather making.
- To understand the importance of different stages of tanning and comprehend the chemistry and mechanism of tanning through the method of tanning process.
- To provides knowledge on functions of different chemicals used in leather processing.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Explain the importance of various chemicals in leather manufacturing technology.	C1, C2
CLO2	Describe the chemistry of various leather chemicals used in the beamhouse processes.	C2, A2
CLO3	Evaluate and analyze the manufacturing technology of tanning and retanning chemicals.	C3, C4
CLO4	Justify the importance of ethical and balanced ingredients in the production of wet and dry finishing chemicals.	C5

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	3		2								
CLO2	3	3		2	1							
CLO3	3	3	2				2					
CLO4	3	3	2	2			2	2				

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, group discussion, Multimedia presentation Problem-based learning, Hands on Demonstration	In-course Exam; Final Exam, Assignment, Group Presentation
CLO2	Lecture, group discussion	In-course Exam; Final Exam,
CLO3	Lecture, group discussion, Multimedia presentation Problem-based learning	In-course Exam; Final Exam, Assignment
CLO4	Lecture, group discussion, Problem-based learning, Hands on Demonstration	In-course Exam; Final Exam, Assignment, Group Presentation

Learning Materials

i. Recommended Readings

- a) Enzyme Technology in Beamhouse Practice, R. Puvanakrishnan, Susil C. Dhar
- b) Theory and Practice of Leather Manufacture- K.T. Sarkar
- c) Retanning, Dyeing and Finishing of Leather-K.T. Sarkar
- d) An Introduction to The Principles of Leather Manufacture-S.S. Dutta
- e) Tanning Chemistry, The Science of Leather-Anthony D Covington
- f) Possible defects in Leather Production- Gerhard John

ii. Supplementary Readings

- a) Chemistry and Technology of Leather-Roddy, O` Flaherty and Lollar, Vol. 2 and 3. Robert E. Kreiger Publishing Co.,N. Y.
- b) Chemistry of Tanning Processes – K. H. Gustavson, Academic Press N. Y.
- c) Fundamentals of Leather Manufacture – Eckhart Hidemann.

iii. Others: Handout/lecture material provided by the course teacher.

Course Code: 0723- LE 4201

Course Title: Solid Waste Management

Credits: 3

Rational of the Course: Solid waste management is the core of the industrial ecology and circular economy in the present world. It is also an emergent element for environmental protection. This course focuses on the modern practice of collecting, transporting, processing, and disposing of tannery solid waste.

Course Content

Introduction: Introduction to solid waste management (SWM) system, Characteristics of solid wastes generated from leather and allied industries.

Reuse, recycling and disposal of solid wastes: Waste generation from leather, footwear and leather goods industries, waste minimization, material reuse, material recycling, energy recovery, utilization of leather wastes, disposal of solid wastes.

Types of solid waste in tanning industry: De-dusted salt, raw hides trimming, hair, fleshing, splitting, pickle trimming, chrome shaving, crust trimming, finished leather trimming, sludge from ETP.

Solid waste management: Integrated solid waste management approach: Basics of IWM, characteristics, planning, implementation, benefits of IWM for developing economies, waste management modelling, benefits and stages of life cycle assessment (LCA) landfill-transportation, site selection and types of landfilling, advantages and disadvantages, leachate collection and treatment, landfill gas collection and treatment, design of landfilling.

Waste to energy: Waste as fuel, flue gas characteristics and treatment, solid residue generation, characterization and treatment, waste-to-energy (WTE) plants- incineration, pyrolysis and gasification

Bioremediation of tannery waste: Definition and phases of composting, factors affecting composting process, types of composting, vermicomposting; Anaerobic digestion: definition, stages and factors affecting anaerobic digestion, pretreatment and co-digestion for enhancement of biogas production, types of biogas digesters, methane and biogas formation, biodiesel, heat and electricity production, biochemical conversion, gasification, plasma cracking, advantage of gasification.

