Rules and Guidelines
for
The B.Sc. and M.Sc. Engineering in Leather Engineering Programs

Institute of Leather Engineering and Technology
University of Dhaka

Dhaka-1209, Bangladesh

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Contact : Office of the Director

Institute of Leather Engineering and Technology

University of Dhaka, Dhaka-1209

Email : ilet@du.ac.bd

Foreword

The Institute of Leather Engineering and Technology (ILET), University of Dhaka offers B.Sc. Engineering (Leather Engineering, Footwear Engineering and Leather Products Engineering) and M.Sc. Engineering (Leather Engineering, Footwear Engineering and Leather Products Engineering) degrees under certain rules and guidelines. These Rules and Guidelines of the Institute of Leather Engineering and Technology have been approved by the academic committee, Board of Governors (BoG) meeting, and finally have been approved by the Academic Council of the University of Dhaka. I wish that respective faculty members as well as students will be benefited from this handbook.

Finally, I would like to express my sincerest gratitude and thanks to my esteemed colleagues, BoG members, industry personnel for their support and cooperation in successful compilation of this handbook.

Professor Dr. Mohammed Mizanur Rahman
Director
Institute of Leather Engineering and Technology
University of Dhaka, Dhaka-1209, Bangladesh

Institute of Leather Engineering and Technology, University of Dhaka

Table of Contents

SL	Details		Page
1.	About the Institute		3
2.	Undergraduate Degrees offered by the Institute		4
3.	Graduate Degrees offered by the Institute		4
4.	Course Credit Summary		4
5.	Major Research Area		4
6.	Rules and Guidelines for B.Sc. Engineering in Leather Engineering Program		5
	6.1	The B.Sc. Engineering in Leather Engineering Program	5
	6.2	Admission	5
	6.3	Definition of Credit	5
	6.4	Credit Requirements for the B.Sc. Engineering Program	5
	6.5	Grades and Grade Points	5
	6.6	Marks Distribution for a Course	5
	6.7	Exam Committee Formation	6
	6.8	Evaluation of the Courses	6
	6.9	Requirements to Sit for Course Final Exam	7
	6.10	Promotion to the Next Academic Year	7
	6.11	Requirements for the Award of the B.Sc. Engineering in Leather Engineering Degree	7
	6.12	Tabulations	7
	6.13	Improvement Examination	7
	6.14	Re-admission and Dropout	8
	6.15	Director's Award	8
	6.16	Other General Regulations	8
7	Rules and Guidelines for M.Sc. Engineering Program		8
	7.1	The Master of Leather Engineering Program	8
	7.2	Admission	8
	7.3	Definition of Credit	8
	7.4	Credit Requirements for the Master of Engineering Degree	8
	7.5	Grades and Grade Points	8
	7.6	Marks Distribution for a Course	9
	7.7	Exam Committee Formation	9
	7.8	Evaluation of the Courses	9
	7.9	Requirements to Sit for Course Final Exam	10
	7.10	Duration of Exam	10
	7.11	Requirements for the Award of the M.Sc. Engineering in Leather Engineering Degree	10
	7.12	Tabulations	10
	7.13	Improvement/Retake Examination	11
	7.14	Re-admission and Dropout	11
	7.15	Other General Regulations	11

1. About the Institute

The Institute of Leather Engineering and Technology (ILET), University of Dhaka was established on 20 June 2011 by merger and integration of the erstwhile "Bangladesh College of Leather Technology" of the Directorate of Technical Education, the ministry of education, the government of Bangladesh with the University of Dhaka with all its assets, funds, rights, interests, properties, etc. and all its employees. Now, the Institute of Leather Engineering and Technology is functioning as an integral part institution of the University of Dhaka and affiliated with Faculty of Engineering and Technology.

This institute has a glorious history which was officially inaugurated on 15th August 1947, just after the end of British rule, by the Ministry of Industry with the name of "East Bengal Tanning Institute" for the development of the tanning industry. The institute started its journey on 10 June 1949 and academic activities were commenced from the year 1952 after the provision of infrastructure. Later, the name of the institute was substituted with "Pakistan Leather Technology". In 1967, the institute was transferred to the Ministry of Education and supervised under the administrative control of the technical education board to disseminate better academic and educational facilities. After liberation, the institute was renamed as the "Bangladesh College of Leather Technology" and was providing diploma, certificate, and artisan level education on leather technology until 1979. Then the government of Bangladesh started a graduate course in B.Sc. Engineering in Leather Technology under the University of Dhaka from the 1979-1980 academic session. Later, on 20 June 2011, the "Bangladesh College of Leather Technology" was handed over to the University of Dhaka with its resource and manpower and started as a distinct institute of the University of Dhaka.

Under the University of Dhaka, the institute has been commenced its journey with the following objectives–

(a) to produce qualified manpower and skills in the field of tannery, footwear and leather goods sector.

(b) to provide quality education leading to Bachelor of Science (B. Sc.), Master of Science (M.Sc.), Master of Philosophy (M.Phil), Doctor of Philosophy (Ph.D.) and Diploma degrees in the Leather Engineering and Technology and related field;

(c) to initiate, organize and undertake research in the field of Leather Engineering and Technology;

(d) to provide in-plant and industry-oriented short- and long-term training programs on various fields of leather, footwear, and leather products;

(e) to provide quality control and laboratory facilities for testing raw materials, consumable, and finished goods;

Institute of Leather Engineering and Technology, University of Dhaka

(f) to organize seminars, conferences, workshops, exhibitions and other events to disseminate knowledge about cutting-edge technology for raw hides/skins processing and the development of footwear and leather product;

(g) to provide consultancy and advisory services to institutions, NGOs, private and public sector corporations, who seek such assistance;

(h) to establish link-programs and research collaborations with various institutions/ organizations within the country and abroad.

Administration and Management of ILET

The ILET is run by the seventeenth statutes under President's order of 1973 and its budget is a part of the university budget. The Vice-Chancellor is the chief executive of the Institute. The Director is the administrative head of the Institute. Administration and Management of the Institute is vested in the following bodies, subject to the approval of their actions by the Syndicate and or Academic Council of the University, as the case may be:

a. The Board of Governors (BoG), of which the Vice-Chancellor is the Chairman;
b. The Selection Board for Professorships and Associate Professorships of which the Vice-Chancellor is the Chairman;
c. The Selection Board for teaching Posts other than Professorships and Associate Professorships of which the Pro-Vice-Chancellor (Academic) is the Chairman;
d. The Selection Board for appointments to non-teaching posts not below the rank of Section Officers of which the Pro-Vice-Chancellor (Administration) is the Chairman;
e. The Selection Board below the rank of Section Officer of which the Director is the Chairman;
f. The Coordination and Development (C&D) Committee, of which the Director is the Chairman;
g. The Academic Committee, of which the Director is the Chairman.

At present, the programs are offered by the Institute are as follows with the latest curriculum based on the need of modern tanneries and leather products industries:

1. B.Sc. Engineering in Leather Engineering (4 years; 8 semesters)
2. B.Sc. Engineering in Footwear Engineering (4 years; 8 semesters)
3. B.Sc. Engineering in Leather Products Engineering (4 years; 8 semesters)
4. M.Sc. Engineering in Leather Engineering (1.5 years; 3 semesters)
5. M.Sc. Engineering in Footwear Engineering (1.5 years; 3 semesters)
6. M.Sc. Engineering in Leather Products Engineering (1.5 years; 3 semesters)

ILET aims at creating efficient human resources in the fields of the leather industry, the leather products industry, and the footwear industry. The institute provides its

undergraduate students with the opportunity to participate in industrial training where students are attached to different companies and they relate theories, concepts and techniques learned from the academic courses with real-life experiences. At the end of the final year, our graduate students are involved in project work, report writing, and presentation. The master's students involve in research and writing up a thesis vigorously. We are committed to providing our students, the very best education, and training opportunities designed to enable each and every student to make the best use of their potentials and achieve their ambitions.

ILET has an interdisciplinary team of faculty members having a strong research background. The faculty members have expertise in tannery effluent treatment, leather processing technologies, materials science, environmental chemistry, medicinal chemistry, organometallic chemistry, analytical chemistry and synthetic organic chemistry, nanotechnology for leather engineering, cleaner technologies, product design and development, circular economy, sustainability, supply chain risk management, industry 4.0, and foot comfort. We also conduct outreach activities to disseminate the industrial-scale solutions beyond the University of Dhaka. We provide the expertise needed for pre- and post-implementation assessment of projects, programs, and policies regarding the Leather industry, the Leather products industry, and the Footwear industry.

2. Undergraduate Degrees Offered by the Institute

a) B.Sc. Engineering in Leather Engineering
b) B.Sc. Engineering in Footwear Engineering
c) B.Sc. Engineering in Leather Products Engineering

3. Graduate Degrees Offered by the Institute

a) M.Sc. Engineering in Leather Engineering
b) M.Sc. Engineering in Footwear Engineering
c) M.Sc. Engineering in Leather Products Engineering

Institute of Leather Engineering and Technology, University of Dhaka

4. Course Credit Summary

(a) For B.Sc. Engineering Degree

Summary (B.Sc. Engineering in Leather Engineering)					
Sl.	**Course Type**		**Credit**		
			Theory	**Lab**	**Total**
1.	Basic Sciences	Mathematics	12	-	37.5
		Physics	3	1.5	
		Chemistry	15	6.0	
2.	Allied Engineering	Materials Science and Engg. (3)/ Mechanical Engineering (4.5)/ EEE (3)/ CSE (4.5)/ Engineering Drawing (1.5)	12	4.5	16.5
3.	Humanities	Employability Skill (3), Sociology (3)	3	3	6.0
4.	Business Studies	Supply Chain Management for Leather and Leather Products (3), Total Quality Management (TQM) for Leather and Leather Products (3), Cost and Management Accounting (3)	9	-	9.0
5.	Common Courses	Polymer Science and Engineering (4.5)/ Environmental Science & Engineering (4.5)/	6	3.0	9.0
6.	Core Courses	**Core Subjects of LE**	**54**	**23.0**	**88.0**
		Project (3)/ Internship (3)/ Viva (2)/ Field Tour (3)	-	**11.0**	
7.	Grand Total		**114**	**52**	**166.0**

(b) For M.Sc. Engineering Degree

SL. No.	Title	Credit
		M.Sc. Engg.
1	Total Credits	36
2	Credits for theory courses	21
3	Credits for thesis	15

5. Major Research Areas

Tannery Effluent Treatment, Leather Processing Technologies, Materials Science, Environmental Chemistry, Medicinal Chemistry, Organometallic Chemistry, Analytical Chemistry and Synthetic Organic Chemistry, Nanotechnology for Leather Engineering, Cleaner Technologies, Product Design and Development, Circular Economy, Sustainability, Supply Chain Risk Management, Industry 4.0, Foot Comfort etc.

6. Rules and Guidelines for B.Sc. Engineering in Leather Engineering

The rules and guidelines of the B.Sc. Engineering in Leather Engineering have been approved by the Academic Committee meeting dated 29th October 2020, BoG meeting dated 11th November 2020 and finally have been approved by the Academic Council dated 10th December 2020. It will be applicable from Session 2020-2021 and onward.

6.1 The B.Sc. Engineering in Leather Engineering

The B.Sc. Engineering in Leather Engineering program in the Institute of Leather Engineering and Technology, University of Dhaka is a four academic year program. The program comprises eight semesters, each having duration of six academic calendar months to be distributed as follows:

(a) Classes : Fifteen active weeks
(b) Preparatory Leave : Maximum two weeks
(c) Semester Final Exam : Two-three weeks
(d) Vacation : Only the usual vacation of Dhaka University's will be applicable
(e) Result publication : Within two months from the last Date of theory exam is desirable

6.2 Admission

Students will be admitted to the institute as per Dhaka University rules. Each year application requirements will be defined by the Central Admission Committee of the University of Dhaka. Institute can define specific requirements of subject-wise score in admission test with the approval of the Central Admission Committee.

6.3 Definition of Credit

(i) For theoretical courses fifteen class-hour of fifty minutes each is defined as one credit.
(ii) For practical or lab courses thirty lab hours work is defined as one credit.

6.4 Credit Requirements for the B.Sc. Engineering Program

i. Total credits : 166
ii. Credits for core courses (theory) : 54
iii. Credits for practical courses : 41
iv. Credits for basic sciences (mathematics, statistics, physics & chemistry) (theory) : 30
v. Credit for allied engineering and other common courses (theory) : 18

Institute of Leather Engineering and Technology, University of Dhaka

vi. Credits for general education (theory) : 12
vii. Credits for project : 3
viii. Credits for internship & field tour : 6
ix. Credit for course viva : 2

6.5 Grades and Grade Points

The University Grants Commission (UGC) of Bangladesh approved grading system applies to calculate grade and grade points. Grades and grade points will be awarded on the basis of marks obtained in the written, oral and practical Exam according to the following table

Marks	Letter Grade	Grade Point
80% and Above	A+	4.00
75% to < 80%	A	3.75
70% to < 75%	A-	3.50
65% to < 70%	B+	3.25
60% to < 65%	B	3.00
55% to < 60%	B-	2.75
50% to < 55%	C+	2.50
45% to < 50%	C	2.25
40% to < 45%	D	2.00
Less Than 40%	F	0.00
	I	Incomplete
	W	Withdrawn

(a) Only "D" or higher grade will be counted as credits earned by a student.
(b) A student obtaining "F" grade in any course will not be awarded degree.
(c) CGPA (Cumulative Grade Point Average) is the weighted average of the grade points obtained by a student in all the courses. CGPA will be calculated according to be following formula:

$$\text{CGPA} = \frac{\sum(\text{grade points in a course} \times \text{credits for the course})}{\text{total credits taken}}$$

(d) In the tabulation process, only the total marks of a student in any course will be rounded-up to next number and the published result of the program will show only the grades earned and the Cumulative Grade Point Average (CGPA) at the end of each semester.

