

## **Outcome-Based Curriculum (Sustaining OBE Compliance)**

### **Part A**

**1. Title of the Academic Program:** M.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**

The vision of Institute of Leather Engineering and Technology (ILET) is to enable innovation through research, advance educational programs in leather, footwear, leather products and allied sector and facilitate enrichment of human resources- the students, faculty and staff, thereby establishing itself as a center of excellence at the national and international level.

#### **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:** M.Sc. in Leather Engineering

### **10. Description of the Program**

The program provides its post-graduate students with the opportunity to participate in advanced professional courses and rigorous research training where students are attached to demand-based knowledge and they relate theories, concepts and techniques learned from the academic courses with real-life experiences. There are three semesters in the M. Sc. Program and a student must complete 40 credit. However, there are two groups in the M. Sc. program:

**i. Thesis group:** Students of this group are required to complete 24.0 credit course work and a thesis of 16.0 credits. From the beginning of the 1<sup>st</sup> semester students have to begin their thesis work which must be completed at the end of the 3<sup>rd</sup> semester.

**ii. General:** Students of this group are required to complete 33.0 credit coursework, 2.0 credit industrial internship, 1.0 credit viva voce along with a 4.0 credit project work.

Post-graduate education in Leather Engineering is balanced and well-rounded. With a rationalized course curriculum and advanced tools and teaching methods, the capacity of graduates fulfils the international level and the students will be able to perform advanced professional activities.

**11. Graduate Attributes:** The process of achievement of mission and vision of the program is divided into equal contributions, stated from responses given by key stakeholders like Employers and Alumni. Employers happen to motivate our graduates and know the performance of their traits in some key areas of graduate attributes such as knowledge, work skills, communication skills, 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.

<b>Attribute-1: Knowledge profile</b>
K1: A comprehensive and systematic, theory-based advanced understanding of the modern science and technology
K2: Conceptually based production techniques, formal aspects of emerging technologies, research and business intelligence, creativity and innovation 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 specialist 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: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
K6: Engagement with selected knowledge in the research literature of the 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
<b>Attribute-2: Oral communication</b>
C1: Competency in English language for comprehensive communication through academic writing
C2: Skills for proper presentation in any relevant circumstances in the form of conference preceding, project presentation, oral speech etc.
C3: Engineering judgment based on the knowledge and relevance to the discipline and communication of judgment
C4: Discipline and sense of responsibility with strong ethical and moral value aligned with the international scientific norms
<b>Attribute-3: Aptitude in attending professional seminar and training (Work and interpersonal skills)</b>
A1: Aptitude with regards to having professional degrees
A2: Various professional affiliations with internationally recognized organizations
A3: Time management skills
A4: Leadership and team work ability
A5: Independent thinking and self-confidence

## **12. Program Educational Objectives (PEOs)**

**PEO1:** Offer high quality education in Leather Engineering to develop qualified and responsible manpower to meet the current challenges, requirements in engineering and multidisciplinary professional fields at the local and international levels.

**PEO2:** Practice quality teaching and leather engineering research activities to enrich the qualities of the students to contribute for the sustainable development in the social, environmental, and economic dimensions proactively.

**PEO3:** Provide a platform that nurtures students to pursue sustainable learning through life-long learning of professional practices, creativity, teamwork, and continuous self-development with robust ethical attitudes to position the graduates as successful professionals in engineering and related fields.

**PEO4:** Broaden and enhance their skills in experimental and analytical research methodologies, data analysis, and make pertinent conclusions for academic writing and presentation.

**13. Program Learning Outcomes (PLO):** The Master of Science Engineering in Leather Engineering program is a rigorous and rewarding method of earning a graduate degree. Graduates of the Master of Science Engineering in Leather Engineering program will be able to accomplish the following aspects.

### **PLO1: Engineering Knowledge**

Able to apply knowledge of leather engineering, and science in a creative and innovative way to design, develop and produce new engineering models and products for the solution of complex engineering problems as specified in K1 to K5.

### **PLO2: Environment and Sustainability**

Able to create an ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development by materializing every resource of the relevant field (K7).

### **PLO3: Ethics and Integrity**

Students will be able to reason ethically in evaluating various perspectives, policies, and/or practices relevant to one's field of research and study. Students will be able to recognize ethical responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, and societal contexts as specified in K7 and C3-C4.

### **PLO4: Communication**

Graduates will be able to articulate their thoughts vocally and in writing (oral communication; written communication). Additionally, they will be able to present the research output in the form

of effective writing in international journals, conferences, patents, research proposals, and other scientific venues (C1 to C4).

**PLO5: Professional autonomy**

Graduates would be able to demonstrate all-encompassing professionalism in leather and allied engineering contexts and to make sound decisions that take into account the global, economic, environmental, and social implications of engineering solutions (K7).

**PLO6: Research and Execution**

Graduates would be able to critically examine and comprehend scientific studies, current events, and new developments in the Leather Engineering area to identify, formulate, research, analyze and reach substantiated conclusions along with recommendations for complex leather and allied engineering problems (K6-K7).

**PLO7: The Engineer and Society**

Ability to apply reason informed by context to assess societal, health, safety, legal, and cultural issues and the resulting professional engineering responsibilities, as well as contribute to society by creating collaborative and inclusive environments and using problem-solving skills to make a more just world (K7).

**PLO8: Leadership and Teamwork**

Ability to function effectively as part of a team, collectively to offer leadership, foster an atmosphere of cooperation and inclusion, set and achieve goals, and organize and execute tasks effectively in a multi-disciplinary environment (A1-A5).

**14. Mapping mission of the university with PEOs**

	<b>Mission 1</b>	<b>Mission 2</b>	<b>Mission 3</b>
<b>PEO1</b>	✓	✓	✓
<b>PEO2</b>	✓	✓	✓
<b>PEO3</b>	✓		✓
<b>PEO4</b>	✓	✓	

**15. Mapping of PLOs with PEOs**

<b>PLOs</b>	<b>PEO1</b>	<b>PEO2</b>	<b>PEO3</b>	<b>PEO4</b>
<b>PLO1</b>	✓	✓		✓
<b>PLO2</b>	✓	✓	✓	
<b>PLO3</b>	✓		✓	✓
<b>PLO4</b>			✓	✓
<b>PLO5</b>	✓	✓	✓	✓
<b>PLO6</b>		✓		✓
<b>PLO7</b>	✓	✓		
<b>PLO8</b>			✓	

### 16. Mapping courses with the PLOs

Course Code	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
0723-LE-6101	✓	✓		✓		✓		
0723-LE-6103	✓	✓		✓	✓	✓		
0723-LE-6105	✓	✓	✓	✓		✓	✓	✓
0723-LE-6107	✓	✓	✓	✓	✓	✓	✓	
0723-LE-6109	✓	✓	✓		✓	✓		✓
0723-LE-6111	✓	✓	✓		✓	✓	✓	✓
0723-LE-6213	✓	✓	✓	✓	✓	✓	✓	✓
0723-LE-6215	✓	✓			✓	✓	✓	
0723-LE-6217	✓	✓	✓	✓	✓	✓	✓	✓
0723-LE-6219	✓	✓		✓		✓	✓	
0723-LE-6221	✓	✓	✓	✓	✓	✓	✓	✓
0723-LE-6000	✓	✓	✓	✓		✓	✓	✓
0723-LE-6300	✓	✓	✓	✓		✓	✓	✓
0723-LE-6302	✓	✓		✓	✓	✓	✓	✓
0723-LE-6304	✓			✓				
	15	14	9	12	9	14	11	9

### Part B

#### 17. Structure of the Curriculum

(a) Duration of the Program: Years: 1.5, Semesters: 3

(b) Admission Requirements:

- i. Any applicant who has completed the undergraduate degree in Leather Engineering/ Footwear Engineering/ Leather Products Engineering, University of Dhaka and obtained CGPA of 3.0 or above will be eligible for M. Sc. by Research program. The academic committee may set further eligibility conditions.

- ii. Students who have completed their bachelor's degree with a CGPA of 3.25 from Bangladeshi universities, other departments of DU will be able to enroll into the regular master's program. Aspirants will have to sit for a 100-mark written and viva test for empty seats available. The admission requirements and procedure will set by academic committee of the institute and approved by the University authority. Students who have undergraduate degrees from universities overseas will also be allowed to enroll.

(c) Total credit requirement to complete the program: 40.0

(d) Total class weeks in a semester: 14 weeks

(e) Minimum CGPA requirements for graduation: 2.50

(f) Maximum academic years of completion: 1.5+1

(g) Category of Courses:

**i. General Education Courses:** N/A

**ii. Core Courses:** In M.Sc. in Leather Engineering program, ILET, DU would like to provide the core courses as following:

**Core Courses**

<b>Course Code</b>	<b>Course Title</b>	<b>Course Credit</b>	<b>Semester</b>
0723-LE-6101	Advanced Leather Processing	3.0	I
0723-LE-6103	Circular Economy and Life Cycle Assessment	3.0	I
0723-LE-6105	Research Methodology	3.0	I
0723-LE-6107	Industrial Hazards and Waste Management	3.0	I
0723-LE-6109	Ergonomics and Industrial Safety	3.0	I
0723-LE-6111	Advanced Leather Biotechnology	3.0	I
0723-LE-6213	Environmental Management and Impact Assessment	3.0	II
0723-LE-6219	Advanced Leather Dyeing and Finishing*	3.0	II
0723-LE-6221	E-Commerce and International Trade*	3.0	II

**\*Additionally, for general group.**



**iii. Elective Courses:** There are two elective courses from which students (Thesis group) have to choose one.

Course Code	Course Title	Course Credit	Semester
0723-LE-6215	Nanotechnology for Leather and Leather Products	3.0	II
0723-LE-6217	Industrial Automation	3.0	II