Conversion of solid waste into value added products: Gelatin from flesh, glue and thicker, biopolymer, fat for saponification, collagen, adsorbent materials, protein source for fish and poultry feed, bone paste powder, health care products, industrial raw materials dental pad and fertilizer.

Course Objectives

- to introduce the holistic approach of integrated solid waste management from generation to disposal through a proper systematic approach.
- to inculcate conventional solid waste management approaches (landfilling, aerobic and anaerobic digestion)
- to engraft the modern approaches of waste-to- energy, bioremediation of tannery waste and conversion of tannery waste into value added products.

Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

CLOs: The course is intended to obtain the following learning outcomes from the graduates:

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the methods for characterizing and utilizing the tannery solid waste and treatment processes.	C2
CLO2	Capable to explain the implication of the production, resource management and environmental impact of solid waste management, resource recovery, recycling, reuse and reclamation of solid waste.	C1, C2
CLO3	Design and analyze the efficiency of different solid waste management approaches for selecting the sustainable and cost-effective option.	C3

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	3	3	3									
CLO2				3	3	3	3					
CLO3							3	2	2		3	3

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course-Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation, white board illustration, problem-based exercises, group discussion	Quiz, In- course exam; Final Exam
CLO2	Lecture, multimedia presentation, Problem based Learning (PBL): Identifying the problems to be solved	Assignment, Group presentation, In-course exam, Final exam
CLO3	Lecture, multimedia presentation, group discussion, analyze and compare through various case-studies	Assignment, In-course Exam, Final Exam

Learning Materials

i. Recommended Readings

- a) Assessment of Tannery Solid Waste Management and Characterization by Abajihad Zulfikar.
- b) Handbook of Solid Waste Management by Frank Kreith and George Tchobanoglous.
- c) Solid Waste Management: Principles and Practice by Diganta Bhusan Das and Ramesha Chandrappa.

ii. Others: Handout/lecture material provided by the course teacher

Course Code: 0723-LE-4202 **Course Title:** Waste Management Lab **Credits:** 1.5

Rationale of the Course: This course offers in-depth knowledge of physical and chemical properties of leather industry solid waste. Topics include waste analysis, dechroming, glue/gelatin preparation, comparative IR analysis of leather waste, sulfide/calcium determination in fleshing waste, and fat extraction from tannery solid waste. Aims to equip students for sustainable utilization of leather industry waste.

Course Contents

1. Determination of physical properties of (specific weight, moisture content) of solid waste.
2. Determination of chemical properties (proximate analysis, fusing point of ash, ultimate analysis, energy content) of solid waste.
3. Determination of total solids (TS, TSS, VSS, and FS) in wastewater/ sludge samples
4. Dechroming of chrome tanned solid waste generated in tanneries.

5. Chromic oxide content in leather waste: Raw trimmings, fleshing waste, wet blue trimmings, shaving dust, buffing dust, crust trimming, finished trimmings.
6. Protein content in leather waste: Raw trimmings, fleshing waste, wet blue trimmings, shaving dust, buffing dust, crust trimming, finished trimmings.
7. Preparation of glue and gelatin from raw trimmings, fleshing waste, wet blue trimmings, shaving dust, buffing dust, crust trimming, finished trimmings.
8. Comparative IR analysis of raw trimmings, fleshing waste, wet blue trimmings, shaving dust, buffing dust, crust trimming, finished trimmings.
9. Determination of dissolved oxygen (DO)/ biological oxygen demand (BOD)/ chemical oxygen demand (COD) of industrial wastewater.
10. Extraction of fat content from tannery solid waste.