6.6 Marks Distribution for a Course:

(a) Theory Course

(i) Attendance 10%

(ii) In-course exam 30%
(iii) Final exam 60%
Total Marks 100%

(b) Lab Course

(i) Lab attendance : 20%
(ii) Continuous evaluation : 40%
(iii) Final exam : 40%
Total Marks 100%

(c) Project

(i). Defense : 40%
(ii) Project Report : 60%
Total Marks 100%

(d) Guideline for Attendance Mark

Attendance (%)	Marks (10)
90 and above	10
85 to 89	08
80 to 84	06
75 to 79	04
60 to 74	02
Less than 60	00

6.7 Exam Committee Formation

(a) At the beginning of each academic semester/session, an exam committee shall be formed for that semester/session by the academic committee of the institute. Chairman of the exam committee will act as a course coordinator for that semester/session. The role of a course coordinator is to monitor the academic activities and report to the director of the institute to avoid any unexpected situation.

(b) The exam committee will consist of four members proposed by the academic committee of the respective program.

(c) The committee members are a chairman, two internal members from the institute and one external member outside of the institute.

(d) The exam committee will be responsible for all exam related activities as per University rules.

Institute of Leather Engineering and Technology, University of Dhaka

6.8 Evaluation of the Courses

The performance of a student in a course will be evaluated in the following ways:

(a) For a theory course the evaluation will be made on the basis of attendance, quiz/assignment/presentation, in-course exam and final exam.

(b) For any courses attendance, quiz/assignment/presentation, in- course exam will be evaluated by the course teacher/s and the result must be submitted to the exam committee and controller of exam before commencement to the semester final examination.

(c) The percentage of attendance of students for each course (according to the format supplied by the Director) along with the attendance sheet must be submitted to the Director of the institute before commence to the semester final examination.

(d) The in-course exam scripts must be shown to students before the last class of a semester.

(e) If more than one in-course exam is taken final mark will be calculated by averaging all of them **(best one will not be allowed).**

(f) For theory course final exams, generally there will be two examiners: course teacher will be the first examiner and the second examiner will be within the institute or from a relevant department of the University of Dhaka. If a suitable examiner is not found from the University of Dhaka, a second examiner may be appointed from other universities with prior permission from the Vice Chancellor.

(g) (i) The answer scripts of final exam will be evaluated by two examiners and the average mark will be considered as the mark obtained, if the difference of two examiner marks not exceeded 20%.

(ii) In case of a difference of marks between the two examiners is more than 20% then the script will be evaluated by a third examiner. Marks of nearest two examiners will be taken for average.

(iii) If the differences of marks of third examiner from the first and second examiner become equal then average of three examiners marks will be obtained mark.

(h) The assessment of laboratory /practical / field course will be made by observing overall performance of a student during practical (continuous

evaluation), attendance, viva-voce, assignments and evaluation of lab final exam (set by the Institute).

(i) For fourth year, project evaluation will be made on the basis of presentation on project defense and project report.

(j) For field study evaluation will be made on the basis of written examination or presentation on that field study and field study report.

6.9 Requirements to Sit for Course Final Exam

(i) Students having 75% or more attendance on average is eligible to appear in the semester final Exam.

(ii) Student having average 60-74% attendance will be allowed to sit for the exam with a fine Tk. 1000.00 (one thousand) in the University central account. In addition to usual fees, institute may include additional fine as per the decision of the Academic Committee.

(iii) Student having average attendance below 60% will not be allowed to sit for the semester final Exam but may seek re-admission in the program.

(iv) The semester final exam will be arranged centrally by the controller of examination of the University of Dhaka.

(v) The duration of theory course final exams will be as follows:

Credit	Duration of Exam
3 credits course	3 hours

(vi) Duration of lab exam will be defined by the institute.

6.10 Promotion to the Next Academic Year

A student has to attend courses required for a particular semester, appeared at the annual exams and scored a minimum specified CGPA for promotion to the next year.

Promotion to the next year will be given if a student scores minimum CGPA as follows:

Year Description	CGPA
1st year to 2nd year	CGPA: 2.00
2nd year to 3rd year	CGPA: 2.25
3rd year to 4th year	CGPA: 2.50

Institute of Leather Engineering and Technology, University of Dhaka

6.11 Requirements for the Award of the B.Sc. Engineering in Leather Engineering Degree

(a) The student Must earn required credits in a maximum period of six academic years starting from the date of admission at 1st year 1st semester.

(b) The student Must obtain CGPA of at least 2.5 out of 4.00 to achieve the B.Sc. Engineering in Leather Engineering degree without "F" grade in any course.

6.12 Tabulations

(a) The exam committee will appoint two tabulators.

(b) Tabulators will receive marks of all courses from the chairman of the Exam committee.

(c) The two tabulators will independently prepare the tabulation sheets and compare before submitting it to the office of the Controller of Examination through the Chairman of Exam committee.

6.13 Improvement Examination

(a) A student will be allowed a single earliest available chance to clear "F" grade/grades complying with the time requirement for the degree. A student will not be allowed for grade improvement if he or she passes and the final semester result is published.

(b) A student may sit for improvement exam for courses where grade obtained is less than or equal to "C+" (C plus) and the best grade that a student can be awarded is "B+" (B plus). However, if the grade is not improved the previous grade will remain valid.

(c) Improvement exam for all odd semesters will always be held with immediate next even semester and the same exam committee will conduct the improvement exam (for example, 1st semester improvement exam will be held on immediate 2nd semester, 3rd semester in improvement exam will be held on immediate 4th semester, 5th semester improvement exam will be held on immediate 6th semester, 7th semester improvement exam will be held on immediate 8th semester. Improvement exam for all even semesters will always be held with immediate next academic session or batch.

(d) In case of improvement exam in addition to usual fees a fine will be charged by the institute through its Academic Committee

6.14 Re-admission and Dropout

(a) A student may be allowed re-admission for a maximum of two times to complete the B.Sc. Engineering in Leather Engineering program.

(b) A student may seek re-admission provided he or she has at least 30% (thirty percent) attendance in the previous semester or year.

(c) A student who is unable to get minimum required CGPA even after taking re-admission twice will be dropped out from the academic program.

6.15 Director's Award

In recognition of excellent academic performance students may be given Director's Merit Award for every batch after completion of the B.Sc. Engineering in Leather Engineering program as per following criteria.

(a) An awardee must not have appeared in any improvement exam during his or her study period.

(b) An awardee must have CGPA 3.75 or above.

(c) However, the number of awardees of each group/discipline will not exceed two. In case of equal CGPA the final semester CGPA will be considered to break the tie.

6.16 Other General Regulations

For any matter not covered in the above guidelines, existing rules of the University of Dhaka will be applicable.

Disciplinary and punishable actions will be applied according to the existing rules of the University of Dhaka.

Institute of Leather Engineering and Technology, University of Dhaka

7. Rules and Guidelines for M.Sc. Engineering in Leather Engineering Program

The rules and guidelines of the M.Sc. Engineering in Leather Engineering have been approved by the Academic Committee meeting dated 29th October 2020, BoG meeting dated 11th November 2020 and finally have been approved by the Academic Council dated 10th December 2020. It will be effective from Session 2020-2021 and onward.

7.1 The Master of Leather Engineering Program

The Master of Leather Engineering program in the Institute of Leather Engineering and Technology, comprises three semesters, each having duration of six academic calendar months to be distributed as follows:

(a) **Classes** : Fifteen active weeks
(b) **Preparatory Leave** : Maximum two weeks
(c) **Semester Final Exam** : Two weeks
(d) **Vacation** : Only the usual Dhaka University's vacation will be applicable
(e) **Result publications** : Within two months from the last theory exam date of thesis defense date

7.2 Admission

Students will be admitted to the institute as per University rules.

7.3 Definition of Credit

For theoretical courses fifteen class-hour of fifty minutes each is defined as one credit.

7.4 Credit Requirements for the Master of Engineering Degree

(a) Total Credits : 36
(b) Credits for theory courses : 21
(c) Credit for thesis : 15

7.5 Grades and Grade Points

The University Grants Commission (UGC) of Bangladesh approved grading system applies to calculate grade and grade points. Grades and grade points will be calculated on the basis of marks obtained in any type of examination.

Marks	Letter Grade	Grade Point
80% and Above	A+	4.00
75% to < 80%	A	3.75

70% to < 75%	A-	3.50
65% to < 70%	B+	3.25
60% to < 65%	B	3.00
55% to < 60%	B-	2.75
50% to < 55%	C+	2.50
45% to < 50%	C	2.25
40% to < 45%	D	2.00
Less Than 40%	F	0.00
	I	Incomplete
	W	Withdrawn

(a) Only "D" or higher grade will be counted as credits earned by a student.

(b) A student obtaining "F" grade in any course will not be awarded degree.

(c) CGPA (Cumulative Grade Point Average) is the weighted average of the grade points obtained by a student in all the courses. CGPA will be calculated according to be following formula:

$$\text{CGPA} = \frac{\Sigma(\text{grade points in a course} \times \text{credits for the course})}{\text{total credits taken}}$$

(d) In the tabulation process, only the total marks of a student in any course will be rounded-up to next number and the published result of the program will show only the grades earned and the Cumulative Grade Point Average (CGPA) at the end of each semester.

7.6 Marks Distribution for a Course

(a) Theory course

(i)	Attendance	10%
(ii)	In-course exam	30%
(iii)	Final exam	60%
	Total Marks	100

(b) Thesis

(i)	Defense	: 40%
(ii)	Report Evaluation	: 60%
	Total Marks	100

Institute of Leather Engineering and Technology, University of Dhaka

(c) Guidelines for Attendance Marks

Attendance (%)	Marks (10)
90 and above	10
85 to 89	8
80 to 84	6
75 to 79	4
60 to 74	2
Less than 60	00

7.7 Exam Committee Formation

(a) At the beginning of each academic semester/session, an exam committee shall be formed for that semester/session by the academic committee of the Institute. Chairman of the exam committee will act as a course coordinator for that semester/session. The role of a course coordinator is to monitor the academic activities and report to the Director of the Institute to avoid any unexpected situation.

(b) The exam committee will consist of four members proposed by the Academic Committee of the Institute.

(c) The committee members are a Chairman, two internal members from the Institute and one external member outside of the Institute.
The exam committee will manage or coordinate all exam related activities as per university rules.

7.8 Evaluation of the Courses

a. Theory Courses Evaluation

The performance of a student in a theory course will be evaluated in the following ways:

(i) For a theory course the evaluation will be made on the basis of attendances / quiz/assignment/presentation, in-course exam and final exam.

(ii) For any courses attendance, quiz/assignment/presentation, in- course exam will be evaluated by the course teacher and the result must be submitted to the exam committee and controller of exam before commencement of semester final examination.

(iii) The percentage of attendance of students for each course (according to the format supplied by the Director) along with the attendance sheet must be submitted to the Director of the Institute before commence to the semester final Exam.

(iv) The in-course exam scripts must be shown to students before the last class of the semester.

(v) If more than one in-course exam is taken the in course mark will be calculated by averaging all of them (**best one will not be allowed**).

(vi) For theory courses final exam scripts generally evaluate by two examiners: course teacher will be the first examiner and the second examiner will be within the Institute or from a relevant department of University of Dhaka. If a suitable examiner is not found from University of Dhaka, a second examiner may be appointed from other universities with the prior permission from the Vice Chancellor.

(vii) The average mark of two examiners will be considered as the mark obtained if the difference of theirs marks is less than or equal to 20%.

- In case of a difference of marks between the two examiners is more than 20% the exam script will be evaluated by a third examiner. Marks of nearest two examiners will be taken for average.
- If the differences of marks of third examiner from the first and second examiner become equal then mark obtained will be calculated from average of three examiners.

b. Thesis evaluation

Thesis will be coordinated by the examination committee. Examination committee may include external expert to assess the thesis. Thesis will be evaluated on the basis of 100% marks where there will be thesis defense (40% marks) and thesis report will evaluation (60% marks). Evaluation will be done in following ways:

(i) Pre-defense (If may or may not)

The student will defense his or her thesis work which is approved by the respective supervisor. The examination committee can accept or reject or conditionally accept the thesis for further process.

(ii) Final defense

A student will submit his or her thesis or revised thesis which was accepted or conditionally accepted in the pre-defense (if happened). The exam committee will announce specific date to defense his or her thesis and he or she has to defense on that date.

(iii) Thesis report evaluation

Two external examiners will evaluate the thesis report and their average mark will be considered. In case of a difference of marks between the two examiners

Institute of Leather Engineering and Technology, University of Dhaka

is more than 20% the thesis will be evaluated by a third examiner. Marks of nearest two examiners will be taken for average. If difference is equal, then the average of three marks will be considered.

7.9 Requirements to Sit for Course Final Exam

(i) A student having 75% or more attendance on average is eligible to appear in the semester final Exam.

(ii) Student having average 60-74% attendance will be allowed to sit for the exam with a fine Tk. 1000.00 (one thousand) in the University central account. In addition to usual fees, institute may fine according to the decision of the Academic Committee Meeting.

(iii) A student having an average attendance below 60% will not be allowed to sit for the semester final exam but may seek re- admission in the program.

(iv) In case of open credit system all the above evaluation will done course wise.

7.10 Duration of Exam

(i) The semester final exam will be arranged centrally by the Controller of Examination of the University of Dhaka.

(ii) The duration of theoretical course final Exams will be as follows:

Credit	Duration of Exam
3 credits course	3 hours

7.11 Requirements for the Award of the M.Sc. Engineering in Leather Engineering Degree

(a) A student must earn required credits in a maximum period of three continuous semester starting from the date of admission in Master in 1st semester.