**N.B.** These two courses are compulsory for students of general group.

**iv. Capstone Course/Internship/Thesis:**

Course Code	Course Title	Credit	Semester
0723-LE-6000	Thesis	16.0	I-III
0723-LE-6300	Project	4.0	II, III
0723-LE-6302	Internship	2.0	III
0723-LE-6304	Viva voce	1.0	III

**18. (a) Semester-wise distribution of courses (Thesis group)**

Semester-I		
Course Code	Course Title	Credits
0723-LE-6101	Advanced Leather Processing	3.00
0723-LE-6103	Circular Economy and Life Cycle Assessment	3.00
0723-LE-6105	Research Methodology	3.00
0723-LE-6107	Industrial Hazards and Waste Management	3.00
0723-LE-6109	Ergonomics and Industrial Safety	3.00
0723-LE-6111	Advanced Leather Biotechnology	3.00
0723-LE-6000	Thesis	-
	<b>Total</b>	<b>18.0</b>

Semester-II		
Course Code	Course Title	Credits
0723-LE-6213	Environmental Management and Impact Assessment	3.00
0723-LE-6000	Thesis	-
	<b>Optional Course (Any one from the following List)</b>	
Course Code	Course Title	Credits
0723-LE-6215	Nanotechnology for Leather and Leather Products	3.00
0723-LE-6217	Industrial Automation	3.00
	<b>Total</b>	<b>6.00</b>

Semester-III		
Course Code	Course Title	Credits
0723-LE-6000	Thesis	16.00
	<b>Grand Total</b>	<b>40.00</b>

**N.B.** Thesis to be taken from Semester-I and will complete in Semester-III.

#### 18. (b) Semester-wise distribution of courses (General group)

Semester-I		
Course Code	Course Title	Credits
0723-LE-6101	Advanced Leather Processing	3.00
0723-LE-6103	Circular Economy and Life Cycle Assessment	3.00
0723-LE-6105	Research Methodology	3.00
0723-LE-6107	Industrial Hazards and Waste Management	3.00
0723-LE-6109	Ergonomics and Industrial Safety	3.00
0723-LE-6111	Advanced Leather Biotechnology	3.00
	<b>Total</b>	<b>18.0</b>

Semester-II		
Course Code	Course Title	Credits
0723-LE-6213	Environmental Management and Impact Assessment	3.00
0723-LE-6215	Nanotechnology for Leather and Leather Products	3.00
0723-LE-6217	Industrial Automation	3.00
0723-LE-6219	Advanced Leather Dyeing and Finishing	3.00
0723-LE-6221	E-Commerce and International Trade	3.00
0723-LE-6300	Project	-
	<b>Total</b>	<b>15.00</b>

Semester-III		
Course Code	Course Title	Credits
0723-LE-6300	Project	4.00
0723-LE-6302	Internship	2.00
0723-LE-6304	Viva voce	1.00
	<b>Total</b>	<b>7.00</b>
	<b>Grand Total</b>	<b>40.00</b>

**N.B.** Project to be taken from Semester-II and will complete in Semester-III.

## Part C

### 19. Description of all courses of the program:

**Course Code:** 0723-LE-6101      **Course Title:** Advanced Leather Processing

**Credits:** 3.0

#### **Rational of the Course:**

This course covers the knowledge, skills, and attitudes required to produce leather in an advanced environment-friendly manner. This course will cover contents related to cleaner processing techniques from curing, soaking, and unhairing to tanning and post-tanning. This course will also cover some modern concepts utilized in modern days leather manufacturing plants. Finally, this course will provide a well-designed guide to manufacturing specialized leathers.

#### **Course Contents:**

**Cleaner processing (pre-tanning):** Current development in Preservation; less salt and salt-free curing options; Bio-beamhouse; eco-friendly process technologies, enzymatic and eco-benign soaking, sulphides-free unhairing systems: enzymatic, oxidative, ionic liquid; Ammonia-free delimiting; Salt-free pickling systems; Solvent-free degreasing systems; Use of Green Solvents in Pre-Tanning Processes; Use of Alternative Carrier Media to Water in Pre-Tanning Processes.

**Cleaner processing (Tanning, post tanning):** Current development in Chrome tanning; Pickle free tanning; less chrome and chrome-free tanning systems, chrome alternative tanning system, waterless chrome tanning, chrome recovery and reuse system; Wet-white technology; Eco-friendly combination tanning systems; Polymeric and synthetic based tanning systems; Use of Green Solvents in Tanning Processes; Use of Alternative Carrier Media to Water in Tanning Processes; Use of Alternative Fluids in Post-Tanning Operations; Genepin and Oleuropin tanning; Tanning by ionic liquids; Eco-friendly retanning system; Dyeing technologies using co-polymer; Avoidance of eco-sensitive substances viz., formaldehyde, APE, Cr(VI), VOX, AOX free post tanning; ECHA/REACH guidelines; brand/eco-labeling requirements and trend integrated strategies to achieve permissible BOD, COD, and TDS standards of tannery effluents.

**Advanced finishing techniques:** Current development in Finishing; the role of finishing equipment, solvent-free finishing systems, techniques for newer and novel finishing systems viz., aqueous-based patent finishing, cationic finishing, foam finishing, shoe suede, garment suede, transfer foil/coating, lamination techniques, etc. in split finishing; Latest progress in leather finishing agent development: polymer, nanocomposite and photosensitive materials in leather finishing, smart leather manufacturing system.

**Modern concepts in leather manufacture:** Process controls and automation, productivity improvement, quality consistency, water management and zero discharge approaches, energy audit, energy conservation, and environmental footprints.

**Special leather:** Raw materials, properties required, physical and chemical standards required and process details to achieve the specifications of different types of leathers such as upholstery, washable garment, water-resistant leathers, chamois glove leather and fashion leathers. Processing of exotic leathers, such as reptiles, crocodiles, lizards, fish and ostrich.

**Course Objectives:**

- (a) To introduce the different recent advanced technologies and principles related to cleaner processing techniques from curing, soaking and unhairing to tanning and post-tanning.
- (b) To familiarize the basic mechanisms related to leather manufacture.
- (c) To disseminate and apply the modern concepts utilized in modern days leather manufacturing plants justify the different stages of pre-tanning, tanning and post-tanning.

**Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

a) **CLOs:** Upon completion of the course, the students will be able to:

	<b>Course Learning Outcomes (CLOs)</b>	<b>Learning Level</b>
CLO1	Describe the mechanisms of different stages of leather processing with the help of modern tanning principles.	C1, C2
CLO2	Design the elucidation of every process of raw to finished leather manufacturing methods.	C3
CLO3	Investigate and justify the eco-friendly processes of leather making in every processing stages.	C4, C5
CLO4	Create the new technology based on leather engineering research to evaluate the regulations of industrial wastes and to be able to recognize the environment-friendly utilization methods.	C5, C6

**b) Mapping of CLO with PLO**

<b>(CLOs)</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>
CLO1	3	3				2		
CLO2	3	3				2		
CLO3	3	3		2				
CLO4	3	3				3		

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

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

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CLO1	Lecture, slide presentation	In-course exam, Final exam
CLO2	Lecture, slide presentation, and Group Discussion	Assignment, in-course exam, Final exam
CLO3	Lecture, slide presentation, Hands-on Demonstration, and Group discussion	Assignment, In-course exam, Final exam
CLO4	Lecture	In-course exam, Final exam, and Group presentation

**Learning Materials**

**i Recommended Readings**

- Theory and Practice of Leather Manufacture- K.T. Sarkar
- Tanning Chemistry, The Science of Leather-Anthony D Covington
- Possible Defects in Leather Production-Gerhard John
- Chemistry & Technology of Leather-Roddy, O` Flaherty & Lollar, Vol. 2 & 3. Robert E. Kreiger Publishing Co.,N. Y.

**ii Supplementary Readings**

- Chemistry of Tanning Processes – K. H. Gustavson, Academic Press N. Y.
- Chemistry of Vegetable Tannins –E. Haslam, Academic Press, N. Y.
- 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-6103

**Course Title:** Circular Economy and Life Cycle Assessment

**Credits:** 3.0

**Rational of the Course:**

This course intends to teach students about the environmental performance of products, systems, and associated activities. This course will provide students with the concepts of circular economy, and a detailed technique of the LCA process. At the end of the course students will be able to conduct an inventory analysis, analyze potential environmental impacts, and finally, interpreting the life cycle are the stages involved.

**Course Content:**

**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, Leather Wastes and Its Circulation, Industrial Circular Manufacturing, Options for end-of-life management of leather wastes, Drawbacks to recycling, Recycling and material recovery technologies, Pre-fragmentation processes, Fragmentation processes, Post-fragmentation separation processes, footwear recycling, leather waste and recycling, Circular Economy challenges and opportunities for leather wastes, Circular Economy applications in leather waste management.

**Life Cycle Perspective:** ISO norms, benefits, drawbacks, LCA software and databases.

**Life Cycle Assessment:** Origins, Principles and Context, Main characteristics of LCA, Role of LCA in wider applications, Limitations of LCA, LCA as part of a tool box.

**Goal and Scope:** Understanding unit processes, Basics of energy and Mass flows and exchanges with the environment, goal definition, system boundaries, Functional units, Allocation methods; scope definition- requirement for data and data quality, compiling the data, review, and reporting.

**Life Cycle Inventory Analysis:** Scientific principles, Fundamentals of the inventory analysis, the unit process, flow charts, reference values, energy analysis, allocation, procurement, origin and quality of data, data aggregation and units, presentation of inventory results, illustration of the inventory phase by an example, calculation of the life cycle inventory.

**Life Cycle Impact Assessment:** Basic principle of life cycle impact assessment, method of critical volumes, structure of impact assessment according to ISO 14040 and 14044, method of impact categories, impact categories, impact indicators and characterization factors, illustration of the phase impact assessment by practical example.