Course Objectives

- a) To provide sound knowledge about basic environmental analysis through different laboratory experiments.
- b) Graduates will learn to analyze industrial wastewater, which will help them to implement the appropriate industrial wastewater treatment facility in the industries.
- c) Analysis of heavy metals and solids will help students to understand the ecological movement of these materials in the ecosystem.
- d) To enrich students' skills in proper disposal and waste management approaches for leather and footwear industries.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

CLOs	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Describe the analytical tools and techniques for measuring the environmental parameters.	C2, A1, P2
CLO2	Perform different experiments for the determination of different environmental pollutants using modern analytical tools and instruments.	C3, A2, P2
CLO3	Analyze and evaluate the experimental results to monitor the environmental quality of tannery effluents and solid wastes.	C4, C5, A4, P4
CLO4	Design and implement strategic approaches for wastewater and solid waste management.	C6, A4, P4

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO 1	3	1	-	-	-	-	1	-	-	-	-	-
CLO 2	3	2	-	-	2	-	2	-	2	-	-	-
CLO 3	3	2	2	3	2	-	3	-	2	-	-	-
CLO 4	3	2	3	3	3	-	3	-	2	-	2	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Interactive Lectures, Group Discussions, Demonstrations, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO2	Interactive Lectures, Demonstrations, Hands-on practice, and Group work	Presentation, Report evaluation, Final Exam
CLO3	Interactive Lecture with illustration, Demonstration, Hands-on practice, and Group work	Quiz, Viva Voce, Report evaluation, Final Exam
CLO4	Lecture, Demonstration, Hands-on practice, and Group work	Report evaluation, Final Exam

Learning Materials

i. Recommended Readings

- a) Gary D. Christian- Analytical Chemistry
- b) John Kenkel- Analytical Chemistry for Technicians
- c) Skoog, Holler and Nieman- Principles of Instrumental Analysis

ii. Supplementary Readings

- a) Thierry Chambolle-Environment and Tannery
- b) DE A.K. - Environmental chemistry

iii. Others: Lecture material/ Lab manual provided by the course teacher.

Course Code: 0723-LE-4203 **Course Title:** Production Planning and Quality Control

Credit Value: 3.0

Rationale of the Course: The course emphasizes production systems, facility location, and efficient production layout. This course will pronounce how to conduct an analysis of demand forecasting for production, and inventory management. Moreover, students will learn in detail knowledge of work and method study and its application in leather/footwear production.

Course Contents

Introduction to production management: Production, production system, functions of manufacturing firms, basic production management function, the strategies of decision making in leather and footwear industry, concept of productivity and calculations, multi-factor productivity, key variables for improved labor productivity, ethics, social responsibility, and sustainability.

Facility planning and layout design: Strategic importance of layout decisions, layout design considerations, types of layout, warehousing and storage layouts, problems related to layouts, staffing and balancing work cells, assembly-line balancing, line-balancing heuristics.

Inventory management: Basic ideas of inventory, functions of inventory, types of inventory, managing inventory, ABC analysis, terms used in inventory management, cycle counting, inventory models, basic economic order quantity (EOQ) model, quantity discount model, probabilistic models and safety stock, probabilistic demand and example.

Demand forecasting: Basic concept of forecasting, types of forecasts, strategic importance of forecasting for leather products industry, steps in forecasting, overview of qualitative methods, and quantitative approaches, time-series forecasting, common measures of error, least squares method for demand forecasting, multiple-regression analysis, monitoring and controlling forecasts, tracking signal, adaptive smoothing.

Capacity planning: Definition, design capacity, effective capacity, determinants of effective capacity, capacity requirement, developing capacity alternatives, evaluating alternatives.

Operation scheduling and sequencing: Basic concepts of short time scheduling, scheduling flow, forward and backward scheduling, scheduling criteria, Gantt charts, assignment method, sequencing jobs, FCFS, SPT, EDD, LPT, critical ratio, Johnson's rule for sequencing, linear programming, transportation model, network analysis, critical Path Method (CPM), programme evaluation and review technique (PERT).

Work study: Method study, Purpose and Techniques used, and Procedure. Precautions when introducing new methods, Relationship with work measurement. Work measurement, purpose and techniques used, Rating, Elements, Break points, Basic time, Use of allowances. Activity sampling, definition, purpose and procedures, use of pilot study, Interpretation of results. Production studies, machine utilization, operator performances, and Hok.