(b) A student must obtain CGPA of at least 2.5 to achieve the M.Sc. Engineering degree without "F" grade in any course to fulfill required credits.

(c) The student can re-admit for another three semesters.

7.12 Tabulations

(a) The exam committee will appoint two tabulators.

(b) Tabulators will receive marks of all courses from the Chairman of the Exam Committee.

(c) The two tabulators independently prepare the tabulation sheets and compare

Institute of Leather Engineering and Technology, University of Dhaka

before submitting to office of the Controller of Examination through the Chairman of Exam Committee.

7.13 Improvement/Retake Examination

(a) A student will be allowed a single earliest available chance to clear "F" grade/grades complying with the time requirement for the degree. A student will not be allowed for grade improvement if he or she passes and the final semester result is published.

(b) A student may sit for improvement exam for courses where grade obtained is less than or equal to "C+" (C plus) and the best grade that a student can be awarded is "B+" (B plus). However, if the grade is not improved the previous grade will remain valid.

(c) In addition to usual fees, institute may fine according to the decision of the Academic Committee Meeting.

7.14 Re-admission and Dropout

(a) A student may be allowed re-admission for one time.

(b) A student may seek re-admission provided he or she has at least 30% (thirty percentages) attendance in the previous semester or year.

(c) A student who is unable to get minimum required CGPA even after taking re-admission will be dropped out from the academic program.

(d) In case of rejection of a thesis or "F" grade in a thesis the student can retain his or her theory course mark for a period one semester.

7.15 Other General Regulations

(a) For any matter not covered in the above guidelines, existing rules of University of Dhaka will be applicable.

(b) Disciplinary and punishable actions will be applied according to the existing rules of the University of Dhaka.

Institute of Leather Engineering and Technology, University of Dhaka

B.Sc. Engineering in Leather Engineering (B.Sc. Engg. in LE)
Semester Wise Course Outline

Year-1, Semester-1

Course Code	Course Name	Credit	
		Theory	Lab
LE-101	Fundamentals of Leather Engineering	3	
MTH-101	Algebra and Geometry	3	
PHY-101	Engineering Physics	3	
CHM-101	Inorganic Chemistry	3	
CHM-102	Physical Chemistry	3	
CHM-103	Inorganic and Physical Chemistry Lab		1.5
ME-101	Engineering Drawing		1.5
HUM-101	Employability Skills-I		1.5
LE-102	Field Tour		1.0
	Total	**15**	**5.5**
	Semester Total	**20.5**	

Year-1, Semester-2

Course Code	Course Name	Credit	
		Theory	Lab
LE-103	Leather Processing-I	3	
LE-104	Leather Processing-I Lab		1.5
CSE-101	Fundamentals of Computer and Information Technology	3	
CSE-102	Fundamentals of Computer and Information Technology Lab		1.5
MTH-102	Calculus	3	
CHM-104	Organic and Collagen Chemistry	3	
CHM-105	Organic and Collagen Chemistry Lab		1.5
PSE-101	Polymer Science and Engineering	3	
PSE-102	Polymer Science and Engineering Lab		1.5
	Total	**15**	**6.0**
	Semester Total	**21.0**	

Year-2, Semester-1

Course Code	Course Name	Credit	
		Theory	Lab
LE-201	Leather Processing-II (Mineral)	3	
LE-202	Leather Processing-II Lab		1.5
LE-203	Leather Biotechnology	3	
LE-204	Leather Biotechnology Lab		1.5
MTH-201	Differential Equation and Numerical Methods	3	
CHM-201	Analytical Chemistry for Leather and Leather Products	3	
CHM-202	Analytical Chemistry Lab		1.5
EEE-201	Fundamentals of Electrical and Electronics Engineering	3	
PHY-201	Physics and Electronics Lab		1.5
	Total	**15**	**6.0**
	Semester Total	**21.0**	

Year 2, Semester-2

Course Code	Course Name	Credit	
		Theory	Lab
LE-205	Leather Processing-III (Non-Mineral)	3	
LE-206	Leather Processing-III Lab		1.5
LE-207	Dyeing and Finishing-I	3	
LE-208	Dyeing and Finishing Lab		1.5
CHM-203	Instrumental Analysis of Leather and Leather Products	3	
CHM-204	Chemical Analysis of Leather and Leather Products Lab		1.5
MTH-202	Probability and Statistics	3	
MSE-201	Fundamentals of Materials Science and Engineering	3	
LE-209	Field Tour		1.0
	Total	**15**	**5.5**
	Semester Total	**20.5**	

Institute of Leather Engineering and Technology, University of Dhaka

Year-3, Semester-1			
Course Code	**Course Name**	**Credit**	
		Theory	**Lab**
LE-301	Post-Tanning and Finishing	3	
LE-302	Leather Finishing-I Lab		1.5
LE-303	Fundamentals of Leather Products Manufacturing	3	
LE-304	Leather Products Manufacturing Lab		1.5
ME-301	Fundamentals of Mechanical Engineering	3	
ME-302	Mechanical Workshop		1.5
ENV-301	Environmental Science and Engineering	3	
ENV-302	Environmental Science and Engineering Lab		1.5
HUM-301	Industrial Sociology	3	
LE-305	Field Tour		1.0
	Total	**15**	**7.0**
	Semester Total	**22.0**	

Year- 3, Semester-2			
Course Code	**Course Name**	**Credit**	
		Theory	**Lab**
LE-306	Eco-Friendly Leather Processing	3	
LE-307	Eco-Friendly Leather Processing Lab		1.5
LE-308	Quality Assurance of Leather and Allied Materials	3	
LE-309	Quality Assurance of Leather and Allied Materials Lab		1.5
LE-310	Fundamentals of Footwear Manufacturing	3	
LE-311	Footwear Manufacturing Lab		1.5
LE-312	Dyeing and Finishing-II	3	
LE-313	Leather Finishing-II Lab		1.5
BUS-301	Supply Chain Management for Leather and Leather Products	3	
	Total	**15**	**6.0**
	Semester Total	**21.0**	

Year-4, Semester-1			
Course Code	**Course Name**	**Credit**	
		Theory	**Lab**
LE-401	Leather Processing Chemicals	3	
LE-402	Products Quality Analysis Lab		1.5
LE-403	Tannery Solid Waste Management	3	
LE-404	Lean Manufacturing of Leather and Leather Products	3	
LE-405	Production Planning and Control for Leather and Leather Products	3	
LE-406	Application of Computer in Leather Products Design		2.0
LE-407	Industrial Utility and Maintenance	3	
LE-408	Maintenance Workshop		1.5
HUM-401	Employability Skills-II		1.5
	Total	**15**	**6.5**
	Semester Total	**21.5**	

Year-4, Semester-2			
Course Code	**Course Name**	**Credit**	
		Theory	**Lab**
LE-409	Tannery Wastewater Management	3	
LE-410	Wastewater and Solid Waste Management Lab		1.5
BUS-401	Total Quality Management (TQM) for Leather and Leather Products	3	
BUS-402	Cost and Management Accounting	3	
LE-411	Project		3.0
LE-412	Comprehensive Viva		2.0
LE-413	Internship		3.0
	Total	**9**	**9.5**
	Semester Total	**18.5**	

Total Credit: 166.0

Institute of Leather Engineering and Technology, University of Dhaka

First Year (1st Semester)

LE-101: Fundamentals of Leather Engineering		
Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives: The aims of this course are:

- To introduce the fundamentals of leather manufacture.
- To provide basic concepts of raw hide and skin processes in leather engineering.
- To deliver knowledge about several types of footwear with distinct features.
- To provide an overview of human foot functions and foot anatomy.
- To make the students to gain fundamentals knowledge about the leather products.

Course Contents:

Introduction and historical background of leather making: Definition of hides, skins and leather, define the region of hides and skin, types and sources of hides and skins, world supply position, supply position in Bangladesh.

Defects of hides and skins: Definition, pre-mortem and post-mortem defects of hide and skin and their effect on leather, methods of identification of defects, common defects of hides and skins in Bangladesh and their remedies.

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

Skin structure and its components: Hierarchy of collagen structure; amino acid sequence, α-helix, Triple Helix, Isoelectric point, structure of fibrous and globular proteins of connective tissues like keratin, reticulin and elastin; albumin, globulin, mucine, etc. **Histological structure**; Epidermis, Grain, Junction, Corium, Flesh layer, Flesh. Skin Feature; Hair or wool, Follicles, Erector Pill Muscle, Sweat Glands, Veins and arteries, Elastin. Non-structural components; Glycosaminoglycans (GAGs), Hyaluronic acid, Dermatan Sulfate, chondroitin sulfate A and C, Melanin.

Natural and Man-made polymer: Natural; Vegetable (cellulose); Cotton, Jute, etc. Animal (protein); leather, wool, virgin wool, silk, hair etc. Mineral; asbestos. Man-made; Cellulosic; viscose, acetate etc. Rubber. Synthetic polymers, Inorganic etc.

History of Leather products and its classification: History of leather products, types of leather products, classification of leather goods, terms used in leather goods tools and machinery used in leather goods and garments manufacturing, accessories used in leather products manufacturing, definition of edge construction, types of edge construction, unit operations for leather goods.

Footwear types and requirements: Types of footwear- oxford, derby, court, moccasin, sandal, casual, boot, sports, mule, clogs, safety footwear, occupational footwear, fashion footwear etc. Bespoke footwear- meaning of bespoke footwear, advantages and customer of bespoke footwear, contribution of hose to foot comfort, properties of comfortable footwear, causes of customer dissatisfaction for footwear, footwear care.

Parts of footwear: Shoe section, parts of upper - vamp, quarter, toe cap, apron, tongue, counter, backstraps, fastenings, toe puff, stiffener, eyelets, trims/ornaments and parts of lining. Bottom parts- insole, insock, welt, rand, bottom filler, mid sole, runner, sole, heel, shank piece. Parts of sandals.

Human foot anatomy: Necessity of foot anatomy, bones, muscles, ligament, nerves and blood vessels, joint, arches, skin etc. development of human foot from infants to adult. Characteristic features of infant, children and adult foot, biometry of human foot, types of foot, foot dynamics- weight bearing foot, walking foot, running foot, gait analysis, foot motion, foot stances, foot care and their relationship to footwear.

Learning Outcomes: At the end of the course the students will be able to:

- Understand and explain the concepts involved in histological structure and chemical composition of raw hides and skins.
- Identify the different aspects of leather and their influence on overall manufacturing process.
- Gain fundamentals knowledge about the leather products.
- Know about different types of footwear with characteristic features.
- Know about foot functions and foot anatomy.

Reference Books:

1. Anthony D. Covington- Tanning Chemistry The Science of Leather
2. Dutta S.S.-An introduction to the principles of leather manufacture.
3. Sarkar K.T.-Theory and Practice of Leather Manufacture.
4. Sarphouse J.H.-Leather Technicians Handbook.
5. Heidenmann Eckhart - Fundamentals of Leather Manufacture.
6. Procter H.R.-The Principle of Leather Manufacture.
7. Venkatappaiah B.- Introduction to The Modern Footwear Technology
8. Miller R. G. (Editor) - Manual of Shoe Making
9. Carr & Latham-The Technology of Clothing Manufacture
10. Kirsten Jorgensen-Making Leather Clothes
11. Ben and Elizabeth Morris-Making Clothes in Leather
12. Roland Kilgus editor-Clothing Technology from fibre to fashion

MTH-101: Algebra and Geometry		
Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To know about Inequalities, Vector algebra and vector calculus
- To know about Matrices and Determinants
- To know about Applications of the Algebra in science, engineering and business
- To know about Two and three-dimensional geometry

Course Contents:

Inequalities, Vector algebra and vector calculus: Review of geometric vectors in R^2 and R^3 space, scalar and vector products, solutions of vector equations, applications of vectors in geometry, Vectors in R^n and C^n. Inner product. Norm and distance in R^n and C^n.

Matrices and Determinants: Notion of matrix, Types of matrices, Matrix operations, laws of matrix Algebra, Determinant function, Properties of determinants, Minors, Cofactors, expansion and evaluation of determinants, Elementary row and column operations and row-reduced echelon matrices, Invertible matrices.

System of Linear Equations: Linear equations. System of linear equations (homogeneous and non-homogeneous) and their solutions. Application of Matrices and determinants for solving system of linear equations.

Applications of the Algebra in science, engineering and business.

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

Three dimensional geometry: Plane and lines - co-ordinates, direction ratios and cosines of a line, equations of a line and a plane, intersecting planes, symmetric form of a straight line, angle between lines and planes, coplanar lines, skew lines, shortest distance, curved surfaces, equations of a sphere, section by a plane, tangent plane, standard equations of cone, cylinder and conchoids properties.

Learning Outcomes:

- Compute dot and cross product of vectors.
- Find the length of a vector.
- Define basic terms and concepts of matrices and determinants.
- Solve system of linear equations.
- Determine different properties of straight lines, circles and conics with identification of curves.
- Determine directional cosines and directional ratios of straight lines manually with geometric interpretations, and different properties of conics and straight lines in three dimensions.

Reference Books:

1. H. Anton, and C.Rorres, Linear Algebra with Applications, 7th Edition,
2. S. Lipshutz, Linear Algebra, Schaum's Outline Series.
3. W. Greub, Linear Algebra.
4. Khosh Mohammad, Analytic Geometry and Vector Analysis.
5. J. A. Hummel, Vector Geometry.
6. A.F.M. Abdur Rahman & P.K. Bhattacharjee, Analytic Geometry and Vector Analysis

PHY-101: Engineering Physics

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To provide a broad training in physics and demonstrate the students on various skills including; expertise with core physics concepts and their applications to relate the physical phenomenon with the practical problems in engineering purposes, proficiency in problem solving, critical thinking, and analysis.
- In future, it will help the students to function effectively in laboratory environment and pursue independent research towards the development of new devices and products using sophisticated physical concepts.