**Life Cycle Interpretation, Reporting and Critical Review:** Development and rank of the interpretation phase, the phase interpretation according to ISO 331, techniques for result analysis, reporting, critical review, illustration of the component interpretation using an example of practice.

**Life Cycle Sustainability Assessment:** Sustainability, Sustainable Development Goals (SDGs), nexus between sustainability and life cycle analysis, three pillars of sustainability, social life cycle assessment.

**Life Cycle Assessment Applications:** LCA of chemicals and chemical Products, wastewater treatment, solid waste management systems, prospects for life cycle assessment development and practice in the quest for sustainable consumption, life cycle costing.

**Course Objectives:**

- a) To integrate the circular economy concept in leather processing.
- b) To implement the concept of LCA concept, potentialities in leather manufacturing.
- c) To provide necessary skills for sound application of LCA method and proper interpretation of its results.

d) To disseminate basic knowledge of tools for environmental assessment of technology.

**Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

a) **CLOs:** Upon completion of the course, the students will be able to:

	<b>Course Learning Outcomes (CLOs)</b>	<b>Learning Level</b>
CLO1	Describe and state the basic concepts of circular economy, LCA, and its stages.	C1, A1
CLO2	Explain and apply the circular economy concept in the leather industry	C2, C3
CLO3	Apply the LCA tools to ensure sustainability in the leather industry and other relevant industries.	C3
CLO4	Analyze and evaluate the LCA results in different settings.	C4, C5

b) **Mapping of CLO with PLO**

<b>(CLOs)</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>
CLO1	3	2						
CLO2	3	3			2	2		
CLO3	3	3		2	2	3		
CLO4	3	3		2	3	3		

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

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

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
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, whiteboard illustration, and problem-based learning : Identifying the problem to be solved	Assignment, Group Presentation, 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 Readings**

- Life Cycle Assessment (LCA): A Guide to Best Practice by Walter Klöpffer.
- Life Cycle Assessment: Principles, Practice and Prospects, by Ralph Horne, Tim Grant and Karli Verghese, Published by CSIRO Publishing, 2009.
- Life Cycle Assessment Theory and Practice, by Michael Z. Hauschild, Ralph K. Rosenbaum, Stig Irving Olsen © Springer International Publishing AG 2018.

**ii. Supplementary Readings**

- Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards by Jeroen B. Guinée.
- Life cycle assessment: Best practices of ISO 14040 series, by K.-M. Lee and A. Inaba, Center for Ecodesign and LCA (CEL), Ajou University, 2004.

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

**Course Code:** 0723-LE-6105

**Course Title:** Research Methodology

**Credits:** 3.0

**Rational of the Course:**

This course provides an opportunity for students to establish or advance their understanding of research through critical exploration of research language, ethics, and approaches. Students will be able to examine and be practically exposed to the main components of a research framework i.e., problem definition, research design, data collection, ethical issues in research, report writing, and presentation.

**Course Content:**



**Introduction to research:** Definitions, characteristics, types, differences and role of research, research and investigation, research methods versus research methodology, criteria of good research, paradigms and ethics in research, proposition, axiom, postulate, theorem and model of research, variables and types, properties of relationships between variables, inductive and deductive method.

**Literature review and research problem:** Definition, objectives, advantages, principles and procedures of literature review, problem definition, finding a researchable problem, selecting the problem, importance of defining the problem, important qualities of a research problem, techniques involved in defining a problem, evaluating a proposed design.

**Research questions and objectives:** Research objective and research question, practical examples of research objectives and research question, formulation of research questions, criteria of research objectives, evaluation of research questions, classification and importance of research objectives.

**Research hypothesis, design, and proposal:** Source, functions, and characteristics of a good research hypothesis, formulation and possible difficulties of research hypothesis, research hypothesis versus research objectives; definition, function, classification of research design, feature of a good research design, qualitative research, observation studies, surveys, experimentation, steps in a research design; meaning of research proposal, contents of research proposal, steps in the development of a research proposal, criteria for evaluating research proposal.

**Qualitative research tools, measurement and scaling technique:** Definition, characteristics, uses, and general steps of qualitative research, qualitative research approaches, steps in grounded theory, nature of measurement, measurement scales, types of measurement scales, Likert scale.

**Questionnaire design:** Questionnaire and questionnaire design, consideration and types of questions, questionnaire designing process, necessary properties of questionnaire, characteristics of a good questionnaire, precaution required in the use of questionnaire, guidelines for constructing questions and questions sequence.

**Sampling and sampling design:** Concepts and importance of sampling, planning and designing a survey, classification of sampling techniques, probability sampling design, non-probability sampling design, determination of sample size.

**Data collection and analysis:** Data, data versus information, types and sources of data collection, secondary data collection methods, primary data collection methods, qualitative and quantitative methods of data collection, data validation, editing and coding, data entry and exploring, displaying and examining data, Univariate analysis, Bivariate analysis, Multivariate analysis, SWOT analysis, and Hypothesis testing.

**Presenting insights and findings:** Importance of the report and presentation, report preparation and presentations process, precautions in interpretation, research report, contents and precautions in writing research report, presentation of statistics, oral presentation, writing thesis/dissertation, writing journal articles and conference papers, bibliography and reference writing styles, copy right, plagiarism.

**Course Objectives:**

- a) To familiarize the students with the key terms, concepts, and practices in the field of research.
- b) To prepare research problems and/or hypotheses in a clear and concise format.
- c) To demonstrate a systematic understanding of the range of advanced research techniques, be able to critically evaluate these techniques and apply them appropriately.
- d) To evaluate and critically analyze the components of scholarly writing and published research.

**Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

- a) **CLOs:** Upon completion of the course, the students will be able to:

	<b>Course Learning Outcomes (CLOs)</b>	<b>Learning Level</b>
CLO1	Outline the basic framework of research process, and identify various sources of information for literature review and data collection.	C1, A1
CLO2	Explain the ethical dimensions of conducting basic and applied research.	C2, A2
CLO3	Design questionnaire, explain the procedures and techniques, and analyze data with different statistical tools and techniques using statistical computing for making better decisions.	C2, C3, A3
CLO4	Acquaint with the process of conducting research to identify real-life problems recurrently encounter and to suggest suitable and pragmatic solutions to those problems.	C4, A4
CLO5	Compare the advanced research techniques and critically analyze the components of scholarly writing and published research.	C5, A4

**b) Mapping of CLO with PLO**

<b>CLOs</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>
CLO1	3		3			2		
CLO2	3		3			2		
CLO3	3		3			3		2
CLO4	3	3	3	3		3	2	
CLO5	3	2	3	3		3	3	

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

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

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
<b>CLO1</b>	Lecture, Whiteboard illustration, Multimedia presentation, Interactive Discussion	Assignment, Case study, In-course Exam and Final Exam
<b>CLO2</b>	Lecture, Whiteboard illustration, Multimedia presentation, Interactive Discussion	Assignment, Case study, In-course Exam and Final Exam
<b>CLO3</b>	Lecture, Whiteboard illustration, Multimedia presentation, Interactive Discussion	Assignment, Case study, In-course Exam and Final Exam
<b>CLO4</b>	Lecture Whiteboard illustration, Multimedia presentation, Interactive Discussion	Presentation, Assignment, In-course Exam and Final Exam
<b>CLO5</b>	Lecture, Whiteboard illustration, Multimedia presentation, Interactive Discussion	Presentation, Assignment, In-course Exam and Final Exam

**Learning Materials**

**i Recommended Readings**

- M. A. Salam Akanda (2019). *Research Methodology-A Complete Direction for Learners*. Latest Ed., Akanda& Sons, Dhaka.
- C. R. Kothari (1996). *Research Methodology- Methods & Techniques*. Wishaw Prokashan, New Delhi, Wiley Eastern Limited.
- *An Introduction to Research Methods* ; Author: M. Nurul Islam ; Year: 2011 ; Edition: 2nd ; Publisher: Mullick& Brothers

**ii Supplementary Readings**

- Ranjit Kumar (2005). *Research Methodology- A Step-by-Step Guide for Beginners*, 3<sup>rd</sup> Ed., Singapore, Pearson Education.

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

**Course Code:** 0723-LE-6107

**Course Title:** Industrial Hazards and Waste Management

**Credits:** 3.0

**Rationale of the Course:** This course is designed to provide in-depth knowledge of the exploitation of valuable products from tannery wastes by utilizing modern technology. This course will facilitate students with deeper understanding of different types and characteristics of industrial hazardous wastes and a comprehensive overview of hazardous waste management approaches.

**Course Contents:**

**Industrial Hazards:** Hazard, Types of industrial hazards, Identification of hazardous wastes, Hazardous waste management, Treatment technology, Disposal of radioactive materials, Ground water contamination and remediation. Route of industrial hazard entry into human body-

Inhalation, Absorption, Swallowed, Injection, Food chain - Contaminated soil, Vegetables, Crops, Fish and Chicken, Adverse impact of hazard, Occupational cancer.

**Solid Waste Generation in the Leather industry and its Utilization:**

Generation: Skin collagen waste, Fleshing waste, Wet blue, Trimming, Buffing, Chrome shaving, Chrome split, trimming from crust and finished leather. Utilization: Fleshing- Modified fleshing hydrolysate, Reactive protein (RP), feed ingredients.

Chrome shaving: Treatment with enzyme, MgO, Carbonates and other alkalies, application of hydrolysate.

**Waste generation in Footwear and Leather Products Industry:** Materials being processed: Leather, Natural rubber/poly-isoprene, Reaction Injection Moulded (RIM) polyurethane (PU), Polyvinyl Chloride (PVC) and blends, Ethylene Vinyl Acetate (EVA) and blends, Styrene Butadiene Rubber (SBR), Thermoplastic Polyurethane (TPU), Thermoplastic Rubber (TR), Leather, textile, cotton, polyesters, nylon, adhesive, solvent, oil.