Course Objectives: The objectives of this course are as follows:

- a) To provide the basic concepts on production systems, production layout, and quality control.
- b) To impart knowledge on inventory, demand forecasting, operation scheduling, and sequencing for production management.

- c) To disseminate in-depth knowledge for the implementation of tools and techniques related to work and method studies.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	State and follow the basic concept of production systems, capacity planning, and facility planning.	C1, A1
CLO2	Estimate and prepare layout design and inventory management system of the leather and footwear industry.	C2, C3, A2
CLO3	Compare and interpret the demand forecasting method, capacity planning and operation scheduling procedure for the production system.	C4, A3
CLO4	Evaluate and justify work-study and method-study techniques for productivity improvement	C5, A3

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO 1	3	1	-	-	-	-	-	-	-	-	-	-
CLO 2	3	2	2	-	2	-	-	-	-	-	-	-
CLO 3	3	3	2	2	2	-	-	-	-	-	-	2
CLO 4	3	3	-	3	3	-	-	-	2	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation, demonstration and problem-based exercises (PBE)	In-course Exam; Final Exam
CLO2	Lecture, group discussion and Multimedia presentation	Group Presentation, In-course Exam; Final Exam
CLO3	Lecture, group discussion, guided reading and problem-based learning (PBL): Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam, and Final Exam
CLO4	Lecture, group discussion, literature review, and problem-based exercises (PBE)	In-course Exam, and Final Exam

Learning materials

i. Recommended readings

- a) Jay Heizer, Barry Render, Chuck Munson- Operations Management: Sustainability and Supply Chain Management (13th Edition).
- b) Jay Heizer, Barry Render- Operations Management (11th Edition).
- c) Gideon Halevi- Handbook of Production Management Methods.

ii. Supplementary Readings

- a) Nicholas J. Aquilano and Richard B. Chase- Production and Operations Management.
- b) Edward S. POUND, Jeffrey H. Bell, and Mark L. Spearman- Factory Physics for Managers: How Leaders Improve Performance in a Post-Lean Six Sigma World.
- c) Larry P. Ritzman, Lee J. Krajewski, and Manoj K. Malhotra-Operations Management: Processes and Supply Chains.

iii. Others: lecture/hand notes provided by the course teachers.

Course Code: 0723-LE-4205 **Course Title:** Green Manufacturing of Leather **Credits:** 2.0

Rationale of the Course: This course provides an overview of green manufacturing with a focus on the leather industry. Students will learn about the importance of sustainability in manufacturing, the principles of green manufacturing, and metrics for measuring environmental impact. The course also covers life cycle assessment, circular economy, green chemistry, and green manufacturing of non-leather materials.

Course Content

Introduction to Green Manufacturing: Definition; Importance, Local and global perspective of green manufacturing, Benefits and barriers of green manufacturing, Terminologies.

Sustainability and manufacturing: The social, business and policy environment for green manufacturing; Basics of production, Metrics of green manufacturing; Principles of Green Manufacturing; Drivers of sustainability, Ms of manufacturing.

Life cycle assessment: Perspective of life cycle assessment; Goal and scope definition, Inventory analysis, Impact assessment, Interpretation, reporting and critical review and Application.

Circular economy: Fundamental concepts of circular economy; Linear and circular approach; 6R approach; Legislation across the leather lifecycle; Life Cycle Thinking in a Circular Economy; Beyond Cleaner Production to Life Cycle Thinking; Leather Wastes and Its Circulation; Low-carbon economy.

Green Chemistry: Introduction, background and importance; 12 basic principles of green chemistry; Evaluation criteria suitable for green chemistry; Green chemistry in synthesis; Catalysts in green chemistry; Renewable energy sources; 3R and sustainability; Green chemistry applications.

Green manufacturing in leather industry: Importance of green manufacturing in leather industry; Green manufacturing options for leather industry; Challenges towards application of green manufacturing in leather industry.