Course Contents:

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

Surface Tension: Surface energy and surface tension, excess of pressure inside a spherical liquid drop, capillarity.

Fluid mechanics: Fluids, types and properties of fluids, fluid statics, fluid flow, equation of continuity, Bernoulli's equation.

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

Heat: Humidity, vapor pressure, temperature related humidity, transmission of heat, thermal conductivity of solids and liquids, coefficient of thermal conductivity, good and bad conductor of heat, heat flow through compound walls, convection, free and forced convection, domestic and industrial application, ventilation.

Sound: Sound wave, sound field, power and intensity, sound pressure level, psycho-acoustics, loudness, pitch, masking, types of noise.

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

Nuclear physics and modern physics: Properties of atomic nucleus, mass defect, binding energy, nuclear stability, natural and artificial radioactivity, laws of radioactive disintegration, half-life and mean life, radio-toxicity, radioactive waste management. X-ray and their applications, Crystal structure, Fundamental types of lattices, Miller indices Wave particle duality, de-Broglie hypothesis, Photo-electric effect, Compton effect.

Learning Outcomes: Successful completion of this course will help students with following outcomes:

- Work efficiently in leather, leather products, and footwear industries where proper application of engineering knowledge requires the basics of physics.
- Solve problems with critical thinking and effective communication.
- Ready for entry level research and secured positions in industry.
- Recognition for students in other majors who wish to enhance their understanding and mastery of a broader range of subjects than is provided in their core courses alone.
- Ability to communicate their ideas with others and function effectively in multidisciplinary terms.
- Start career as a practicing engineer in fields such as design, research, development, testing, manufacturing, operations, and service systems.

Reference Books:

1. Resnick/Halliday/Krane-Physics, Vol I & II.
2. David Halliday/Robert Resnick/Jearl Walker-Fundamentals of Physics.
3. F.W.Newman and V.H.L.Searl -The General properties of Matter
4. D.S.Mathur- Elements of Properties of Matter
5. Charles Kittel/Herbert Kroemer -Thermal Physics.
6. F.Sears and G.L. Salinger -Thermodynamics, Kinetic Theory and Statistical Thermodynamics
7. S.C.Arrora/S. Domkundwar-A Course in Heat & Mass Transfer.
8. Harvey E.White/Francis A. Jenkins-Fundamentals of Optics.
9. ArtherBeiser-Concepts of Modern Physics.
10. C. L. Arora -B.Sc. Physics, Vol-I & II.

CHM-101: Inorganic Chemistry

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

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

- This course serves as a cursory to understand the basic concepts involved in inorganic chemistry including periodic properties, acid-base reactions, redox reaction, chemical bond, transition metals and coordination chemistry that will prepare the student for advanced coursework in chemistry as well as in Leather Chemistry.
- It explores the unknown knowledge of different types of bond exist leather.
- The course will provide a foundation for further education in chemical science directed towards materials, energy technology and leather process chemistry.

Course Contents:

Concepts in Chemical Bond: Concepts and types of chemical bonding, polarization of ions, Fajan's rule, metallic bond, Pi back bonding, organic metallic compounds, hydrogen bond, intermolecular interaction, London force, van der Waal's forcers, MOT, VBT, and VSEPR theories.

Institute of Leather Engineering and Technology, University of Dhaka

Acid-Base concept: Modern concept of acids and bases, acid and base strength, pH, buffer solution and its mechanism, importance of pH in tanning processes, acid base indicator, equivalent point and end point, acid-base titration, precipitation titration, oxidation-reduction titration, potentiometric titration, strong and weak electrolytes, degrees of dissociation, Oswald dilution law, dissociation constants of weak electrolytes.

Structure of transition metal complexes: Synthetic strategies to transition metal complexes, spectroscopy of co- ordination compounds, structure and property relations in 'd' block elements. Aqueous chemistry of chromium, titanium, iron, aluminium and zirconium including their redox behavior, application of transition metal compounds in tanning.

Theories of Co-ordination: Coordination or complex compounds, ligands or co-ordinating groups, coordination number, primary and secondary valency, coordination sphere, chelate complexes, application of chelates, nomenclature of coordination compounds, isomerism-structural, geometrical, optical, optical isomerism in 6-coordinate complexes, Werner's coordination theory, effective atomic number (EAN), limitation of EAN rules, Valence Bond Theory (VBT) of structure of inorganic complex with simple examples, Crystal Field Theory, application of crystal field theory color of transition metal complexes.

Inorganic compounds used for tannings: Chromium salts, its behavior in solution, variable oxidation state of chromium, color of chromium compounds, structure and bonding of chromium in leather, impact of chromium on the environment, way to avoid Cr(VI) formation in leather, application of chromium compounds in leather.

Learning Outcomes: After completion of this course the students will be able to

- Understand the different types of bonding in leather.
- Learn types of bond involved in complex compound, complex ion and chromium-collagen bond formation in leather.
- Explain different oxidation state of transition metal elements especially iron and chromium.
- Explain pH and its implications in different steps of leather tanning process.
- Understand different color of chromium compounds.

Reference Books:

1. G. F. Lipotrot- Modern Inorganic Chemistry.
2. F. Albert Cotton, Geoffrey Wilkinson, Paul L. Gaus- Basic Inorganic Chemistry.
3. Esmarch S. Gilreath- Fundamental Concepts of Inorganic Chemistry.
4. S. Z. Haider- Introduction to Modern Inorganic Chemistry.
5. H. J. Emeleous and A. G. Sharpe- Modern Aspects of Inorganic Chemistry.
6. R. D. Madan- Modern Inorganic Chemistry.
7. A. K. De- A Text Book of Inorganic Chemistry.
8. K. N. Upadhyaya- A Text Book of Inorganic Chemistry.

CHM-102: Physical Chemistry

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives: The learning objectives of this course are to-

- understand the scientific and mathematical principles underlying their chosen discipline
- understand and explain different laws of physical chemistry
- make analytic in calculating physico-chemical parameters using standard equations
- Increase ability for interpreting the tabulated experimental data for different physical processes.
- Promote knowledge on the basic concepts of the Physical chemistry to enter into the field of engineering education.

Course Contents:

Surface chemistry: Adsorption and absorption, physical and chemical adsorption, types of adsorption isotherms, theoretical study of adsorption of gas by solid, adsorption of solid from solution, application adsorption.

Colloid: True solution, suspension, types of colloid, general methods of preparation and purification, general properties (Physical, colligative, kinetic, optical and electrical properties) of sol, protective action and application of colloid, emulsion, types and preparation of emulsion, emulsifier, stability of emulsions, application of colloids in tanning processes.

Photochemistry: Laws of photochemistry - Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law (derivation and problems). Photo physical processes – Jablonski diagram. Chemiluminescence, fluorescence, phosphorescence, luminescence, photo-sensitization and photoquenching – mechanism and examples. Spectroscopy: Electromagnetic radiation, electromagnetic spectrum - absorption of radiation - electronic, vibrational and rotational transitions.

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

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

Thermodynamics: Work, heat, energy, internal energy and enthalpy, some thermodynamic terms, first law of thermodynamics, reversible and irreversible processes, isothermal and adiabatic expansion of ideal gas, Joule-Thomson effect, molar heat capacity at constant pressure and constant volume and their relation, second law of thermodynamics, spontaneous process, entropy, entropy changes for ideal gas, Carnot's cycle, efficiency of a machine, free energy and work function, Gibbs-Helmholtz's equation.

Learning Outcomes: Upon completion of the course, the students should be able to

- Use dimensional analysis in solving different types of problems.
- Explain colloid and its implications in different steps of leather tanning process.

Institute of Leather Engineering and Technology, University of Dhaka

- Understand and apply laws of photochemistry and surface chemistry.
- Describe different kinetics law and reaction rate theories.
- Understand& explain four colligative properties.
- Understand and apply laws of thermodynamics in advance courses.

Reference Books:

1. G. M. Barrow- Physical Chemistry.
2. W. J. Moore- Physical Chemistry.
3. Bahl And Tuli- Essentials Physical Chemistry.
4. Sharma and Sharma- A Text Book of Physical Chemistry.
5. S. Glasstone-Text Book of Physical Chemistry.
6. P. W. Atkins- Physical Chemistry.
7. Taylor and Taylor- Elementary Physical Chemistry.
8. Moron and Lando- Fundamentals of Physical Chemistry.
9. J. Bruce Brackenridge & Robert M. Rosenberg- The Principle of Physical Chemistry.
10. Samuel H. Maron& Carl F. Prutton- Principle of Physical Chemistry.

CHM-103: Inorganic and Physical Chemistry Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Lab based of the content of CHM-101 and CHM-102

ME-101: Engineering Drawing

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives:

- To know about different types of drawing equipment
- To know how to represents letters & numbers in drawing sheet
- To know about different types of projection
- To know projection of points, straight lines, solids etc.
- To know development of different types of surfaces.

Course Contents:

Drawing equipment and the use of instruments; Basic drafting techniques, planning of drawing sheet. Dimensioning, types of lines.

Development of surfaces of prism, pyramids, cylinders and cones, Geometrical curves including plane curves; Cycloid, Hypocycloid, and the Involutes. Lettering, numbering. Orthographic projection. Isometric projection. Auxiliary projection. Sectional view. Assembly drawing. Perspective. Drawing of gear tooth profile cam profile.

Learning Outcomes: Upon completion of the course, the students should be able to

- know about different types of drawing equipment
- know how to represents letters & numbers in drawing sheet

- know about different types of projection
- know projection of points, straight lines, solids etc.
- know development of different types of surfaces.

HUM-101: Employability Skills-I		
Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives:

- To develop ability to gain key strategies and expressions for communicating with professionals and non-specialists.
- To improve the skills of writing, for example, report or letter writing.

Course Contents:

Speaking Skills: Conversational skills (formal and informal contexts)-telephonic communication, attending job interviews (responding to FAQs)-taking part in GDs-making presentations.

Writing Skills: Job applications – cover letter – resume – applying online – writing proposals – emails – letters – reports – memos – minutes – blogging – tweeting – writing recommendations and instructions – writing for publications.

Reading Skills: Vocabulary building – speed reading (skimming – scanning) – reading different genres of texts from newspapers to philosophical treatises – critical reading – effective reading strategies such as reading 'beyond the lines', summarizing, graphic organizers and distinguishing facts from opinions.

Report Writing: Types of report, Characteristics and importance of different types-Purpose-Scope-different styles of writing reports. The process of preparing informal and formal reports, Drafting reports, Progress reports, Technical reports, Industrial reports etc.

Proposals: For new equipment, increasing production, Description of visits, Experiments etc.

Listening/Viewing Skills: Speeches of different nationalities with focus on American and British accent (TED talks, podcasts) – listening to lyrics – lectures – instructions – dialogues – news casting – talk shows – interviews (Hard talk, Devil's Advocate)

Soft Skills

Motivation - persuasive skills – negotiations – time management – emotional intelligence – stress management – creative and critical thinking.

To be totally learner-centric with minimum teacher intervention as the course revolves around practice.

Suitable audio/video samples from Podcast/YouTube to be used for illustrative purposes.

Portfolio approach for writing to be followed. Learners are to be encouraged to blog, tweet, text and email employing appropriate language.

GD/Interview/Role Play/Debate could be conducted off the laboratory (in a regular classroom) but learners are to be exposed to telephonic interview and video conferencing.

Learners are to be assigned to read/write/listen/view materials outside the classroom as well for graining proficiency and better participation in the class.

Institute of Leather Engineering and Technology, University of Dhaka

Learning Outcomes:

- Recognize, explain, and use the formal elements of specific genres of organizational communication: white papers, recommendation and analytical reports, proposals, memorandums
- Understand how to critically analyze data from research; incorporate it into assigned writing clearly, concisely, and logically; and attribute the source with proper citation.
- Practice the unique qualities of professional rhetoric and writing style, such as sentence conciseness, clarity, accuracy, honesty, avoiding wordiness or ambiguity, using direct order organization, readability, coherence and transitional devices.

Reference Books:

1. Gartside's Model Business Letters and Other Business Documents, Shirley Taylor.
2. Business correspondence and Report Writing, R. C. Sharma & Krishna Mohan.
3. The Complete Degree General English Grammar and Composition, Amjad & Hoq.
4. Advanced Lerner's Degree General English, Chowdhury & Hossain.
5. High School English Grammar & Composition-PC. Wren and H. Martin.
6. Business Communication Systems and Application, Betty R. Ricks & Kay F. Gow, John Wiley & Sons, USA.
7. A University Grammar of English-Randolph Quirk and Sidney Greenbaum.
8. A Practical English Grammar-A.J. Thomson/A.V. Martinet (Latest edition).
9. Barker, A. Improve Your Communication Skills. New Delhi: Kogan Page India Pvt. Ltd., 2006.
10. Craven, Miles. Listening Extra – A resource book of multi-level skills activities. Cambridge University Press, 2004.
11. Gammidge, Mick. Speaking Extra - A resource book of multi-level skills activities.

LE-102: Field Tour		
Credit	Class/week (h)	Total Class (h)
1.0	-	-

The students shall have a daylong visit of one relevant industry.

First Year (2nd Semester)

LE-103: Leather Processing-I		
Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To know different stages of pre-tanning process
- To understand the importance of different stages of pre-tanning
- To comprehend the chemistry and mechanism of unhairing and liming

- To learn the methods of pre-tanning processes

Course Contents:

Preservation / curing of hides and skins: Introduction, objectives and principles of preservation, short and long terms preservation, methods of preservation/curing, advantages and disadvantages of different types of curing, factors affecting preservation / curing process.