**Solid Waste Management:**

Solid waste–sources and engineering classification, characterization, generation and quantification. Transport - collection systems, collection equipment, transfer stations, collection route optimization.

Treatment methods - various methods of refuse, recovery, recycle, composting –aerobic and anaerobic, incineration, pyrolysis and energy recovery.

Disposal methods – Impacts of open dumping, site selection, sanitary land filling – design criteria and design examples, leachate and gas collection systems, and leachate treatment.

Hazardous Waste Management- Introduction, Sources, Classification, Physico-chemical, Chemical and biological Treatment of hazardous waste, regulations.

Thermal treatment - Incineration and pyrolysis.

Soil contamination and site remediation – Bioremediation processes, monitoring of disposal sites.

**Removal of Refractory Organic Compounds:** Theories on Advanced Oxidation Process viz., Photocatalytic treatment, Membrane separation, Homogenous catalysis system using hydrogen peroxide, ozone, etc. Hetero catalytic systems using metal oxides, activated carbon – Removal of inorganic compounds through electro dialysis, reverse osmosis, multiple effect evaporator, ion-exchange.

**Learning Objectives:**

- a) To provide the advance knowledge about the environmental problems, industrial hazards, and its methods of mitigation.
- b) To estimate solid waste generation from tanning industry, and leather goods industry and their utilization using modern techniques.
- c) To improve a comprehensive skill on tannery solid waste, biomedical and other hazardous wastes and integrated solid waste management system.
- d) To familiarize students with modern biological techniques available for the wastewater treatment.

## Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

a) **CLOs:** Upon completion of this course, students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
<b>CLO1</b>	Narrate industrial hazards and their adverse impact on the environment and humans.	C1, A1
<b>CLO2</b>	Analyze tannery solid waste utilization into the valuable byproducts as part of circular economy and clean technology.	C3, A3
<b>CLO3</b>	Apply knowledge on the estimation of solid waste generated from leather and allied industries.	C4
<b>CLO4</b>	Justify modern techniques of wastewater treatment with traditional treatment processes.	C5, A4

b) **Mapping of CLO with PLO**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
<b>CLO1</b>	3	2	-	-	-	2	1	-
<b>CLO2</b>	2	3	3	2	-	-	3	-
<b>CLO3</b>	3	3	3	-	-	2	2	-
<b>CLO4</b>	3	3	-	-	3	1	-	-

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

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

CLOs	Teaching-Learning Strategy	Assessment Strategy
<b>CLO1</b>	Lecture, Multimedia presentation, demonstration and problem-based exercises	In-course Exam; Final Exam
<b>CLO2</b>	Lecture, audiovisual presentation, group discussion and problem-based exercises, literature review	Presentation, In-course Exam; Final Exam
<b>CLO3</b>	Lecture, problem-based learning : Identifying the problem to be solved	Assignment, Group Presentation, In-course Exam, and Final Exam
<b>CLO4</b>	Lecture, multimedia presentation, group discussion, literature review, demonstration, and problem-based exercises	Assignment, In-course Exam, and Final Exam

## Learning Materials

### i. Recommended Readings

- Arceivala S. J., “Waste water treatment and disposal” Marcel Dekkar Inc., New York, 1981.
- Besselievie, B. E. and Schwartz, M., “The Treatment of Industrial wastes”, 2nd edn., McGraw Hill.
- Karia G.L., and Christian R.A., (2001), “Wastewater Treatment Concepts and Design Approach”, Prentice Hall of India Pvt. Ltd., New Delhi.

### ii. Supplementary Readings

- Assessment of Tannery Solid Waste Management, a case study Sheba Leather Industry, UNIDO, 2018.
- Benefield R.D., and Randal C.W., (1980), “Biological Process Design for Wastewater Treatment”, Prentice Hall, Englewood Chiffs, New Jersey.

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

**Course Code:** 0723-LE-6109

**Course Title:** Ergonomics and Industrial Safety

**Credits:** 3.0

**Rationale of the Course:** This course is intended to instruct knowledge by different approaches to improve better workspace design and efficient work environment designs and management. After completion of this course, the students will be able to design better factory environment and thereby will be able to ensure effective safety management practices in the leather industry.

### Course Contents:

#### Ergonomics

**Introduction:** What is Ergonomics; History of Development; Scope & Application of Ergonomics; Importance of Ergonomics; Anthropometry.

**Muscle Physiology and Manual Material Handling:** Muscle and Work Physiology; Measure of Physiological Strain; Physical Workload; Manual Materials Handling.

**Hand Tools and Devices:** Introduction to Hand Tools; Structure and Motion of Hand; Principles of Designing Hand Tools and Devices; Vibration & HAVS; Gripping Principles.

**Workspace Design:** Designing Workspace Envelopes for Seated and Standing Personnel; Designing Horizontal Work Surfaces; Designing Seated and Standing Work Surfaces.

**Work Environment Design:** Lighting in Work Environment; Vision and Structure of Eye; Visual Defects; Guidelines for Colour Selection; Measurement of Light Photometry; Lighting and

Illumination; Reflectance; Lighting Problem; Improving Visibility; Characteristics and Efficiency of Light Sources; Lighting Design Considerations; Glare; Uniformity of Lighting; Complaints, Causes and Control Measures of Visual Discomforts; Sound Propagation; Structure of Human Ear; Process of Hearing; Health Effects of Noise Pollution; Control Measures for Noise Pollution; Thermal Balance; Heat Illness; Heat Acclimatization; Heat Stress Measurement; Cold Injury; Cold Climate Protection.

## **Safety Management**

**Introduction to Safety Management:** Objectives; Importance of Safety Management; Occupational Health and Safety (OHS); Hazard and Risk.

**Introduction to Workplace Safety:** Aims; Considerations to Manage Workplace Safety Effectively; Nature, Functions and Benefits of Workplace Safety; Challenges for Practicing Safety; PDCA Cycle in OHS; Idea Generation.

**Creating an Effective Workplace Safety Program:** Core Regulatory Requirement; Program Review/Audit; Establishing Goals and Objectives; Management Commitment and Responsibility; Work-Site Analysis; Hazard Recognition and Resolution; Job Hazard Analysis (JHA)/Job Safety Analysis (JSA); Hazard Resolution; Incident Investigation; Best Practices.

**Workers' Compensation and Record Keeping:** Early and Modern Workers' Compensation Laws; Premium Calculation; Background Record Keeping; OSHA 300, 300A and 301 Forms; Recordable Occupational Injuries and Illness; First Aid Cases; Fatalities; Privacy Concern Cases; Posting Annual Summary Requirements.

**Introduction to Industrial Hygiene:** Definition; Toxicology; Industrial Hygiene Practice.

**Fire Prevention and Protection:** Means of Egress Regulations; Fire Tetrahedron; Categories of Fire; Categories of Fire Extinguisher.

**System Safety:** Importance of System Safety; System Life Cycle; Management of System Safety; Elements of A System Safety Program Plan (SPSS); Preliminary Hazard Analysis (PHA); Subsystem Hazard Analysis (SSHA); System Hazard Analysis (SHA); Technique of Operations Review (TOR); Failure Mode and Effect Analysis (FMEA).

**Improving Safety Performance with Behavioural Safety:** Introduction; Pilot Error Syndrome; Concepts of Risk; Incidents and Accidents; Loss Exposures; Control Techniques for Loss Exposures; Accident Causation Theories; Single Factor Theory; Heinrich's Domino Theory; Multiple Factors Theory; Human Factors Theory; Energy Release Theory; Further Incident Investigation.

**Learning Objectives:** Make the students able to-

- a) To identify the components needed to provide a safe and healthful work environment through case studies and review of injury statistics provided in the course.



- b) To identify potential workplace safety and health hazards and determine how to mitigate the hazards through engineering controls, administrative controls and personal protective equipment.
- c) To conduct basic safety inspections using strategies that they have developed through hazard identification and job hazard analysis.
- d) To identify the requirements of training programs in the workplace under the existing OSHA and State-OSHA requirements.
- e) To understand essential elements of an occupational safety and health program and the components of international standard organizations in safety and health.

**Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

a) **CLOs:** Upon completion of this course, students will be able to:

	<b>Course Learning Outcomes (CLOs)</b>	<b>Learning Level</b>
CLO1	Recall knowledge of fundamentals of ergonomics and safety management related to leather engineering.	C1, A1
CLO2	Explain various methods and tools to ensure proper ergonomics facilities and safety management.	C2, C3
CLO3	Apply various modern techniques to design an ergonomic friendly work environment as well as a safer workplace with protection from possible accidents and hazards.	C4
CLO4	Investigate and solve any problem/issue related to ergonomics and safety management in real world leather manufacturing.	C5, A4

b) **Mapping of CLO with PLO**

<b>(CLOs)</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>
CLO1	3							
CLO2	3	3			2			
CLO3	3	3				3		
CLO4	3	3	2		2	2		2

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



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

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

**Learning Materials**

**i Recommended Readings**

- Human Factors in Engineering & Design by Mark S. Sanders, Ph. D. and Ernest J. McCormick, Ph. D
- Introduction to Ergonomics by R. S. Bridger
- Workplace Safety A Guide for Small and Midsized Companies by Dan Hopwood, Steve Thompson
- Fundamentals of Occupational Safety and Health (fourth edition) by Mark A. Friend and James P. Kohn

**ii Supplementary Readings**

- The Occupational Ergonomics Hand Book, Edited by Waldemar Karwowski and William S. Marras, CRC Press, New York, USA.

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

**Course Code:** 0723-LE-6111

**Course Title:** Advanced Leather Biotechnology

**Credits:** 3.0

**Rational of the Course**

This course is designed to provide the advance concepts of leather biotechnology. More specifically this course covers contents of bacterial genetics, recombinant DNA technology. It also

covers the knowledge of different microbial fermentation methods and control of undesirable microorganisms are incorporated required for leather manufacture. Additionally, this course contains contents of larger scale production of industrially important enzymes. This course will also provide insights into the informatics and pollution remediation aspects of microbiology and biotechnology.