Green manufacturing of Non-leather material: Polyurethane coated fabrics- transfer coated fabrics, manufacturing procedure, advantages and disadvantages; Bonded leather- Physical and chemical structure and properties of bonded leather fiber, green manufacturing procedure and uses; Vegan leather- green manufacturing procedure.

Course Objectives

- To introduce the principles and concepts of green manufacturing and its significance in promoting sustainable practices
- To enable students to explore various aspects of sustainability, life cycle assessment, and circular economy within the context of manufacturing processes, including their application in leather and non-leather materials
- To acquaint students with the knowledge of green chemistry principles and their role in promoting environmentally friendly practices in the manufacturing industry.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	State the principle of green manufacturing of leather, allied material and its sustainability.	C1, A1
CLO2	Explain life cycle assessment and circular economy for green manufacturing.	C3
CLO3	Apply the circular economy techniques in leather manufacturing.	C4, A2
CLO4	Develop methods to incorporate green chemistry in leather manufacturing.	C5, A4, P2

Mapping of CLO with PLO

(CLOs)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	3	2		2	2		3					
CLO2	3	1	3		3		3					
CLO3	3	2		3	2	2	3	1				
CLO4	3	2					3			2		

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Slide presentation, Audio-visual presentation	In-Course, and Final Exam
CLO2	Lecture, Software Demonstration, PowerPoint slide presentation	In-Course, and Final Exam
CLO3	Lecture, PowerPoint slide presentation, Hands on Demonstration	In-Course, Final Exam, and Group presentation
CLO4	Lecture, PowerPoint slide presentation, Hands on Demonstration	In-Course, Assignment and Final Exam

Learning Materials

i. Recommended Readings

- a) David A. Dornfeld (Editor)- Green Manufacturing: Fundamentals and Applications.
- b) Paulo Davim J- Green Manufacturing Processes and Systems
- c) Mrityunjay Singh, Tatsuki Ohji, Rajiv Asthana (Editors)- Green and Sustainable Manufacturing of Advanced Material

ii. Supplementary Readings

- a) Dr. Kaliyan Mathiyazhagan, Dr. K. E. K. Vimal, Dr. Harish Kumar, Dr. Anbanandam Ramesh, Vernika Agarwal (Editors)- Lean and Green Manufacturing Towards Eco-Efficiency and Business Performance
- b) J. Paulo Davim- Sustainable Manufacturing
- c) David R. Hillis, J. Barry DuVall -Improving Profitability Through Green Manufacturing: Creating a Profitable and Environmentally Compliant Manufacturing Facility

iii. **Others:** Lecture material/ Lab manual provided by the course teacher.

Course Code: 0723-LE-4206

Course Title: Capstone Project

Credit Value: 3.0

Rationale of the Course: The course is designed to encourage students to think critically, solve challenging problems, and develop skills such as oral communication, research skills, teamwork, and goal setting. It teaches them to successfully complete the projects within financial and ethical boundaries and to be able to gain an insight of the latest trends and applications ongoing in the respective fields and to communicate with society and professionals both in verbal and written form in a successful manner.

Course Contents

Experimental and theoretical investigation of various problems related to Leather, Environmental Science and related Engineering will be carried out. The topic should provide an opportunity to the student in developing initiative, creative ability and engineering judgment. Individual study will be required. At the end of term, the student is expected to complete the preliminary literature

review/survey, select the topic for study, complete theoretical study and basic research methodology on the topic and submit an individual detailed report for evaluation.