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

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

Soaking: Objects and mechanism of soaking, soaking of green, wet-salted, dry-salted and dried (flint)hides and skins, enzymatic soaking, factors influencing the soaking process, role of hyaluronic acid in soaking, aids and controls in soaking, cleaner methods of soaking, eco-friendly process technologies in soaking; enzymetic soaking, soaking defects and their remedies, Green fleshing- its advantages and limitations for the production of quality leather.

Unhairing and Liming: Objectives of unhairing and liming, types of unhairing and liming, hair saving method, hair burning method, advantage and disadvantage of hair saving method and hair burning method, immunization of keratin, swelling of collagen based on Dornan's theory, mechanism of unhairing, sulphide free unhairing system, enzymetic in unhairing, control of enzymatic unhairing, advantages and disadvantages of enzymatic unhairing, scope for hair utilization or disposal, prevention of H_2S emissions from lime effluents.

Fleshing Objectives of fleshing, types of fleshing, advantage and disadvantage of fleshing.

Deliming and bating: Objectives of deliming and bating, selection of deliming agents, test of deliming, mechanism of bating, effect of bating on leather quality, acid bating, alkali bating, advantage and disadvantage of acid bate over alkaline bating, polluting emissions in deliming and bating, cleaner technologies options (ammonia free) in deliming and bating, enzyme working mechanism in bating, solvent free degreasing system. Chemistry of proteolytic enzymes used for bating, necessity of bating, Its preparation and controls for desired properties of leather.

Pickling: Acid binding capacity of collagen, use of organic acids or salts in pickling, its necessity and controls, concept of, de-pickling.

Degreasing Objects and necessity of degreasing, different systems and methods.

Learning Outcomes: At the end of the course the students will be able:

- to explain the necessity of different stages of pre-tanning process
- to elucidate the methods of soaking, liming, de-liming, pickling and degreasing
- demonstrate different process of leather making like soaking, liming, deliming, bating, pickling and tanning

Reference Books:

1. Theory and Practice of Leather Manufacture- K.T. Sarkar
2. Tanning Chemistry, The Science of Leather-Anthony D Covington
3. Possible Defects in Leather Production-Gerhard John

Institute of Leather Engineering and Technology, University of Dhaka

4. Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edn. I. L. T. A.,Calcutta.
5. Chemistry & Technology of Leather-Roddy, O` Flahorty & Lollar, Vol. 2 & 3. Robert E. Kreiger Publishing Co.,N. Y.
6. Chemistry of Tanning Processes – K. H. Gustavson, Academic Press N. Y.
7. Chemistry of Vegetable Tannins –E. Haslam, Academic Press, N. Y.
8. Fundamentals of Leather Manufacture – Eckhart Hidemann.
9. Theory and Practice of Leather Manufacture –K. T. Sarkar, Macmillan India Press, Madras.
10. Leather Technician`s Handbook –J. H. Sharphouse, Vernon Lock Ltd., 125 High Holborn, London W-C1.

LE-104: Leather Processing-I Lab		
Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0 /Group

Learning Objectives: The aim of this course is to:

- Introduce students to quantitative & qualities methods for conducting meaningful inquiry and practical.
- Enhance the students' ability to analyze and critically evaluate the issues of practical in the realm of leather manufacturing engineering.
- Enhance knowledge and skills of student for designing and conducting an academic practical independently.

Course Contents:

1. Curing of freshly flayed cowhide and goatskin with sodium chloride (Common salt) and its effect on water content at different time interval.
2. Enzyme soaking of cow hides and goat skins
3. Determination of rate of water uptake and degree of swelling of cow hides and goat skins during soaking.
4. Paint unhairing of wet salted goat skins and sheep skins
5. Liming with slaked lime and sodium sulphide with and without enzyme.
6. Deliming of cow hide with boric acid, lactic acid, ammonium and ammonium sulphate.
7. Bating of goat skins with pancreatic bate.
8. Determination of the rate of acid uptake by cow hides during the pickling.
9. Effect of sodium chloride on pickling
10. Identification of leather based on pore structure (Grain patterns).
11. Manufacture of chrome- tanned leather.

Learning Outcomes: At the end of the course the students will be able to:

- Display familiarity with a broad array of methods and approaches that are used within the industry.
- Demonstrate practical competence in critical thinking by presenting and evaluating arguments in an academic fashion.

- Develop a manufacturing hypothesis and frame the manufacturing problem with the correct methodology.
- Know how to write a process recipe using mixed methods of practical.
- Apply practical mythological tools and techniques for conducting research & development in the areas of leather engineering.

Reference Books:

1. Theory and Practice of Leather Manufacture- K.T. Sarkar
2. Tanning Chemistry, The Science of Leather-Anthony D Covington
3. Possible Defects in Leather Production-Gerhard John
4. Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edn. I. L. T. A.,Calcutta.
5. Chemistry & Technology of Leather-Roddy, O` Flahorty & Lollar, Vol. 2 & 3. Robert E. Kreiger Publishing Co.,N. Y.
6. Chemistry of Tanning Processes – K. H. Gustavson, Academic Press N. Y.
7. Chemistry of Vegetable Tannins –E. Haslam, Academic Press, N. Y.
8. Fundamentals of Leather Manufacture – Eckhart Hidemann.
9. Theory and Practice of Leather Manufacture –K. T. Sarkar, Macmillan India Press, Madras.
10. Leather Technician`s Handbook –J. H. Sharphouse, Vernon Lock Ltd., 125 High Holborn, London W-C1.

CSE-101: Fundamentals of Computer and Information Technology

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To aim at imparting a basic level computer knowledge for the students.
- To understand how a computer operates, and how a computer process and store data.
- To learn the basic knowledge on a computer network and other associated things related computers.
- To learn the Information and Data management as well as the functionalities of Information System.

Course Contents:

Computer Architecture: Introduction to computer and its history, Organization and architecture of computer, Internal Mechanism of Computer, Computer hardware and Software, Software classification with its development phases, Operating system and its components.

Computer Software: Operating system concepts, Software, Software classification with its development phases, Operating system and its components.

Computer Programming Basics: Introduction, Basics of Computer programming. Computer Networks and Internet: Concepts of network, different types of network and topologies, study of LAN concepts and operation, hardware and software for networks, data transmission, network architectures, study of connectivity between LAN and wide area networks, Networking Protocols, Mobile network, Different types of mobile network, GSM, CDMA, World wide web including navigating the internet, Internet services: Telnet, FTP, e-mail, www, internet, Intranet, Bluetooth, Wi-Fi, etc.

Information and Data Management: Introduction to Data and Information, Data and Management Strategy, Database Concept, Types of Database, Database Management.

Information System: Introduction of Information System, the Decision-Making Process, System Approach to Problem Solving, the Structure of Management Information System, Kinds of Information Systems. Basics of Enterprise Resource Planning (ERP), Evolution of ERP, Enterprise Systems in Large Organizations, Benefits and Challenges of Enterprise Systems

Learning Outcomes:

- Makes students aware of the computer and information Technologies, their internal mechanism and classifications.
- Teaches the basic of the Internet, mobile, and wireless communications.
- Students learn the fundamental of computer programming as well as software development process and networking.
- Describes the Information System briefly with real example.

Reference Books:

1. S. Frence- Computer Science.
2. Warford- Computer Science.
3. Peter Norton – An Introduction to Computer Science
4. L. Rosch- Hardware Bible, Baraddy Publishing, Indianapolis.
5. Clive Finkelstein – An Introduction to Information Engineering
6. Ian Macdonald - Information Engineering
7. James Martin - Information Engineering: Introduction
8. Kenneth C. Laudon and Jane P. Laudon- Management Information Systems: Managing the Digital Firm
9. James A. O'Brien George M. Marakas - Introduction to Information System

CSE-102: Fundamentals of Computer and Information Technology Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives:

- To learn Office Word, Excel and PowerPoint to students.
- To understand the basic of preparing his personnel/business letters, viewing information on Internet (the web), sending emails, using internet banking services etc.
- To understand the basics of computer programming and database

Course Contents:

Operating system: Students will learn how to operate a computer in two basic environments- dos and windows and to install DOS, windows operating system.

Word and Power Point: Students will learn to use a popular word processing software to create a camera-ready test file complete with figures, columns and tables. They will also learn to make presentation for business meeting or any conference.
Spread sheet: Students will learn how to use a popular spread sheet to maintain a minor book keeping, statistical and graphical analysis off data.
Data base: Students will learn how to design a database structure/table.
Programming: student will learn very basic of computer programming.
Learning Outcomes:

- Students will learn to use a popular word processor to create a camera-ready test file complete with figures, columns, and tables.
- Students will have the ability to prepare power point and present effectively.
- Students will learn how to use a popular spreadsheet to maintain a minor book keeping, statistical and graphical analysis of data.
- Students can understand how to design a database structure/table.
- Student will learn the basic of computer programming

MTH-102: Calculus		
Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To provide a firm foundation in the concepts and techniques of the calculus, including basic functions and graphs and their properties, curve sketching, limits, continuity, differentiation, relative extrema and applications.
- To learn integral calculus, to the techniques of integration and to some of the applications of integration to physical problems.
- To learn the application of calculus in commerce and economics.

Course Contents:
Differential calculus: Functions of real variable and their graphs, Limits of Functions, Continuity and Derivative, Higher Derivatives, Leibnitz Theorem, Role's theorem, Mean Value theorem, Taylor's theorem, Taylor's and Maclaurin's series, Maximum and Minimum values of functions and applied maximum and minimum problems in science, and engineering, functions of two and three variables.
Application of Differential calculus in commerce and economics: Cost Function, Demand Function, Revenue function, Profit Function, Break-Even Point, Average and Marginal Functions.
Integral calculus: Integrals: Antiderivatives and indefinite integrals, Techniques of integration, Definite integration using antiderivatives, Definite integration using Riemann sums, Applications of the definite integral in geometry, science, and engineering.
Fundamental theorems of calculus: Basic properties of integration. Integration by reduction, Application of integration: Plane areas. Solids of revolution. Volumes by cylindrical shells. Volumes by cross-sections. Arc length and surface of revolution. Improper integrals: Gamma and beta functions.

Institute of Leather Engineering and Technology, University of Dhaka

Application of integration to commerce and economics: Determination of cost function, Determination of Total Revenue Function.
Vector calculus: vector function of scalar variables, differentiation of vector functions and applications.
Learning Outcomes:

- Interpret a function from an algebraic, numerical, graphical and verbal perspective and extract information relevant to the phenomenon modeled by the function.
- Understand the concept of limit and continuity of a function at a point graphically and algebraically using appropriate techniques.
- Interpret the derivative of a function at a point as the instantaneous rate of change and as the slope of the tangent line, and understand the consequences of Rolle 's Theorem and the Mean Value theorem for differentiable functions.
- Evaluate integrals using different techniques of integration.
- Learn how to calculate the area between curves, volumes of solids of revolution, surface area, arc length using integration.

Reference Books:

1. H. Anton et al, Calculus with Analytic Geometry.
2. E.W. Swokowski, Calculus with Analytic Geometry.
3. L. Bers& P. Karal, Calculus.
4. S. Lang, A First Course in Calculus.
5. frank s budnick; mathematics for commerce economics and business.

CHM-104: Organic and Collagen Chemistry		
Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives: The learning objectives of this course are to-

- Make students understand the fundamental principles of organic chemistry, synthesis and reactivity of important functional groups.
- Gain experience to predict the functional group transformations, simple reaction mechanisms, and the synthesis of organic molecules by multi-step synthesis strategies
- Help students to understand the chemical reactions occur during leather processing.
- Acquire concepts of metal-collagen cross linking in leather.

Course Contents:
Molecular bonding: Valence bond approach and atomic orbital hybridizations. LCAO-MO theory, Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, Hyper conjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Aromaticity: Hückel's rule, Electrophilic and nucleophilic aromatic substitution reactions, Redox reactions.
Organic tanning agents and compounds: Chemistry of condensed and hydrolysable tannins proantho cyanidins, dimers, trimers and other oligomers. Chemistry of sulphonyl chloride, quinone, oxazolidine, phosphonium and other organic tanning agents. Methods of

preparation of vegetable tannin extracts, spray dried vegetable tannins, generation stability of organic reactive intermediates: carbocations, carboanions, free radicals, carbenes, benzynes, nitrenes, amines, diazonium salt formation, coupling reaction, azo compounds, azo dye, banned amines.

Amino acids and proteins: Introduction, classification of amino acids, synthesis of amino acids, physical and chemical properties of amino acids, synthesis of polypeptides, characteristics of proteins, classification of proteins, structure of proteins.

Molecular structure of collagen: Arrangement of amino acid, peptide chain, collagen genes and RNA, amino acid composition and primary structure – Double helix structure, collagen triple helix; helix stabilization–synthetic collagen like polypeptides, denaturation, renaturation, stabilization. X-ray diffraction studies of collagen, electron microscopic appearance of collagen.

Properties of collagen fibre: diameter, strength, three dimentional weave of collagen in leather, water retention capacity, inter weave, angle of inter weave in leather, bonding, tensile strength, flexibility.

Collagen crosslinks: Crosslink, properties of crosslinks - intramolecular and intermolecular crosslinks, difunctional and multifunctional crosslinks, lathyrism and crosslinks, analysis of collagen crosslinks.

Characterization of collagen: Chromatographic properties, electrophoretic properties. Microscopy and spectroscopy techniques for collagen morphology. Non-invasive methods of liquid and solid imaging of biological specimen and their relevance to location of defects in hides/skins.

Learning Outcomes: Upon completion of this course students will be able to-

- illustrate the hybridization and geometry of atoms and the three-dimensional structure of organic molecules
- explain the fundamental properties, reactivity and stability of an organic molecule based on structure, including conformation and stereochemistry
- understand the behavior of organic tanning material
- gather knowledge on amino acid, protein structure in leather
- enhance knowledge on DNA, three-dimensional collagen structure, crosslinking and strength of leather fibre.