### **Course Content**

**Introduction:** Historical development, scope and essential features of biotechnology with special concentration to leather processing.

**Bacterial genetics & Recombinant DNA technology:** Chemical nature of hereditary material, the Watson and Crick model of DNA structure, classification and composition of nucleic acids, bases, sugars, nucleosides, nucleotides and polynucleotides, replication of the DNA molecule. Transcription and Translation of genetic information, different types of RNA molecules, regulation of gene expression. Mutation- types of mutation, how mutations occur, how mutations are repaired, bacterial recombination, vectors for gene cloning: plasmids, other vectors, expression of cloned genes, enzyme purification techniques: filtration, chromatography, HPLC, bacterial conjugation, bacterial transduction, bacterial transformation, recombinant DNA technology, DNA cloning.

**Instrumentation and control of fermentation process:** Principles of microbial growth kinetics, different types of fermentation, stages of fermentation process, downstream processing, bioreactor, Control systems: manual, automatic and combinations of methods of control; methods of control of process variables- temperature, pH, flow measurement, pressure measurement, pressure control, safety valves, agitation-shaft power, rate of stirring, foam sensing and control weight, measurement and control of dissolved oxygen, exit-gas analysis, redox and carbon dioxide electrodes.

**Large scale production of industrially important enzymes:** Screening and selection of enzyme producing microorganisms, enzymes production, packaging and finishing, protease enzyme: an eco-friendly alternative for leather industry, industrial approach to enzyme production with special attention to production of protease, development of new enzyme preparations.

**Bioremediation of the tannery effluent:** Microbial waste treatment system, biological processing of industrial wastes, use of bio-augmentation in industrial waste treatment, use of enzymes and immobilized microbial cells in industrial (tannery) waste treatment, removal of metals by microbes from industrial (tannery) waste.

**Microbial deterioration of leather and its control:** Biodeterioration of organic materials and its evaluation, biodeterioration in the leather industry, the technology of leather production, curing of raw hides, soaking, liming, de-liming, bating, tanning and re-tanning, drying and finishing of leathers, control of microbial deterioration of leather, fungicides, bactericides and other controlling agents for leather.

**Introduction to Bioinformatics:** Basic concepts-definition, scope of bioinformatics, data structures and database concepts; sequence comparison and alignment techniques; FASTA and BLAST algorithm; profiles, motifs and features identification; phylogenetic analysis; molecular modeling; practical bioinformatics.

**Course Objectives:** Make the students able to-

- a) Understand the basic concepts of heredity-DNA and RNA structure, DNA replication, gene expression, rDNA technology and bacterial genetics.
- b) Explore knowledge on structure and functions of enzymes and its application in leather manufacturing.
- c) Improve skills on the instrumental control techniques of fermentation process.
- d) Acquire biological treatment of tannery effluents.
- e) Familiarize with the Bioinformatics and its application in biotechnology.

**Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

a) **CLOs:** Upon completion of the course, the students will be able to:

	Course Learning Outcomes (CLOs)	Learning level
CLO1	Explain biotechnology's relevance to leather processing.	C1, C2, A1
CLO2	Analyze bacterial genetics and DNA technology.	C4
CLO3	Evaluate fermentation and enzyme production in the leather industry.	C4
CLO4	Compare bioremediation processes of tannery effluent.	C4
CLO5	Explore and depict bioinformatics and its practical applications.	C5, A4, P3

b) **Mapping of CLO with PLO**

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3			1	2		
CLO2	3	3				3		
CLO-3	3	3	1			3	2	
CLO-4	3	3			3	2	2	
CLO-5	3	3				3	2	2

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

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

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CLO1	Lecture, slide presentation	In-course exam, Final exam
CLO2	Lecture, slide presentation, and Group Discussion	Assignment, in-course exam, Final exam
CLO3	Lecture, slide presentation, and Group discussion	Assignment, In-course exam, Final exam
CLO4	Lecture, Audio-visual presentation	Case study In-course exam, and Final exam
CLO5	Lecture, Audio-visual presentation	In-course exam, Final exam, and Group presentation

**Learning Materials**

**i Recommended Readings**

- Principles of Genetics, 6th Edition- D. Peter Snustad, Michael J. Simmons.
- Principles of Fermentation Technology-Peter F. Stanbury, Allan Whitaker and Stephen J. Hall.
- Enzymes in Industry: Production and Applications, 3rd Edition - Wolfgang Aehle (Editor).
- Bioinformatics For Dummies, 2nd Edition, By Jean-Michel Claverie, Cedric Notredame.

**ii Supplementary Readings**

- Microbial Ecology: Fundamentals and Applications - Ronald M. Atlas & Richard Bartha.
- Gene Cloning and DNA Analysis: An Introduction, 6th Edition- Terence A. Brown.

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

**Course Code:** 0723-LE-6213

**Course Title:** Environmental Management and Impact

Assessment

**Credits:** 3.0

**Rational of the Course:**

This course is designed to train the graduates in analysis and assessment methods applicable to environmental contamination problems, particularly national and international legislative

frameworks. This course is contemplated for LWG and other environmental certification processes for the leather industry.

**Course Content:**

**Environmental Audit:** Principles and philosophies of environmental auditing, basic steps in audit process, Auditing techniques Concept of industrial ecology, cleaner technologies in industrial processes and evaluation of processes, waste minimization

**Environmental health hazard and risk assessment:** Biological, chemical, physical and psychological health hazard; health risk assessment and management, toxicology, exposure measurement of toxic (carcinogenic and non-carcinogenic) substances

**Clean Development Mechanism:** Overview on sustainable development. greenhouse gasses reduction mechanism, project cycle for the CDM, CDM for small scale projects, risks and opportunities for industries, financing of CDM projects, case studies.

**Environmental Impact Assessment (EIA):** Definition, purposes and characteristics of EIA, global evolution of EIA, participants in EIA process, stages of EIA, types of EIA, environmental inventory, baseline data on EIA-environmental data, project data and project alternative data, measurement of impact– physical, social, economic, natural, public participation in environmental decision making, framework of environmental assessment, description of environmental setting, Environmental impact factors and area consideration, environmental impact statement (EIS) and environmental management plan (EMP).

**Environmental Impact Analysis:** Impact identification and methods of impact identification-adhoc method, checklist, matrix, network, overlay and index methods; impact prediction and predictive methodologies, impact evaluation (assessment) and impact mitigation.

Basic steps for the impact identification, prediction and assessment of air, water, noise, vegetation and wildlife environment with case studies.

**Environmental Management System (EMS):** Basic definitions and terms, Framework for environmental management system, approach for developing Environmental Management System, International standards, environmental management systems in tanneries and their implementation, environmental reporting, Occupational health and safety management, cross-boundary environmental management, mandatory regulations and ecolabelling criteria governing various substance in leather, life -cycle assessment and carbon footprint in leather industries.

**Hazard Mitigation:** Classification of hazards, basic concept of disaster (causative factors of disaster, classification of disasters), Hazards due to dams and reservoirs, nuclear power plants, industrial hazards, occupational hazards, mitigation measures, hazard assessment, risk assessment.

**EIA in Bangladesh:** An overview of history, current procedures, practices and guidelines for Environmental Clearance Certificate, EIA of water resource projects, industries, mining and quarrying, highway construction, and tourism developments.

**Course Objectives:**

- a) To provide knowledge on legal and policy frameworks within which quantitative environmental assessment activities are carried out and
- b) To conduct systematic EIA and auditing methodologies in the leather industry.
- c) To carry out quantitative techniques of analysis for direct determination of contaminant concentrations and distributions within environmental systems.
- d) To investigate statistical and computer modeling techniques for analysis of data.

**Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

a) **CLOs:** The course is intended to achieve the following learning outcomes:

	<b>Course Learning Outcomes (CLOs)</b>	<b>Learning Level</b>
CLO1	Recognize ethical and narrate professional responsibilities in engineering situations and make judgments.	C1, A1
CLO2	Familiarize with the application of a variety of professional tools for predicting environmental impacts.	C2, A2
CLO3	Developing perspectives on impact assessment and relating to practical industrial activities.	C3, C4

**b) Mapping of CLO with PLO**

<b>(CLOs)</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>
CLO1	3	3	3					
CLO2	2		3	3	2	3	3	
CLO3	3		2			3	2	3

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

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

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CLO1	Lecture, Multimedia presentation, white board illustration, problem-based exercises, group discussion by analyzing different case studies	Quiz, In- course exam; Final Exam
CLO2	Lecture, multimedia presentation, Problem based Learning : 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**

- Morris, P and Therivel, R. 2001. Methods of environmental impact assessment. London. UCL press
- Introduction to Environmental Impact Assessment: Principles and Procedures, Process, Practice and Prospects - 2nd edition. J. Glasson, R. Therivel, A. Chadwick
- Environmental Impact Assessment Methodologies, Y. Anjaneyulu, Valli Manickam, BS Publication
- Environmental and Health Risk Assessment and Management: Principles and Practices, ISBN: 9789048169610,9048169615

**ii. Supplementary Reading**

- Bregman, J.I. and Mackenthum, K.M. 1992. Environmental impact statements. Chelsia Michigan: Lewis.
- Calow, P. 1997. Handbook of environmental risk assessment and management. Oxford: Blackwell Science.

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

**Course Code:** 0723-LE-6215

**Course Title:** Nanotechnology for Leather and Leather

Products

**Credits:** 3.0

**Rational of the Course:**

This course is designed to provide in-depth theoretical knowledge of nanotechnology and outlines its applications in leather and allied engineering fields. The course also deals with the design of nano systems, nanomaterials together with their processing, properties and characterization.