Course Objectives: The objectives of this course are as follows:

- a) To make the students capable of taking new professional challenges.
- b) To ensure utilization of gathered knowledge in solving new real-life problems.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify, analyze and formulate a leather engineering problem and use project management skill for obtaining its solution considering potential of social and environmental impact on leather sector.	C1, C5
CLO2	Apply the industrial state of the art leather technology for verifying, validating, detecting accuracy and develop a leather engineering based real-life problem into an engineering solution using modern tools.	C3
CLO3	Demonstrate the concept of professional ethics, confidentiality, leather and related industrial sector standards and explain the impact of leather engineering solutions on society and environment.	C2
CLO4	Deliver designed project findings through oral presentations, demonstrations, and written technical report format.	C2, C3

Mapping of CLO with PLO

	PLO 1	PLO 2	PLO 3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO 10	PLO 11	PLO 12
CLO1	3	2	2	-	-	-	-	-	2	-	2	-
CLO2	-	-	-	2	3	-	-	-	-	-	-	2
CLO3	-	-	-	-	-	3	2	2	-	-	-	-
CLO4	2	-	-	-	-	-	-	-	-	3	-	2

Rank: 3-High match, 2-Medium match, 1-Low match

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Discussion, Discussion and encouragement, Self-study, Discussion and Motivation, Final report, proofreading	Project defense and report evaluation by external as well as internal
CLO2	Discussion, Lecture, Discussion and Motivation, Final report, proofreading	
CLO3	Lecture, Final report, proofreading	

CLO4	Discussion and demonstration, Routine discussion, Final report, proofreading	
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Learning Materials

i. Recommended Readings

- a. Writing the Winning Thesis or Dissertation: A Step-by-Step Guide - By Allan A. Glatthorn, Randy L. Joyner.

ii. Others: Relevant books, scientific journals, handbooks, patents and manuals

Course Code: 0723-LE-4208 **Course Title:** Comprehensive Viva **Credits:** 2.5

Rational of the Course: Comprehensive viva is designed to judge the student's overall academic performance in the studied courses.

Course Content

The comprehensive viva voce examination should be based on both theoretical and practical knowledge. It is based on all the courses the students have studied, the basic science, and core courses of Leather Engineering.

Course Objectives: The objectives of this course are as follows:

- a) To familiarize students with formal interviews.
- b) To judge students' performance based on the subject knowledge.

Course Learning Outcomes (CLOs): After completing this course, students will be able to

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Present personal etiquette in front of a formal interview panel.	C3, A2, P2
CLO2	Demonstrate communicative skills to an interview panel.	C3, A2, P2
CLO3	Deliver the acquired knowledge effectively to the interview panel.	C3, A2, P2

Mapping of CLO with PLO

CLOs	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO 1	3	2	-	-	-	-	-	-	-	3	-	3
CLO 2	3	2	-	-	-	-	-	-	-	3	-	3
CLO 3	3	3	3	-	-	-	-	-	-	3	-	3

Rank: 3-High match, 2-Medium match, 1-Low match.

Learning Materials

All the books of all the semesters and the journals, databases, real problems of leather and allied sector.

Course Code: 0723-LE-4210 **Course Title:** Internship **Credit Value:** 3.0

Rationale of the Course: The internship course is designed to involve students to the real work environment in the industry. Students will be able to familiarize themselves with the state-of-the-art production technologies, innovation, diversified materials and products.

Course Content

Factory inside out: Observe the perimeter and plant layout of the leather factory or tannery. Study the certification and/or accreditation of the factory. Observe the structural buildup of the factory. Observe all the machineries of the factory. Study on the organogram of the organization. Interact with the personnel involved with the organization from top to bottom. Export contribution performed by the factory throughout the last fiscal years and forecast their next three-year export performance.

Material handling: Study the material handling practice of the factory. Study the sorting and grading of raw materials like raw hide and skin. Observe the loading and unloading process of hide and skins into and from containers. Study the packaging process.

Pre-Tanning: Study the pre-tanning processes with relevant tests, from soaking to pickling.

Tanning: Study different types of tanning processes practiced in the tannery with relevant tests, e.g. chrome tanning, vegetable tanning, less-chrome tanning, aluminum tanning, oil tanning etc.

Wet Finishing: Study the post-tanning processes with relevant tests such as retanning, dyeing, fat liquoring etc.

Finishing: Explore and study the finishing processes of different types of leathers including different types of finish formulation and application techniques.