Reference Books:

1. Morrison and Boyd- Organic Chemistry.
2. B. S. Bahl and ArunBahl- Organic Chemistry.
3. L. Finar- Organic Chemistry.
4. Andrew Streitwieser, Clayton H. Heathcock, Edward M. Kosower- Introduction to Organic Chemistry.
5. Amend, Mundy, Armold- General Organic and Biological Chemistry.
6. Fred O, Flaherty, Roddy, T.W Roddy and Robert M. Lollar Ed., `The Chemistry of Technology of Leather', Robert E. Krieger Publishing Co., New York 1978.
7. Gustavson, K. H., `Chemistry of Tanning Processes', Academic Press, New York, 1958.
8. Krishnan, V, Ed. 'Trends in Collagen', Proceedings of the Indian Academy of Sciences (Chemical Sciences), Vol. 111, No. 1, Indian Academy of Sciences, Bangalore, 1999.
9. G. N. Ramachandran (Ed) "Chemistry of Collagen, Treatise on collagen Vol.1, Academic Press, 1967.
10. Nimni, M. E.(ed) Collagen: Vol.3, Boca Raton CRC, 1988.

CHM-105: Organic and Collagen Chemistry Lab		
Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Lab based on the content of CHM-104.

PSE-101: Polymer Science and Engineering		
Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To know the background of macromolecular science, importance of monomers and polymers, structure, properties and classification of polymers.
- To understand basic aspects of the solution properties of polymers, interactions and the relationship to chemical structure, including phase behavior and the measurement of molecular weight.
- To gather the basic knowledge of collagen chemistry

Course Contents:

Polymers: Introduction, classifications, polymerization, mechanisms, polymerization techniques, bulk, solution, suspension, emulsion, solid and liquid phase. polycondenzation techniques, melt, solution and interfacial.

Step-growth polymerization, Functionality, Crosslinking; PET manufacturing; Chain growth polymerization, Free radical polymerization, Kinetics of free-radical initiation, termination, chain transfer, Mayo's equation, cage effect, autoacceleration, inhibition and retardation;

Polypropylene manufacturing; Acrylic manufacturing; Atom transfer radical polymerization, ionic polymerization, ring opening polymerization; Nylon-6 manufacturing; Co-polymerization and its importance. Copolymer equation, reactivity ratio, tailor making of copolymer properties; Techniques of chain polymerization; Bulk, solution, emulsion, microemulsion and suspension polymerization; chemical modification of fibres; Polymer solution, Flory's theory; Interaction parameter.

Molecular weight and its distribution by: End group analysis, osmometry, light scattering, ultra-centrifugation, gel permeation chromatography, intrinsic viscosity; Spectroscopic methods of polymer characterization such as, FTIR. UV, NMR and others.

Compounding of polymers - fillers, plasticizers, antioxidants, UV stabilizers, colouring agents and flame retardants. Polymer processing - compression, moulding, injection, extrusion, calendaring and film casting; Preparation and properties of polyesters,

polyamides, epoxy and silicone polymers; Conductive polymers, super absorbent polymers.
Recycling, remoulding, depolymerisation, incineration, biodegradable polymers. Polymer Degradation, Definition, types, different factors affecting polymer degradation, stabilizers etc.

Learning Outcomes: After completing the course the students will understand

- the basic concept of monomers, polymers, structure, properties and classifications of polymers by origin, processing, mechanism
- different techniques of polymerization methods and
- the properties and application of common polymeric materials used in leather products and footwear manufacturing.

Reference Books:

1. Gowrikar V. R. , Viswanathan N.V. and JayadevSreedhar, "Polymer Science", New Age Publication, New Delhi 2003.
2. Gupta V. B. and Kothari V. K., "Manufacture Fibre Technology", Chapman and Hall Publication, UK 1997.
3. Billmayer F. M., "Text Book of Polymer science", Wiley Inter Science, New York, 2002.
4. Odion G., "Principles of Polymerization", John Wiley, UK, 2002.
5. Woodings C., "Regenerated Cellulose Fibres", Woodhead Publishing, UK, 2000

PSE-102: Polymer Science and Engineering Lab		
Credit	Class/week (h)	Total Class (h)
1.5	3/Group	45.0/Group

Learning Objectives: This course will make the students skilled about

- Synthesis of different types of polymer
- Identification of different types of polymeric materials and their characterization.
- Viscosity determination polymer etc.
- Application of polymer in leather products manufacturing.

Course Contents:

1. Identification of polymers use in leather, footwear and leather products manufacturing.
2. Determination of chemical compositions of selected polymers.
3. Determination of ionic character of selected polymers and surfactants.
4. Determination of viscosity of acrylic, polyurethane, butadiene binders.
5. Determination of electrolyte stability of acrylic, polyurethane, butadiene binders.
6. Determination of solvent stability of acrylic, polyurethane, butadiene binders
7. Determination of film hardness of acrylic, polyurethane, butadiene binders.
8. Determination of adhesive strength of acrylic, polyurethane, butadiene binders.
9. Determination of tensile strength and elongation of the finish film formation by acrylic, polyurethane, butadiene binders
10. Determination of ironing effect of acrylic, polyurethane, butadiene binders
11. Determination of flexibility of finish film based on acrylic, polyurethane, butadiene binders.
12. Determination of water resistance of finish film based on acrylic, polyurethane, butadiene binders, silicones-based compounds and nitrocellulose-based compounds
13. Chromatographic analysis of plasticizer.

Learning Outcomes: After completion of this course students will be able to

- Identify leather, adhesives, fibers, rubbers and plastics
- Synthesis of different types of polymer and their characterization
- Apply knowledge to find out the application of polymer in leather products manufacturing.
- Determine the viscosity of polymer.
- Application of polymer in leather products manufacturing.

Reference Books:

1. Billmeyer F.W. Jr. - Text Book of Polymer Science.
2. Fried J.R. - Polymer Science & Technology.
3. Gowariker V. R. -Polymer Science.
4. Arora M.G. & Singh M. - Polymer Chemistry.
5. Reed R. (Ed.) - Science for Students of Leather Technology.
6. Misra G.S. - Polymer Chemistry.
7. Bienkiewicz K. - Physical Chemistry of Leather Making.
8. Heidemann E. - Fundamentals of Leather Making.
9. Parry D.A.D. & Creamer L.K. - Fibrous Proteins: Scientific, Industrial and Medical aspects.
10. Finar I. L. - Organic Chemistry Volume-II

Second Year (1st Semester)

LE-201: Leather Processing-II (Mineral)		
Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To know the mechanism of mineral tannage
- To get idea about various salts used in mineral tannage
- To understand the mechanism of chrome tanning
- To learn about different kind of mineral tannage

Course Contents:

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

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

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

Emission in chrome tanning, environmental impact in chrome tanning, chrome balance in leather manufacturing; optimization of the process parameters, high exhaustion-modification of the tanning process, direct chrome recycling, chrome recovery and reuse, recovery without reuse, chrome-free leather, wet-white concept, chrome free leather-other mineral tannages.

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

Zirconium Tanning: Tanning behaviour of salts of Zirconium, factors affecting Zirconium Tannage, mechanism of zirconium tannage, Tanning behaviour of salts of Iron and Titanium, Tannages involving the use of Sodium silicate and poly phosphates.

Other tanning Operations: Titanium tanning, Iron tanning

Learning Outcomes:

After completing this course students will be able to gather knowledge about mineral tannage and they can learn how to use various salt in mineral tannage to produce quality leather.

Reference Books:

1. Anthony D. Covington- Tanning Chemistry The Science of Leather
2. Dutta S.S.-An introduction to the principles of leather manufacture.
3. Krystof Bienkieuicz - Physical chemistry of leather making.
4. Flaharty, Roddy, Lollar-The chemistry and technology of leather (vol-2and3)
5. Sarkar K.T.-Theory and Practice of Leather Manufacture.
6. Reed R. -Science for Students of Leather Technology.
7. BASF Manual -Pocket Book for the Leather Technologist.
8. Sarphouse J.H.-Leather Technicians Handbook.
9. Heidenmann Eckhart - Fundamentals of Leather Manufacture.
10. Procter H.R.-The Principle of Leather Manufacture.

LE-202: Leather Processing-II Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0 /Group

Learning Objectives: The aim of this course is to:

- Introduce students to quantitative & qualities methods for conducting meaningful inquiry and practical.
- Enhance the students' ability to analyze and critically evaluate the issues of practical in the realm of leather manufacturing engineering.

Institute of Leather Engineering and Technology, University of Dhaka

- Enhance knowledge and skills of student for designing and conducting an academic practical independently.

Course Contents:

1. Manufacturing of Shoe upper leather.
2. Manufacturing of lining leather
3. Manufacturing of semi chrome leather
4. Manufacturing of shrunken grain leather
5. Manufacturing of Fur skin leather.
6. Manufacturing of Screen/block printed leather.
7. Manufacturing of Glaze kid leather.
8. Manufacturing of Nubuck leather.
9. Manufacturing of Nappa leather/ suede leather.

Learning Outcomes: At the end of the course the students will be able to:

- Display familiarity with a broad array of methods and approaches that are used within the industry.
- Demonstrate practical competence in critical thinking by presenting and evaluating arguments in an academic fashion.
- Develop a manufacturing hypothesis and frame the manufacturing problem with the correct methodology.
- Know how to write a process recipe using mixed methods of practical
- Apply practical mythological tools and techniques for conducting research & development in the areas of leather engineering.

Reference Books:

1. Theory and Practice of Leather Manufacture- K.T. Sarkar
2. Tanning Chemistry, The Science of Leather-Anthony D Covington
3. Possible Defects in Leather Production-Gerhard John
4. Introduction to the Principles of Leather Manufacture- S. S. Dutta, 4th Edn. I. L. T. A., Calcutta.
5. Chemistry & Technology of Leather-Roddy, O` Flahorty & Lollar, Vol. 2 & 3. Robert E. Kreiger Publishing Co.,N. Y.
6. Chemistry of Tanning Processes – K. H. Gustavson, Academic Press N. Y.
7. Chemistry of Vegetable Tannins –E. Haslam, Academic Press, N. Y.
8. Fundamentals of Leather Manufacture – Eckhart Hidemann.
9. Theory and Practice of Leather Manufacture –K. T. Sarkar, Macmillan India Press, Madras.

LE-203: Leather Biotechnology

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives: The learning objectives of this course are:

- To familiarize the students with those concepts that are basic to prepare of specimen for sectioning, free hand sectioning, paraffin embedding method, freezing method, staining techniques.

- To understand the bacteriology and mycology.
- To provide knowledge in Biocides, Fungicides and Insecticides.
- To develop biological processes of waste treatment to reduce the impact of pollution.
- To know about merits and demerits of different methods of sterilization.

Course Contents:

Histology of hides, skins and leather: Preparation of specimen for sectioning, different method of sectioning; methods for staining, stock solutions for staining; mounting techniques, quick test for defect identification.

Bacteriology: Bacteria and its morphology, functions of bacteria, biological needs of bacteria, nomenclature, classification, structure, nutritional requirements; growth of an organism in a medium; infection and immunity, dissociation and association of bacteria; different methods of staining of bacteria.

Mycology: Introduction, spores and its types; classification of moulds, morphology of moulds, biochemistry of moulds, laboratory technique for the study of mould; microbiological problems of leather industry and their remedy.

Biocides, Fungicides and Insecticides: Biocides- definition, classification and chemistry of bactericides**,** fungicides and insecticides; diseases and defects on hides, skins and leather caused by bacteria, insects and moulds with their remedy; application of bactericides, fungicides and insecticides in leather industry.

Control of microorganism: General principles of microbial control, control of undesirable microorganisms by physical means, chemical disinfectants and their use; sterilization and its kinds, method and means of sterilization, merits and demerits of different methods of sterilization; cause of sterilization failure; pasteurization.

Microbial fermentation: Methods of microbial fermentation, types of fermentations, fermentation equipment; preparation of media, preparation of inoculums, separation and purification of products.

Enzymology: Enzyme in leather industry; microbial cells in leather and allied industries; principle of industrial enzymology, enzyme activity; source of enzyme, selection of micro-organisms, mechanism of enzyme biosynthesis, manipulation of enzyme biosynthesis; particular technical enzyme preparation of amylolytic, cellulose, proteolytic, lactase, proteases, lipases, glucose oxidase, catalase, glucose isomase enzymes.

Learning Outcomes: After completion of this unit the students will able to:

- Familiarize the students with those concepts that are basic to prepare of specimen for sectioning, free hand sectioning, paraffin embedding method, freezing method, staining techniques.
- Understand the bacteriology and mycology.
- Provide knowledge in Biocides, Fungicides and Insecticides.
- Conduct different biological processes of waste treatment to reduce the impact of pollution.
- Learn about merits and demerits of different methods of sterilization.
- Evaluate and interpret quantitative data using the scientific method
- Able to practice safety and proper techniques in the laboratory

Institute of Leather Engineering and Technology, University of Dhaka

Reference Books:

1. Stanbury P.F. and Whitaker A. - Principles of Fermentation Technology, Pergamon Press, 1984.
2. Lechniger -Biochemistry: The Molecular Basis of Cell Structure and Function, 2nd edition, Kalyani Publishers, Ludhjana, 1978.
3. Stent G.S. and Calendar C. - Molecular Genetics: An Introductory Narrative, 2nd Edition, Freeman, San Francisco, 1978.
4. Wiseman A.-Topics in Enzyme and Fermentation Biotechnology' (Several volumes). Vol.2.
5. R.Puvanarishnan, Susil C. Dhar- Enzyme Technology In Beamhouse Practice.
6. Srivastava S. and Singhal V. — Fundamentals of Microbiology.
7. J. Nicklin [et al] — Microbiology.
8. Tortora [et al] — Microbiology An Introduction.
9. Prescott [et al] — Microbiology.
10. P. Chakraborty — A Text book of Microbiology.