## Course Contents

**Introduction to Nanoscience and Nanotechnology:** Introduction, history and importance of nanotechnology, properties of nanomaterials, difference between bulk and nanomaterials, molecular building blocks for nanostructured systems, influence of nano structure on mechanical, optical, electronic, magnetic and chemical properties, overview of different nanomaterials available, chemistry and physics of nanomaterials, electronic phenomenon in nanostructures, optical absorption in solids, quantum dot, quantum effects, nanocomposites.

### Nanomaterials Fabrication

**Chemical Methods:** Sol- gel process, self-assembly process, electrodeposition, pyrolysis, metal nanocrystals by reduction, solvothermal synthesis, photochemical synthesis, sonochemical synthesis, reverse micelles and microemulsions, combustion method, template process, chemical vapor deposition, metal organic chemical vapor deposition.

**Physical Methods:** Ball milling, inert gas condensation technique, thermal evaporation, pulsed laser deposition, DC/RF magnetron sputtering, molecular beam epitaxy, microlithography, etching, wet cleaning, atomic layer deposition.

**Biological Synthesis:** Protein based nanostructure formation, DNA template nanostructure formation, protein assembly, biologically inspired nanocomposites.

### Nanomaterials Characterization

**Structural Characterization:** X-ray diffraction (XRD) analysis, FT-IR analysis, Raman spectroscopy

**Microscopic and Surface Analysis:** Electron microscopes: scanning electron microscopy (SEM), transmission electron microscopy (TEM); scanning probe microscopy: atomic force microscopy (AFM), scanning tunneling microscopy (STM).

**Spectroscopy:** X-ray photoelectron spectroscopy (XPS), fluorescence spectroscopy, UV-visible spectroscopy, nuclear magnetic resonance (NMR)spectroscopy, electron spin resonance (ESR) spectroscopy.

**Electrical, Mechanical and Magnetic Properties:** Impedance analysis, electro-analytical techniques: potentiometry, voltammetry, cyclic voltammetry

**Thermal and Optical Properties:** Differential scanning calorimetry (DSC) analysis, Differential thermal analysis (DTA), Thermogravimetric analysis (TGA), contact angle measurement. Dynamic light scattering (DLS) method.

**Applications of nanotechnology in the relevant field and non-leather chemicals:** Possible industrial applications of nanomaterials in leather, footwear and leather goods industries, application of nano materials on collagen matrix at various stages of processing techniques,



synthesis of nano based materials for leather manufacture: syntans, reinforcing materials, finishing chemicals.

**Environmental aspects of nanotechnology:** Handling, safety and hazard of nanomaterials processing, effects of nanomaterials exposure on human and living stock, long term and short term effects, case studies of exposure, effects of nanoparticles on air, water and soil, food and food supplements.

### Course Objectives

- a) To introduce and provide a broad view of the nascent field of nanoscience and nanotechnology.
- b) To promote interdisciplinary interactions among engineering, technology, science, and industrial management/technology majors.
- c) To utilize knowledge about developing new products and systems in leather sector.

### Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

- a) **CLOs:** At the completion of this course students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Define and explain the structure, properties and applications of nanomaterials together with associated chemicals	C1, C2
CLO2	Illustrate the importance of dimensional reduction in materials and its relationship with properties.	C3
CLO3	Compare numerous methods of nanomaterials preparation and analyze nanomaterials thoroughly using engineering tools	C5
CLO4	Assess environmental pollutions/concerns by nano based materials during its production and real-life applications.	C5

### b) Mapping of CLO with PLO

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3					2		
CLO2	3					3		
CLO3	3	2			3	3	2	
CLO4	2	3			2	2	2	

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

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

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
<b>CLO1</b>	Lecture, literature review, multimedia presentation, group discussion	Group Presentation, In-course Exam, Quiz, Assignment, Final Exam
<b>CLO2</b>	Lecture, multimedia presentation, video presentation, demonstration, group discussion	Group Presentation, In-course Exam; quiz, assignment, case study, Final Exam
<b>CLO3</b>	Lecture, demonstration, multimedia presentation, literature review, group discussion	Assignment, Quiz, Group Presentation, In-course Exam, and Final Exam
<b>CLO4</b>	Lecture, multimedia presentation, group discussion, literature review, video presentation, demonstration, and problem-based exercises	Quiz, Assessment, Group Presentation, In-course Exam, and Final Exam

**Learning Materials**

**i Recommended Readings**

- Hand book of Nano science, Engineering, and Technology, William A. Goddard, CRC press 2003.
- Nanolithography and patterning techniques in microelectronics, David G. Bucknall, Wood head publishing 2005.
- Nanocomposite science and technology, Pulikel M. Ajayan, Wiley-VCH 2005

**ii Supplementary Readings**

- Nanotechnology Environmental health and Safety: Risks Regulation and Management, Matthew Hull and Diana Bowman, Elsevier 2010
- Hand book of Nano science, Engineering, and Technology, William A. Goddard, CRC press 2003.

**iii Others**

- Handout/lecture material provided by the course teacher

**Course Code:** 0723-LE-6217

**Course Title:** Industrial Automation

**Credits:** 3.0

**Rationale of the Course:** This course provides an overview of the technologies of industrial automation and control as it is commonly encountered in factories of all types including leather

and footwear items. Automation of the production process increases the efficiency of labor and the overall rate of growth. After completion this course, students will familiar with fundamental knowledge of current industrial automation technologies and their application.

### **Course Contents:**

**Introduction to Automation and Artificial Intelligence:** Introduction, Principles and strategies, Basic elements of an automated system, Advanced automation functions, Levels of automations, Automated flow lines and transfer mechanisms, Introduction of AI, Historical development, Intelligent Systems, Types of Intelligent Agents, Components of AI, Foundations of AI, Scope of AI, Current trends in AI, Relevance to Leather, Products and Footwear Engineering

**Boolean Algebra and Logic Circuits and Programmable Logic Controller (PLC):** Various logic gates, Truth tables, Logic functions, Boolean Laws, Karnaugh maps, Block diagram of PLC, Programming languages of PLC, Basic instruction sets, Networking of PLC, Overview of safety of PLC with case studies. Process Safety Automation: Levels of process safety through use of PLCs,

**Controllers, Sensors and Actuators::** Control Modes, PID and Digital Controllers, Velocity Control, Adaptive Control, Microprocessor and Microcontrollers, important characteristics, Main industrial sensors, Classification of sensors and their usage, Description of different kinds of sensors, Overview of Actuators, usage of Actuators in Robotics, Classification of Actuators (Pneumatic, Hydraulic, Electric), Basics of Pneumatic and Hydraulic Actuation Systems, Mechanical Actuation Systems, Electrical Actuation Systems.

**Robots and their applications:** Introduction to robots, Types, Classifications, Selection of robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Drives and transmission systems, End effectors, Industrial robot applications.

**Concept and Algorithms, No programming or numerical:** Problem Solving: Tree and Graph Search, Uninformed v/s informed search, uninformed methods: depth first search, breadth first search, Informed search: heuristic search, Best first search, branch and bound; Machine Learning: Introduction, types of machine learning; Learning with Decision Trees, Classification and Regression Trees, K means clustering algorithm, K nearest neighbors algorithm, hierarchical clustering, Concept of ensemble methods.

**Artificial Neural Networks and Introduction to AI Technologies:** Concept of ANN, Basic Models, Important Terminologies of ANNs McCulloch-Pitts Neuron, NN architecture, perceptron, delta learning rule, back propagation algorithm, Gradient Descent algorithm, feed forward networks, activation functions, Introduction to AI Technologies in the realm of Automation Concept of Natural Language Processing, Machine Vision, Deep learning, Expert systems, Genetic Algorithms, Industry 4.0

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

- a) To provide fundamental knowledge of automated machines and equipment including AI application in leather industry.

- b) To impart the role of Boolean algebra and PLC in industrial automation.
- c) To develop the operating skill of various sensors, actuators and controllers.
- d) To familiarize with the application of robotic systems and artificial neural networks in automated manufacturing processes.

**Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

a) **CLOs:** Upon completion of this course, students will be able to:

	<b>Course Learning Outcomes (CLOs)</b>	<b>Learning Levels</b>
CLO1	Explore their knowledge on fundamentals of industrial automation and its importance in modern manufacturing.	C1, A1
CLO2	Define and explain various automation technologies in leather and leather products manufacturing and process industries.	C1, C2, A2
CLO3	Apply various modern technologies to design an automated production facility including materials handling with robotics application.	C3, A2
CLO4	Investigate and solve any hurdle related to automation with the help of Artificial Intelligence (AI) applications.	C4, C5

**b) Mapping of CLO with PLO**

<b>(CLOs)</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>
CLO1	3							
CLO2	3				1			
CLO3	3	2	2		1	3	2	
CLO4	3	3	3	3	2	2	2	1

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

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

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

**Learning Materials**

**i Recommended Readings**

- Handbook of Industrial Automation-Richard L. Shell, Ernest L. Hall
- Introduction to Industrial Automation- Stamatios Manesis, George Nikolakopoulos
- Introduction to Artificial Intelligence By Wolfgang Ertel

**ii Supplementary Readings**

- Introduction to Mechatronics and Measurement Systems by David G. Alciatore.

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

**Course Code:** 0723-LE-6219

**Course Title:** Advanced Leather Dyeing and Finishing

**Credits:** 3.0

**Rational of the Course:**

This course is designed to provide students with the latest knowledge of recent trends in lather dyeing and finishing operations. This course will provide comprehensive understanding of dyeing kinetics, the dyeing extraction process, the chemistry of dye, testing of dye and dyeing, principles of finishing, sustainable leather finishing options, and various finishing methods and techniques. At the end of the course, students will be able to solve different finishing problems raised from tannery.

**Course Contents**

**Introduction:** Sources of Natural Dyes, Constitutional Aspects, Types of Dye, Chemical Entities Responsible for Colors, Classification Based on Chemical Nature, Classification Based on Colors.