Occupational Safety and Health (OSH) and Corporate Social Responsibility (CSR):

Explore the ongoing OHS and CSR practices of the factory and compare them with the standards i.e., Bangladesh Labor Law'06 and Bangladesh Labor Rules'15 and amendment'18. Identify the improvement space for the production process, productivity, QC, and QA. Recommendations for better performance of the factory.

Course Objectives: The Course has been designed in a manner

- a) To expose students to the real working environment and get acquainted with the organization structure, business operations, and administrative functions.

- b) To have hands-on experience in unit operation and unit processes involved in the leather manufacturing process.
- c) To familiarize with the cutting-edge technology in leather manufacturing.
- d) To enhance industry-academia collaboration and cooperation.

Course Learning Outcomes (CLOs): After completing this course, students will be able to -

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Demonstrate knowledge and skills in the type of manufacturing process, distribution, and supply chain and their parameters.	C2, A2
CLO2	Utilize technical resources and perform in the actual working environment.	C3, A2
CLO3	Analyze, and evaluate layout, process, production, and efficiency.	C4, C5 A3
CLO4	Generate technical documents and deliver oral presentations.	C5, A3

Mapping course learning outcomes (CLOs) with program learning outcomes (PLOs)

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	3	2	-	-	-	-	-	-	-	-	-	2
CLO2	3	2	3	-	-	-	-	-	-	-	-	2
CLO3	3	2	2	-	-	-	-	-	-	3	-	2
CLO4	2	2	2	-	-	2	-	-	-	-	-	2

Rank: 3-High match, 2-Medium match, 1-Low match.

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Class Lecture, Display, and Demonstration	Participation and performance, Presentation, Report Evaluation
CLO2	Class Lecture, Display, and Demonstration	
CLO3	Discussion, Self-study, Discussion, and Motivation	
CLO4	Class Lecture, Display, and Demonstration	

Learning Materials

i. Recommended Readings

- a) Writing the Winning Thesis or Dissertation: A Step-by-Step Guide - By Allan A. Glatthorn, Randy L. Joyner.
- b) Why (and How) to Take a Plant Tour by David M. Upton and Stephen E. Macadam, published on Harvard Business Review.

Part D

20. Grading/Evaluation:

1. Grading Scale: The letter grade system shall be used to assess the performance of the student and shall be as follows:

Marks Obtained	Grade	Grade point	Grade Description
80% or above	A+	4.00	Grade A: Excellent performance; all course objectives achieved; objectives met in a consistently outstanding manner.
75% to less than	A	3.75	
70% to less than	A	3.50	
65% to less than	B+	3.25	Grade B: Very good performance; significantly more than the majority (at least two-thirds) of the course objectives achieved; objectives met in a consistently thorough manner.
60% to less than 65%	B	3.00	
55% to less than 60%	B-	2.75	
50% to less than	C+	2.50	Grade C: Satisfactory performance; at least majority of the course objectives achieved; objectives met satisfactorily.
45% to less than 50%	C	2.25	
40% to less than 45%	D	2.00	Grade D: Minimally acceptable performance; less than majority but more than the minimum required course objectives
Less than 40%	F	0.00	Grade F: Failed in the course.
Incomplete	I	-	
Withdrawn	W	-	

2. Grades: In the points-based grading system, there is a total number student can earn in a particular course, based on class attendance, in-course exam and final exam scores for a

theoretical course and for a practical course it will be the summation of marks obtained from class attendance, lab reports, class test, viva and final exam. Thus, grade point of a particular course is the summation of possible marks distribution. Provided that, a fraction number in grading calculation shall be considered as the next higher consolidated number.

3. Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA): GPA obtained in all the courses passed/completed by a student in a Semester. 'F' grades will not be counted for GPA calculation. GPA of a Semester will be calculated as follows:

$$\text{GPA} = \frac{\sum(\text{Grade points in a course} \times \text{Credits for the course})}{\text{Total credits of a semester}}$$

The Cumulative Grade Point Average (CGPA) gives the cumulative performance of the student from first semester up to any other semester to which it refers and is computed by dividing the total grade points accumulated up to the date by the total credit hours.

$$\frac{\sum(\text{GPA} \times \text{Credits in a semester})}{\sum(\text{Total credits of all semester})}$$

Both GPA and CGPA will be rounded off to the second place of decimal for reporting.