LE-204: Leather Biotechnology Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives: The learning objectives of this course are:

- To familiarize the students with the basic of comparative microscopic study of Cow hides /Buffalo hides /Goat skin/Sheep skin at liming, bating, tanning and finishing stages.
- To practice counting of bacteria in raw hides and skins, tape water, drain water, soak liquor, bate liquor and tannery drain liquor.
- To isolate and identify of moulds in pelts, wet-blue, and vegetable tanned and finished leathers, stored leather, and shoe and leather goods.
- To provide knowledge in Biocides, Fungicides and Insecticides.
- To develop biological processes of waste treatment to reduce the impact of pollution.
- To prepare glue and gelatin from hides and skins/fleshing/ bones,
- To produce of neat's foot oil from hooves.
- To produce of Sausage casing from spleens. Stomach, etc.
- To manufacture of musical string from stomach.
- To produce of protein binder from blood.
- To develop of blood meal for poultry.
- To produce of different enzymes from slaughterhouse by- products.
- To determine of degree of activity of enzyme.

Course Contents:

1. Section cutting, staining and mounting of samples.
2. Microscopic study of leather defects due to moulds/ insect/bacteria/fungi.

3. Comparative microscopic study of Cow hides /Buffalo hides /Goat skin/Sheep skin at liming, bating, tanning and finishing stages.
4. Cultivation, isolation, staining and identification of bacteria.
5. Counting of bacteria in raw hides and skins, tape water, drain water, soak liquor, bate liquor and tannery drain liquor.
6. Isolation and identification of moulds in pelts, wet-blue, and vegetable tanned and finished leathers, stored leather, and shoe and leather goods.
7. Preparation of glue and gelatin from hides and skins/fleshing/ bones.
8. Preparation of Neat's foot oil from hooves.
9. Preparation of Sausage casing from spleens. Stomach, etc.
10. Preparation of musical string from stomach.
11. Preparation of protein binder from blood.
12. Preparation of blood meal for poultry.
13. Preparation of Tallow from hides and skins/ fleshing.
14. Preparation of different enzymes from slaughterhouse by- products.
15. Determination of degree of activity of enzyme.

Learning Outcomes: After completion of this unit the students will able to:

- Familiarize the students with the basic of comparative microscopic study of Cow hides /Buffalo hides /Goat skin/Sheep skin at liming, bating, tanning and finishing stages. Understand the bacteriology and mycology.
- Perform counting of bacteria in raw hides and skins, tape water, drain water, soak liquor, bate liquor and tannery drain liquor.
- Conduct different biological processes of waste treatment to reduce the impact of pollution.
- Prepare glue and gelatin from hides and skins/fleshing/ bones.
- Develop Sausage casing from spleens. Stomach, etc.
- Prepare different enzymes from slaughterhouse by- products.
- Manufacture musical string from stomach, protein binder from blood, blood meal for poultry.
- Determine the degree of activity of enzyme.

Reference Books:

1. Stanbury P.F.and Whitaker A. - Principles of Fermentation Technology, Pergamon Press, 1984.
2. Lechniger -Biochemistry: The Molecular Basis of Cell Structure and Function, 2nd edition, Kalyani Publishers, Ludhjana, 1978.
3. Stent G.S. and Calendar C. - Molecular Genetics: An Introductory Narrative, 2nd Edition, Freeman, San Francisco, 1978.
4. Wiseman A.-Topics in Enzyme and Fermentation Biotechnology' (Several volumes). Vol.2.
5. R.Puvanarishnan, Susil C. Dhar- Enzyme Technology In Beamhouse Practice.
6. Srivastava S. and Singhal V. — Fundamentals of Microbiology.
7. J. Nicklin [et al] — Microbiology.
8. Tortora [et al] — Microbiology An Introduction.
9. Prescott [et al] — Microbiology.
10. P. Chakraborty — A Text book of Microbiology.

Institute of Leather Engineering and Technology, University of Dhaka

MTH-201: Differential Equation and Numerical Methods

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To introduce the basics of differential equations and terminologies regarding them.
- To solve different types of ordinary differential equations and partial differential equations analytically using well-known techniques.
- To explore the utility of differential equations in modeling numerous physical and biological systems.
- To determine the approximate numerical solutions of mathematical problems that cannot always be solved by conventional analytical techniques.
- To demonstrate the importance of selecting the right numerical technique for a particular application, and carefully analyzing and interpreting the results obtained.

Course Contents:

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

Modelling with first order differential equations: Construction of differential equations as mathematical models (exponential growth and decay, heating and cooling, mixture of solutions, series circuit, logistic growth, chemical reaction, falling bodies). Model solutions and interpretation of results.

Modelling with second order differential equations: Vibration of a mass on a spring, free and undamped motion; free and damped motion; forced motion; electric circuit problems.

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

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

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

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

Initial and Boundary Value Problems for Differentia Equations: Runge-Kutta method for solving first order equations, Milne's and Adams-Bashforth predictor corrector methods for solving first order equations. Finite difference methods for solving two-point linear boundary value problems.

Learning Outcomes:

- Formulate differential equations by removing arbitrary constants from algebraic relations and draw solutions curves using direction field. Construct and analyze graphical displays to summarize data.
- Classify first-order differential equations as separable, homogeneous, linear, exact, Bernoulli's etc. and solve them using appropriate methods.
- Know about higher order differential equations, their classifications and solve them using appropriate methods.
- Find numerical approximations to the roots of an equation by Newton method, Bisection Method, Secant Method, etc.
- Find numerical solution to a system of linear equations by Gaussian Elimination and backward substitution.
- Demonstrate the use of interpolation methods to find intermediate values for any given set of points.

Reference Books:

1. S. L. Ross, Differential Equation.
2. D. G. Zill, A First Course in Differential Equations with Applications.
3. H.J.H. Piaggio, An Elementary Featise on Differential Equations.
4. Grewal. B.S., and Grewal. J.S., "Numerical methods in Engineering and Science", Khanna Publishers, New Delhi, 9th Edition, 2007.
5. Gerald. C. F., and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, New Delhi, 6th Edition, 2006.
6. Chapra. S.C., and Canale. R. P., "Numerical Methods for Engineers, Tata, McGraw-Hill, New Delhi, 5th Edition, 2007.
7. Brian Bradie. "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi, 2007.

CHM-201: Analytical Chemistry for Leather and Leather Products		
Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives: The major objectives of this course are to:

- Acquire fundamental knowledge one errors and statistics, gravimetric and volumetric methods chromatographic technics analytical spectrometry, chemical analysis of leather and related chemicals, environmental analysis, laboratory automation and safety practice in laboratory.
- The course gives an overview of important use of selected classical and instrumental chemical quantitative analytical methods in leather manufacturing and a short introduction to their basic theory.

Course Contents:

Introduction: Evaluation of analytical results, units in measurements, uncertainly in measurement, accuracy and precision, Selectivity, Sensitivity, Specificity of chemical reaction, errors, minimization of errors, significant figure and computation, rejection of data- the Q test. Sampling.

Gravimetric and volumetric methods: Principles of gravimetric methods, conditions for precipitation co-precipitation and post–precipitation, precipitation from homogeneous solution. Principles of volumetric analysis, complexometric titration.

Chromatographic techniques: Introduction, principles, classification of chromatographic methods, partition and adsorption chromatography, instrumentation and application of paper, thin layer chromatography (TLC) and column chromatography.

Ultraviolet-Visible spectrometry: Introduction, principle, absorption laws, deviation from Beer's Law, instrumentation, principles, applications, molar extinction coefficient, measuring unknown concentration, absorbing species, absorption spectrum and λ_{max}, shifting of $\lambda_{max,}$ solvent polarity effect on λ_{max}, Woodward-Fieser rules for λ_{max} calculation, application of transmission spectrophotometry to dyes.

Chemical analysis of leather and related chemicals: Tanning materials- Routine analysis of vegetable, analysis of chrome extract: Cr_2O_3, basicity.

Analysis of leather: moisture content, fats content, ash content, nitrogen and hide substance, degree of tannage, pH of leather sample, analysis of chrome tanned leather, alum tanned leather; formaldehyde tanned leather; Leather auxiliaries: casein, shellac, oils, fats, waxes, acid value, saponification value, iodine value, unsaponifiable matter; determination of sulphide in alkaline liquors, determination of hydroxyproline in materials containing collagen.

Environmental analysis: Sampling procedures of waste water for analysis. Analysis of tannery wastewater sample: alkalinity, acidity, total solids, dissolved solids, suspended solids, sulphate, sulphide, chromium, settle able solid, banned amines, Identification of carcinogenic amine from a mixture of dyes, identification of benzidine-based dye.

Laboratory automation: Introduction, approaches to laboratory automation, principles of automation, planning for laboratory automation, automated instruments, microprocessor-controlled instruments: "smart" instruments, computers in analytical chemistry.

Safety practice in laboratory: Introduction, MAK values of working material that involved health hazard, list of harmful materials, carcinogenic working materials, emission protection law, danger symbols, regulations concerning the transportation of materials classified as dangerous goods, prevention of accidents and first aid in laboratory, hazard and hazard agents identification, hazard classification, hazard control, safety management, safety promotion and awareness creation, safety and emergency provisions.

Learning Outcomes: On completing this course:

- The students will have a theoretical and practical understanding of advanced analytical instruments.
- They will be able to analyze leather and leather related chemicals.
- They will be able to assess the quality of leather, footwear and leather products.
- They will be able to work in environmental research.

Reference Books:

1. Gary D. Christian- Analytical Chemistry
2. John Kenkel- Analytical Chemistry for Technicians
3. Skoog, West and Holler- Fundamental of Analytical Chemistry
4. Browning D. R. - Chromatography
5. Hatakeyama T. and Quinn F.X. - Thermal analysis.
6. Vogel A. I. - Text Book of Quantitative Chemical Analysis
7. P. K. Sarker - Analytical Chemistry for Leather Manufacture.
8. Dr. Sethi P.D. - High Performance Liquid Chromatography.
9. Hamilton, Hamiltoan-Thin Layer Chromatography.
10. Fifield and Haines-Environmental Analytical Chemistry.
11. UNIDO- Tannery and Environment.

CHM-202: Analytical Chemistry Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives: The learning objectives of this course are:

- To apply practical knowledge in analytical chemistry.
- To introduce the fundamental knowledge and skill of different tests in determining moisture content, fat content, acid value pH in leather and leather chemicals.
- To determine toxic metals and other toxic chemicals both in leather and tannery effluents.

Course Contents:

1. Determination of moisture content and pH in synthetic tanning materials.
2. Determination of acid value in supplied samples.
3. Determination of Iron in vegetable tanning extracts.
4. Determination of Chromium in vegetable tanning extracts.
5. Determination of Chromium in chrome tanning extracts.
6. Determination of chloride in alkaline tannery waste water.
7. Determination of hydroxyproline in collagen containing materials.
8. Determination of fat and other soluble substances in shoe upper leather.
9. Determination of originally combined SO3 existing as neutralized sulphuric ester.
10. Determination of total free fatty acids: qualitative identification of surface-active groups.

Learning Outcomes: Upon completion of this course the students will be able to

- Analyze leather chemicals.
- Find out the amount of unused chemicals in tannery waste.

Institute of Leather Engineering and Technology, University of Dhaka

- Interpret different analytical quantitative experimental knowledge and skill to determine moisture content/pH in leather and in synthetic tanning materials.
- Learn the concentration of Cr, Fe in tannery waste liquor.

Reference Books:

1. Gary D. Christian- Analytical Chemistry
2. John Kenkel- Analytical Chemistry for Technicians
3. Vogel A. I. - Text Book of Quantitative Chemical Analysis
4. Sarker P.K. - Analytical Chemistry for Leather Manufacture.

EEE-201: Fundamentals of Electrical and Electronics Engineering

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- Understand the fundamentals of electronics within the field of electrical engineering.
- Understand diode circuits and models.
- Know how to use and analyze distribution circuits, cables and wiring systems
- Analyze amplifier circuits with feedback.
- Design electronic circuits for sensors

Course Contents:

Electrical Engineering: D.C. Current: D.C. fundamentals, Network Theorems, Generators and their characteristics, Motors & their characteristics, Speed control process.

A.C. Current: A.C. fundamentals, Flow of A.C. through inductance, capacitance and resistance Flow of A.C. through inductance, resistance and capacitance in series and in parallel, Power in A.C. Circuit, Power Factor and Power Factor Improvement, Resonance in AC circuits, Transformer, Poly phase circuits, Induction motors. Its types and purpose. Sub-station equipment (HT, LT Switch gear etc.), Distribution board and sub-distribution board.

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

System protection: Types of faults, (transformer and motor) principles of protection, Protective devices-circuit breaker, Switches, starter etc.

Electrical hazards: Protection against shock and fire, earthing and its importance, procedure to be adopted when a person is in contact with a live conductor.

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

Learning Outcomes:

- Conduct standard tests and measurements, and to conduct, analyze, and interpret experiments related to electrical engineering technology.
- Recognize a variety of exciting high-tech products and systems enabled by electronics.
- Manipulate voltages, currents and resistances in electronic circuits.

- Demonstrate familiarity with basic electronic components and use them to design simple electronic circuits.