**Kinetics of dyeing:** Diffusion, pore, free volume models in dyeing, waterless dyeing, dyeing mechanism, kinetic and thermodynamic analysis of dye-collagen interaction, chemical kinetics of dyeing, and the activation energy of dyeing.

**Dye extraction:** Various plant sources for dye extraction, Extraction methods, Assessments of Eco-Friendliness, and antimicrobial Properties of natural dye. Extraction parameters of natural dyes.

**Chemistry of dye:** Relation Between Color and Constitution, Characterization of Natural Dyes, Solubility Studies, Mordants used in Dyeing such as Mordant Tannins, Tannic Acid, Metal Salts Mordants

**Testing of dye and dyeing:** Spectrophotometric analysis, evaluation of the color yield of dyes, assessment of fastness properties of dyes, separation of dyes by chromatographic techniques, Fluorescent Pigments, Phosphorescent Luminous Pigments.

**Sustainable leather dyeing:** Environmental impact of leather dyeing, energy consumption in leather dyeing, laser technology, waterless dyeing, digital printing, neon color, anti-microbial finishing, eco-friendly finishing, modern technologies in finishing.

**Diverse finishing techniques:** Mechanical operations in finishing, oil pull-up, waxy, furnishable, antique, grain suede, screen printing, roller printing, easy-care and patent finishing, cationic finishing, foam finishing, transfer foil, lamination, etc.

### Course Objectives

- a) To critically appraise the processes involved in leather finishing
- b) To provide the critical and analytical skills needed to investigate and analyze the role of dye in leather manufacturing.
- c) To impart knowledge on the chemical kinetics of leather dyeing.
- d) To disseminate the latest knowledge regarding leather finishing processes and their techniques

### Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

- a) **CLOs:** Upon completion of the course, the students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
<b>CLO1</b>	Describe the principles of the kinetics of dyeing	C1, A1
<b>CLO2</b>	Formulate strategies for finishing different types of leather from natural sources	C2
<b>CLO3</b>	Interpret the role of various natural finishing agents and auxiliaries used in leather finishing	C3
<b>CL04</b>	Explain the effect of dyes and chemicals on the properties of leather, in both aesthetic and functional term	C4, A3

<b>CL05</b>	Develop technologies for enhancing the value addition of low-grade substrates	C5, A5
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**b) Mapping of CLO with PLO**

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3			2				
CLO2	3	2						
CLO3	3	2				3		
CL04	3	3		2			2	
CL05	3					2		

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

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

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

**Learning Materials**

**i Recommended Readings**

- Handbook on Natural Dyes for Industrial Applications (Extraction of Dyestuff from Flowers, Leaves, Vegetables) 2nd Revised Edition, Dr. Padma S Vankar.
- The Complete Technology Book on Dyes & Dye Intermediates (2nd Edition), Author Dr. Himadri Panda Publisher Niir Project Consultancy Services.
- The Complete book on Natural Dyes & Pigments by NIIR Board of Consultants & Engineers.
- A Laboratory course in Dyeing -Charles Hugh Giles.
- The Dyeing of Textile Materials -Publio Puene, Jose Valdegeras Jose, Cegera.

ii **Supplimentary readings**

- The Chemistry of Synthetic Dyes and Pigments -Lubs H. A.
- An Introduction to the chemistry of dye stuff -Shenai V. A.
- A Guide to Dyeing Leather - A Collection of Historical Articles on the Methods and
- Equipment Involved in Leather Production Paperback – September 6, 2015

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

**Course Code:** 0723-LE-6221

**Course Title:** E-Commerce and International Trade

**Credits:** 3.0

**Rationale of the Course**

This course comprises basic concepts of e-commerce, mobile commerce, website evaluation and usability testing, internet marketing, e-security, e-core values, and Commerce, which will help students establish online business channels. This course includes an introduction to international trade, modes of operations, export strategy, and marketing, which will deliver ideas to students on how the leather, footwear, and leather products export market can be enlarged.

**Course Contents**

**Introduction to e-commerce:** Conceptual understanding of e-commerce, e-business and e-strategy, E-commerce Drivers, Advantages through E-commerce, Issues and Constraints of E-commerce, Benefits of the Internet, Role of E-strategy, Value-chain in e-commerce, Analyzing Value Chain Activities, and supply-chain management and how they relate to e-commerce and e-business, Business models of the e-environment, A Generic E-commerce Model, Path to Successful E-commerce, A trend toward integrating e-commerce, E-commerce Business Models.

**Mobile Commerce: Concept of Mobile Commerce,** benefits of M commerce, M-Commerce Services and Applications available, Attributes of M-Commerce, Services of mobile commerce, Mobile payment, Mobile Commerce Application, Challenges of Mobile commerce, Advantages, and disadvantages of M commerce.

**Web Site Evaluation and Usability Testing:** Characteristics of Lame Web Sites, Common Mistakes, Questions When Evaluating a Web Site, Basic Web Site Anatomy, Color and Its Psychological Effects, Consumer Association with Key Shapes, Site Evaluation Criteria, Components of Personalization, Steps to Operationalize Personalization, Approaches to Web Personalization, Do You Want a Cookie? Popular Myths About Cookies, Web Site Usability, Effective Web Site Design, Components of Personalization, Reliability, User Testing, Site Performance Issues, Managing Content and Site Traffic.

**Internet Marketing:** The Pros and Cons of Online Shopping, Justifying an Internet Business, Internet Marketing Techniques, Range of Internet Marketing Techniques and Applications, Aggressive Internet Marketing, Pop-up Advertising, Permission Marketing, The E-cycle of Internet Marketing, Examples of the “Best” and “Worst” Web Sites, New Format Brand Ads, Personalization - the fifth “P”, Important Personalization Rules,



Marketing Implications, How to Market Presence, Guidelines for Attracting Customers to your Site.

**Getting the Money:** Real-world and electronic cash and their unique features and uses, the key requirements for Internet-based payments, The many ways people pay to purchase goods and services on the Internet, Business-to-business methods of payment: DigiCash, E-Cash and E-Wallet, Paying for goods and services via the mobile phone, Issues and implications behind electronic money transactions and payments.

**E-Security and the USA Patriot Act:** Equal Credit Opportunity Act, Maine's Anti-Hacker laws, Spyware, Spyware and Adware, Spyware Solutions, Compliance Legislation, Levels of Virus Damage, Steps for Antivirus Strategy, Steps to Prevent E-Commerce Fraud, Security Protection and Recovery, Creating Strong Password, Firewalls and Security, Firewall Design and Implementation Issues, Corporate Networks and Firewalls, How Firewalls Work, Cycle of Recovery from Attack, Biometric Security, Types of Biometrics and Select Application Areas, Terrorism, How Modern Terrorism Uses the Internet, National Strategy to Secure Cyberspace.

**E-Core Values:** Ethical issues and how to improve the ethical climate in e-commerce, Legal issues in terms of liability, warranties, copyrights, trademarks, and trade names, Taxation issues, legal disputes, and domain name disputes, Encryption laws and what they mean, international issues, especially with regard to intellectual property and developing countries.

**Building online store with osCommerce:** Introduction to E-Commerce with osCommerce, Setting Up the Development Environment, How osCommerce Works, Basic Configuration, Working with Data, Customization, Taxes, Payments, and Shipping, Securing Your Store, Advanced Features, Tools, Tips, and Tricks, Deployment and Maintenance, Building Your Business, A case study on building online store with osCommerce.

**International trade:** Introduction, International trade theory, Barriers to trade, non-tariff barriers to trade, Foreign Exchange Exposure and Foreign Trade, foreign exchange market, Exchange rate, Traditional Foreign exchange Instruments: Currency swaps, Futures contracts. Export and Import: characteristics, types, Export Documentation: Objectives, Letter of Credit, Draft, Bill of Lading, Additional Documents.

**Modes of Operations:** Modes of operation in International Business and the Economic Environments facing businesses. Factors influencing the choice of a particular mode of international business. Various forms of contractual entry mode and challenges in choosing a particular mode. Importance of economic environments, Elements of the economic environment and its impact, Balance of Payments and Balance of Trade.

**Export Strategy and Export Marketing:** Marketing strategies, Export marketing plan, setting of marketing objectives, market research, product characteristics, export pricing, distribution channels, find export opportunities, deciding on exports marketing objectives, and preparing action plans to achieve the objectives

**Learning Objectives:** The learning objectives of this course are:

- a) To provide the terms and phrases associated with E-Commerce and International Trade.

- b) To introduce the importance of E-Commerce and International Trade.
- c) To impart the role of e-commerce and international trade in leather, leather products and footwear.
- d) To expose to various techniques employed in internet marketing, e-security and e-core values.
- e) To acquire knowledge on how to develop ecommerce online store, international trade and Export Strategy and Export Marketing.

**Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

a) **CLOs:** Upon completion of this course, students will be able to:

	<b>Course Learning Outcomes (CLOs)</b>	<b>Learning Level</b>
CLO1	Explain e-commerce, international trade, mode of operations, export strategy and export marketing and identify the most favorable way for their business.	C2, A2
CLO2	Identify various Business-to-business methods of payment, E-Security and E-Core Values and also recognize the ethical responsibilities in business.	C3, A3
CLO3	Analyze the value chain activities and supply chain management related to e-commerce and integrate teamwork in e-business.	C4, A5
CLO4	Create an e-commerce website to explore their theoretical knowledge on professional life.	C6
CLO5	Summarize and integrate the impact of e-commerce and international trade on global economy and environmental sustainability.	C6, A5

b) **Mapping of CLO with PLO**

<b>(CLOs)</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>
CLO1	3				2	2		
CLO2	3		3		3		2	
CLO3	3			2		2	2	3
CLO4	3					2	2	2
CLO5	3	3		2	2	2	2	

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

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

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
<b>CLO1</b>	Lecture, Multimedia presentation, demonstration and problem-based exercises	Group Presentation, In-course Exam; Final Exam
<b>CLO2</b>	Lecture, group discussion and problem-based exercises	Group Presentation, In-course Exam; Final Exam
<b>CLO3</b>	Lecture, guided reading and problem-based learning	Assignment, Group Presentation, In-course Exam, and Final Exam
<b>CLO4</b>	Lecture, multimedia presentation, group discussion, literature review, demonstration, and problem-based exercises	Group Presentation, In-course Exam, and Final Exam
<b>CLO5</b>	Lecture, group discussion, literature review, and problem-based exercises	Group Presentation, Assignment, In-course Exam, and Final Exam

**Learning Materials**

**i. Recommended Reading**

- Electronic Commerce: From Vision to Fulfillment by Elias M. Awad, Pearson College Div, 3rd edition.
- Building Online Stores with osCommerce: Professional Edition by David Mercer, PACKT Publishing, Mumbai.
- Francis Cherunilam, International Business, Text and Cases, Himalaya Publishing Company

**ii. Supplementary Readings**

- T. A. S. Balagopal: Export Management, Himalaya Publishing House
- D. C. Kapoor: Export Management, Vikas Publishing House Pvt Ltd

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

**Course Code:** 0723-LE-6000

**Course Title:** Thesis

**Credit Value:** 16.0

**Rationale of the Course**

Students for the M.Sc. in Leather Engineering have to complete a thesis that demonstrates their ability to conduct in-depth research into a specific area and how it will relate to their own academic backgrounds and professionalism. After completing the thesis, students will be able to think independently about specific problems and develop a research methodology.

## Course Content

**Preparation of Research Proposal:** Background, aim and objectives; review of relevant research; methodology; expected outcomes.

**Conformation of Research Proposal:** Proposal submission, presentation, and evaluation.

**Literature Review:** In-depth review of literature, data collection, research gap analysis.

**Experimental Work:** Materials and methods, method optimization, data generation and analysis, modelling and solution.

**Midterm Presentation and Thesis Paper Preparation:** Presentation on preliminary findings, drafting, review and editing of thesis paper, final thesis paper.

**Submission and Defense:** Final thesis paper submission and oral presentation.

**Course Objectives:** The course has been designed in a manner:

- a) To acquaint students with research culture, ethics, and research methodology.
- b) To make the students capable of thinking individually for creative development.
- c) To acquire skills for identifying and analyzing problems as well as devising innovative solutions.
- d) To develop effective communicative skills to present research outcomes.

## Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

a) **CLOs:** At the completion of this course students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Explain the background of the proposed research project and identify the research gaps.	C2, P2
CLO2	Develop research proposal and present it orally to disseminate the identified problem.	C3, A2, P3
CLO3	Analyze the existing methods and modify them based on the literature review.	C4, C5, A4, P4,
CLO4	Optimize new methods and generate, analyze, and modeling of relevant data based on the research outcomes.	C5, A4, P4
CLO5	Prepare a thesis paper with existing standards and present the results of the research through writing and orally.	C6, A5, P5

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

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

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

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

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Discussion and encouragement	Thesis defense and report evaluation by external as well as internal
CLO2	Discussion and encouragement	
CLO3	Self-study	
CLO4	Self-work	
CLO5	Lecture, discussion, demonstration, writing, final proof-reading	

**Learning Materials**

**i. Recommended Readings:**

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

**Course Code:** 0723-LE-6300

**Course Title:** Project

**Credit Value:** 4.0

**Rational of the Course**

M.Sc. in Leather Engineering candidates are expected to demonstrate their research prowess by conducting an in-depth study in a specific area of leather engineering, related to their professional and academic background. It is designed to develop research aptitude among the students. Candidates are expected to complete a project that demonstrates their ability to conduct in-depth investigation of a specific problem to find feasible solution.

### Course Content

During project work, experimental and theoretical investigation of various problems related to leather and allied industry, environmental science, nanotechnology, industrial engineering etc. will be carried out. The topic should provide an opportunity to the student in developing problem-solving skills, team work capability, argumentative skills, excellent writing ability, creativity and technical knowledge etc. Student is expected to complete the literature review/survey, selection of suitable methodology for conducting investigation and submission of an individual research proposal. At the end, student is expected to draw conclusion, prepare the dissertation, submit to the committee and appear for the project defense.

### Course Objectives

- a) To develop values and attitudes related to ethical research work among students.
- b) To ensure utilization of gathered knowledge in solving new real-life problems.
- c) Enhance the ability of the students to analyze and summarize information available in the literature
- d) Develop effective communicative skills to present research on leather and allied issues.

### Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

a) **CLOs:** At the completion of this course students will be able to:

	Course Learning Outcomes (CLOs)	Learning Level
CLO1	Identify, analyze and formulate a research problem and use extensive investigation for obtaining its solution.	C3, A2
CLO2	Explain the concept of ethics in research and impact of leather engineering solutions on society and environment.	C3
CLO3	Deliver designed project findings through oral presentations, demonstrations, and written technical report format.	C5, P3

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

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO-1	3					2	2	1
CLO-2	3	3	3			3	3	
CLO-3	3			3		2		

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

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

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
<b>CLO1</b>	Discussion, encouragement, self-study	Project defense and report evaluation by external as well as internal
<b>CLO2</b>	Lecture, discussion, demonstration	
<b>CLO3</b>	Writing and proofreading	

**Learning Materials**

**i Recommended Readings**

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

**Course Code:** 0723-LE-6302

**Course Title:** Internship

**Credit Value:** 2.0

**Rationale of the Course**

The course is designed to expose students to the working environment in the industry. The intensive training will enable students to understand the theories studied with more detailed and hands-on practice within a real job situation. Furthermore, students will learn how to do a work following the specified instructions coupled with their own technical knowledge, creativity and artistry.

**Course Content**

Factory inside out, material handling, pre-tanning, tanning, wet finishing, occupational safety and health (OSH) corporate social responsibility and waste management.

**Course Objectives:** The Course has been designed in a manner

- a) To expose students to the actual 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 process involved in leather manufacturing process
- c) To enhance industry- academia collaboration and co-operation.

**Course learning outcomes (CLOs) and mapping of CLOs with program learning outcomes (PLOs)**

a) **CLOs:** At the completion of this course students will be able to:

	<b>Course Learning Outcomes (CLOs)</b>	<b>Learning Level</b>
CLO1	Demonstrate acquired skills in the actual working environment.	C3, A3
CLO2	Analyze and evaluate layout, modern technologies, production process and waste management facilities.	C3, C4
CLO3	Summarize the collected data to generate technical reports.	C4

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

	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>
CLO-1	3				2	2	2	2
CLO-2	3	1				2	2	3
CLO-3	3			2				

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

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

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
<b>CLO1</b>	Lecture, display, demonstration, interactive discussion, self-study and motivation	Presentation and Viva voce Report Evaluation
<b>CLO2</b>	Lecture, display, demonstration, interactive discussion, self-study and motivation	
<b>CLO3</b>	Interactive discussion, lecture, motivation and self-study	

### **Learning Materials**

i. Recommended Readings

- Writing the Winning Thesis or Dissertation: A Step-by-Step Guide - By Allan A. Glatthorn, Randy L. Joyner.
- Why (and How) to Take a Plant Tour by David M. Upton and Stephen E. Macadam, published on Harvard Business Review



**Course Code:** 0723-LE-6304**Course Title:** Viva Voce

**Credit:** 1.0

### **Rational of the Course**

This course shall ensure that the students are able to present the knowledge, skills and practical experience they earned throughout the program to the panel of experts'/ Examination committee in the most effective way. The course builds students' confidence, analytical thinking, and communication skills. This course will assist by offering personalized one-on-one interactions, ensuring students are well-prepared for real world interactions, fostering academic success.

### **Course Contents**

It is based on all the courses the students have studied during the M. Sc. in Leather Engineering program.

**Course Objectives:** The learning objectives of this course are-

- a) To equip the students with analytical and evaluation abilities to respond to impromptu questions by the examination panel members.
- b) To train the students to face the expert panel and present the knowledge, skills and problems in well-organized way.

### **Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)**

a) **CLOs:** At the completion of this course students will be able to:

	<b>Course Learning Outcomes (CLOs)</b>	<b>Learning Level</b>
CLO1	Demonstrate the acquired knowledge and expertise in the interview panel.	C3, A3

### **b) Mapping of CLO with PLO**

<b>(CLOs)</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>
CLO1	3			3				

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

### **Learning Materials**

All the books of all the semesters and the journals, data bases, real problems of leather and allied sector.

## 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	Grade Description
80% or above	A+	4.00	<b>Grade A:</b> Excellent performance; all course objectives achieved; objectives met in a consistently outstanding manner.
75% to less than 80%	A	3.75	
70% to less than 75%	A-	3.50	
65% to less than 70%	B	3.25	<b>Grade B:</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 55%	C+	2.50	<b>Grade C:</b> 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	<b>Grade D:</b> Minimally acceptable performance; less than majority but more than the minimum required course objectives achieved.
Less than 40%	F	0.00	<b>Grade F:</b> 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. 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.

**4. Course Withdrawal:** If a student is unable to complete any semester (Semester-I &/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 2.50. A student can't earn the degree if they have any incomplete or failed courses.

**6. Retake:** A student will be allowed maximum of one chance to clear F grade/grades with the immediate next. 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<sup>+</sup>.

**7. Grade Improvement:** A student may sit for improvement exam for courses where grade obtained is less than or equal to C<sup>+</sup> (grade point-2.50) and the best grade that a student can be awarded is B<sup>+</sup>. 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 one time. 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 will be dropped out of the program.

### Course Learning Outcomes (CLOs) Attainment Report

Course Learning Outcomes (CLOs)	Assessment										
	SFE (Summative) 80%				CA (Formative) 20%						CLO Attainment (%)
	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)+.....