For promotion from First Year to Second Year, a student requires to earn a minimum CGPA (calculated for first and second semesters combined) of 2.00. For promotion from second to third year and third to fourth year, a student requires to earn a minimum CGPA of 2.25. Students who failed in courses, but have earned the required CGPA will be promoted to next year on probation. Those on probation shall appear at the retake examination and must pass the failed course(s) to be allowed to continue studies in the next year.

4. Course Withdrawal: If a student is unable to complete any semester (Semester-I and/or Semester-II) due to illness, accident or any other valid reason etc., he/she may apply to the Registrar through the Director of the institute for total withdrawal from the Semester before the start of semester final examination.

5. Incomplete (I) courses: *Incomplete 'I' grade is indicative of a situation where a student, for non-academic reasons beyond his control, is unable to complete the full requirements of the course for not being able to sit for the Semester Final Examination. Students who fail a course are also said to have an incomplete course.* Meanwhile, the student concerned will be promoted

to the next semester. Provided that, for promotion from First Year to Second Year, a student requires to earn a minimum CGPA (calculated for first and second semesters combined) of 2.00. For promotion from second to third year and third to fourth year, a student requires to earn a minimum CGPA of 2.25. If a student has incomplete course, he/she can clear through retake examination in next two semester. Any incomplete or failed course prevents a student from receiving a degree. A student can't earn the degree if they have any incomplete or failed courses.

6. Retake: A student will be allowed maximum of two chances to clear F grade/grades with the immediate next batches by complying with the time requirement for the degree including final year (4th year). He/she shall repeat the course(s) like a regular student with prior application to the Director of the institute. A student getting F grade in any theory course (courses) has to attend only the final examination for that (those) course (courses). In that case, the maximum grade obtainable in any course by the student shall be B⁺.

7. Grade Improvement: A student may sit for improvement exam for courses where grade obtained is less than or equal to C⁺ (grade point-2.50) and the best grade that a student can be awarded is B⁺. A student will not be allowed for grade improvement if he or she passes and the final semester result is published. However, if the grade is not improved the previous grade will remain valid.

8. Dropout/ Re-admission: A student failing to get promotion may seek re-admission to study with the following batch. In the case of re-admission, all previously earned grades for the two semesters of that year will be cancelled. For re-admission, he or she has at least 30% (thirty percent) attendance in the previous semester or year. A student may take re-admission only 2 times. If required, a student may take re-admission in the same class, but the Degree must be completed within 6 years. Re-admission will be allowed only after the approval of the Academic Committee of ILET. A student failing to get minimum required CGPA even after taking re-admission twice will be dropped out of the program.

Course Learning Outcomes (CLOs) Attainment Report

Course Learning Outcomes (CLOs)	Assessment										CLO Attainment (%)
	SFE (Summative) 80%				CA (Formative) 20%						
	Incourse/Class Test/Mid-Semester (30%)		Final Examination (60%)		MCQ/MQ / Quiz (10%)		Assignment/Case Study (5%)		Presentation (5%)		
	AM	AC	AM	AC	AM	AC	AM	AC	AM	AC	
CLO1:											
CLO2											
CLO3											
CLO4											
CLO5											
CLO6											
CLO7											

AM: Actual Marks = (Given Marks/Total Given Marks of Component) × (% of the Course)

AC: Assessment Contribution; M=Average Marks in % and W = Weightage=C/T

$$\text{Attainment (A)} = \sum_{i=1}^M (M_i \times W_i)$$

Or Marks of CLO1 = (% marks distributed Assessment Type1×% Overall)+(% marks distributed Assessment Type-2×% Overall)+(% marks distributed Assessment Type-3×% Overall)+.....