Reference Books:

1. A Textbook of Electrical Technology (vol: I & II), B. L. Theraja
2. Alternating Current Circuit, George F. Corkoran
3. Principles of Electronics, V.K. Mehta
4. Power System, V.K. Mehta

PHY-201: Physics and Electronics Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives: The objective of this course is to provide a broad training in Physics and Electronics principles with laboratory experiments. Demonstrate the students on various skills including; expertise with core physics concepts and basic electronic principles and their applications. This course will help the students to relate the physical phenomenon with the practical problems in engineering purposes, proficiency in measurements and dimensioning, critical thinking and data analysis. In future, it will help the students to function effectively in laboratory environment and conduct independent research towards the development of new devices and products using sophisticated physical concepts.

Course Contents:

Part A: Physics

1. Determination of the value Y, η and σ for the material of a given wire by Searle's apparatus.
2. Determination of the modulus of rigidity of a cylindrical wire by dynamic method.
3. Determination of the thermal conductivity of bad conductor by Lee's method.
4. Determination of the specific heat of a liquid by the method of cooling.
5. Determination of the value of "g" by Kater's reversible pendulum.
6. Determination of the wavelength of sodium light by Newton's ring.
7. Verification of Ohm's law and measurement of low resistance by ammeter and voltmeter.
8. Determination of the refractive index of a material of a given prism by a spectrometer.
9. Determination of the grating constant of a plane diffraction grating.
10. Determination of the optical rotation of sugar solution (at six different concentrations) with the help of a polarimeter.

Part B: Electronics

1. Verification of KCL and KVL.

Institute of Leather Engineering and Technology, University of Dhaka

2. Verification of Norton's and Thevenin's theorem.
3. Study the characteristic of a general purpose and Zener diode.
4. Study the characteristic of a transistor in CB configuration.
5. Study the characteristic of a transistor in CE configuration.
6. Study the characteristic of a single stage amplifier.
7. Study the basic characteristic of logic gates.
8. Study the basic characteristic of SCR and TRIAC.
9. Study the basic operation of different sensors and Transducers.
10. Study the basic operation of Microprocessors.

Learning Outcomes:

- Successful completion of this course will help students with following outcomes:
- Work efficiently in leather, leather products, and footwear industries where proper application of engineering knowledge requires the basics of physics and electronics.
- Design and conduct experiments, as well as to analyze and interpret data.
- Communicate their ideas with others and function effectively in multidisciplinary terms.
- Start career as a practicing engineer in fields such as design, research, development, testing, manufacturing, operations, and service systems.
- Continue to learn through advance study or engagement in professional development activities within physics, electrical engineering or other technical fields.

Reference Books:

1. David Halliday/Robert Resnick/Jearl Walker-Fundamentals of Physics.
2. F.W.Newman and V.H.L.Searl -The General properties of Matter
3. D.S.Mathur- Elements of Properties of Matter
4. Paul D. Malvino - Electronic principles.
5. F.Sears and G.L. Salinger -Thermodynamics, Kinetic Theory and Statistical Thermodynamics
6. S.C.Arrora/S. Domkundwar-A Course in Heat & Mass Transfer.
7. Harvey E.White/Francis A. Jenkins-Fundamentals of Optics.
8. V. K. Mehta- Principles of Electrical Engineering and Electronics.
9. B.L. Therera and A.K. Therera - Solid State Electronics

Second Year (2nd Semester)

LE-205: Leather Processing-III (Non-Mineral)

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To know the basic of organic tannage
- To familiarize with different tanning agents for organic tannage
- To develop knowledge about the mechanism of vegetable tanning
- To understand the chemistry of syntans and the process of synthetic tanning
- To learn the details of oil tanning and aldehyde tanning

Course Contents:

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

Hydrolysable tannins: chemistry of poly phenolic tannins present in major hydrolysable tanning material methods of separation of poly phenolic substance from tanning extracts, structure of galotannins an ellagitannins.

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

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

Vegetable tanning: Mechanism of vegetable tanning, Principle of vegetable tanning, sources, supply of vegetable tanning, mechanism of vegetable tanning, factors affecting vegetable tannage, process of vegetable tanning, manufacturing process of different vegetables tanning, pollution load of vegetable tanning, cleaner method of vegetable tanning.

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

Resin and Polymeric Tannages: study different methylol compounds of nitrogen basis and polymeric compounds used in leather manufacture.

Aldehyde tannage: Concept of aldehyde tanning, mechanism of aldehyde tanning, environmental aspects, cleaner processing, different aldehydes used for tanning, factors involved in tannages, properties of leather tanned with different aldehydes.

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

Learning Outcomes: After completing this course students will be able

- perform organic tannage
- use cleaner processing for leather tanning
- apply organic tannins for leather processing
- determine the effect of syntans on dyeing
- identify the environmental aspects in different organic tannages.

Reference Books:

1. Sarkar, K.T., "Theory and Practice of Leather Manufacture".
2. Dutta. S.S., "An Introduction to the Principles of Leather Manufacture"

Institute of Leather Engineering and Technology, University of Dhaka

3. Wilson, J. A., "The chemistry of Leather Manufactures" Vol. II
4. Gustavson, K. H., "The Chemistry of Tanning Process"
5. Flaherty, Roddy, Lollar, "The Chemistry and Technology of Leather" Vol. II.

LE-206: Leather Processing-III Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0 /Group	45.0/Group

Lab based of the content of LE-205.

LE-207: Dyeing and Finishing-I

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To know about the theory of color
- To develop knowledge about dyes used in leather dyeing
- To learn the theory and mechanism of leather finishing
- To get idea about different finishing materials.

Course Contents:

Color and constitution: Color concept, types of color and colorants, theory of color production, fluorescence, phosphorescence and chemiluminescence.

Primaries and intermediates: Different primaries and intermediates, unit process for primaries and intermediates.

Dyes: Nomenclature and classification of dyes, structure of natural and synthetic dyes; dyes preparation and their interaction with leather, selection of leather dyes, properties of leather dyes, leather dyes in Color Index (CI).

Leather dyeing: Practical aspect of dyeing effect, factors influence in dyeing, dyeing auxiliaries, levelness, fixation of dyes, color measurement, color different and color matching, dyeing defect and their remedies.

Theory of leather finishing: Concept of coating, preparation of leather surface for finishing, theory of adhesion, theory and mechanism of film formation, gloss and gloss retention, plasticization of finish film, evaluation and control of leather finishing.

Leather finishing materials: Types, various types of finishing agents.

Learning Outcomes: After completing this course students will be able to

- determine the dyes fixation in leather and find out the color mismatch
- identify the dyeing defects
- apply various finishing materials in leather finishing
- evaluate and control the leather finishing
- improve the appearance of finished leather using better quality finishing agents.

Reference Books:

1. Eco-Friendly Textile Dyeing and Finishing. Edited by: Melih Günay

2. Advances in the Dyeing and Finishing of Technical Textiles Edited by: M. L. Gulrajani

LE-208: Dyeing and Finishing Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/ Group

Lab based of the content of LE-207.

CHM-203: Instrumental Analysis of Leather and Leather Products

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives: The objectives of this course are to provide:

- An introduction to analytical chemistry for leather and leather products manufacture and an overview of important analytical methods and their range of application in leather within detection of inorganic, organic and other toxic compounds.
- Important analytical quantitative techniques from classical methods, electrochemical methods, spectrochemical/spectrophotometric methods, and separation techniques are reviewed.
- The course also includes risk assessment of chemical experiments, important steps and procedures in analytical chemistry, and evaluation/interpretation of results.
- The course gives an overview of important use of selected classical and instrumental chemical quantitative analytical methods leather product manufacturing and a short introduction to their basic theory.

Course Contents:

Gas chromatography: Introduction, classification, principles of gas-liquid chromatography, gas-solid chromatography, techniques of gas-liquid chromatography, carrier gas, sample injector, gas chromatograph columns and detectors: different types of detectors- thermal conductivity detector (TCD), flame ionization detector (FID), electron capture detector (ECD), nitrogen/phosphorus detector (NPD), qualitative and quantitative, Application of gas-liquid chromatography in leather industries.

High-Performance liquid chromatography: Basic concept, comparison of HPLC with gas–liquid chromatography, apparatus for HPLC, solvent delivery, sample injector, selection of column Different detectors: - UV and RI detectors, Qualitative and quantitative analysis, effect of temperature in HPLC, application of HPLC.

Thermal techniques: Basic principles of Differential thermal analysis (DTA), Differential scanning calorimetry (DSC), Thermogravimetry (TG), application in leather science.

Infrared spectrometry: Basic principles of IR, Types of vibrations, characteristics regions of the spectrum, the parameters determining the position and intensity of bands, experimental technique, characteristic absorption bands and functional groups, Influence of substituent, polarity, ring size, hydrogen bonding, conjugation, application of IR spectrum for chemical analysis.

Institute of Leather Engineering and Technology, University of Dhaka

Nuclear magnetic resonance spectrometry: Fundamental theory, NMR active nucleus, instrumentation, solvents, chemical shift and factors affecting chemical shift, application of ^{1}H-NMR, application of ^{1}H-NMR spectrum in leather chemical analysis.

Atomic absorption spectrometry: Introduction, basic principles, instrumentation, sample preparation, type of techniques, effect of flame temperature, chemical and spectral interference, recent developments, applications.

Learning Outcomes: Upon completion of this course the students will be able to

- Interpret different analytical quantitative techniques from classical methods, electrochemical methods, spectrochemical / spectrophotometric methods, and separation techniques.
- Learn about risk assessment of chemical experiments, important steps and procedures in analytical chemistry, and evaluation/interpretation of results.
- Understand and use of selected classical and instrumental chemical quantitative analytical methods and a short introduction to their basic theory.

Reference Books:

1. Gary D. Christian- Analytical Chemistry
2. John Kenkel- Analytical Chemistry for Technicians
3. Sharma B. K. - Instrumental Methods of Chemical Analysis
4. Browning D. R. - Chromatography
5. Hatakeyama T. and Quinn F.X. - Thermal analysis.
6. Vogel A. I. - Text Book of Quantitative Chemical Analysis
7. Sarker P.K. - Analytical Chemistry for Leather Manufacture.
8. Williams D. H. and Ian Fleming- Spectroscopic methods in Organic chemistry.
9. Kalsi P.S. - Spectroscopy of organic compounds.
10. Dr. Sethi P.D. - High Performance Liquid Chromatography.
11. Banwel l C. N. -Fundamentals of Molecular Spectroscopy.

CHM-204: Chemical Analysis of Leather and Leather Products Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives: The learning objectives of this course are:

- To apply practical knowledge in analytical chemistry.
- To introduce the essential experimental knowledge and skill of different tests to determine moisture content, pH in leather and synthetic tanning materials, total fat in sulphated oils.
- To determine Formaldehyde, Azo colorants, phthalates, VOC, aldehyde, Nitrogen Content, preservative, tetrachlorophenol-, trichlorophenol-, dichlorophenol-, monochlorophenol-isomers, ethoxylated alkylphenols and of *N-methyl-2-pyrrolidone (NMP)*.
- To determine total Chromium, Lead, Cadmium and aluminum by Atomic Absorption Spectroscopy (AAS) and Chromium (VI) by UV-VIS spectrophotometer.

Course Contents:

1. Determination of moisture content/pH in finished leather samples.
2. Determination of chloride content in finished leather.
3. Determination of sulfated ash content of finished leather.
4. Determination of acidity of shoe upper and garments leather.
5. Determination of chromic oxide content in finished leather.
6. Determination of collagen content of finished leather.
7. Determination of Formaldehyde content in leather.
8. Determination of Azo colorants (carcinogenic aromatic amines) content in dyed leather.
9. Determination of phthalates content in leather, leather products and *footwear materials.*
10. Determination of VOC and aldehyde emissions.
11. Determination of Nitrogen Content (Kjeldahl) and Hide Substance Content of Leather.
12. Determination of the preservative (TCMTB, PCMC, OPP, OIT) content in leather by liquid chromatography.
13. Determination of tetrachlorophenol-, trichlorophenol-, dichlorophenol-, monochlorophenol-isomers and pentachlorophenol content.
14. Determination of ethoxylated alkylphenols.
15. Chemical determination of *N-methyl-2-pyrrolidone (NMP)* in leather.
16. Determination of total Chromium in leather samples by Atomic Absorption Spectroscopy (AAS).
17. Determination of total Lead and Cadmium in leather samples by Atomic Absorption Spectroscopy (AAS).
18. Photometric determination of Chromium (VI) by UV-VIS spectrophotometer.
19. Determination of thermal behavior of crust leather by TGA.
20. Determination of thermal behavior of finished leather by TGA
21. Determination of thermal behavior of PU, PVC, rubber by TGA.
22. Identification of leather, PU, PVC, rubber by FT-IR.

Learning Outcomes: Upon completion of this course the students will be able to

- Apply practical analytical chemistry knowledge for leather manufacture
- Interpret different analytical quantitative experimental knowledge and skill to determine moisture content/pH in leather and in synthetic tanning materials.
- Determine Formaldehyde, Azo colorants, phthalates, VOC, aldehyde, Nitrogen Content, preservative, tetrachlorophenol-, trichlorophenol-, dichlorophenol-, monochlorophenol-isomers, ethoxylated alkylphenols and of *N-methyl-2-pyrrolidone (NMP)*.
- Learn the concentration of Cr, Pb, Cd and Cr(VI) by spectroscopic method.

Reference Books:

1. Gary D. Christian- Analytical Chemistry
2. John Kenkel- Analytical Chemistry for Technicians
3. Skoog, Holler and Nieman- Principles of Instrumental Analysis

Institute of Leather Engineering and Technology, University of Dhaka

4. Hatakeyama T. and Quinn F.X. - Thermal analysis.
5. Vogel A. I. - Text Book of Quantitative Chemical Analysis
6. Sarker P.K. - Analytical Chemistry for Leather Manufacture.

MTH-202: Probability and Statistics

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To provide the basic foundations of statistics with applications in real life.
- To provide knowledge on descriptive statistics, correlation, regression, probability, and probability distributions for both continuous and discrete random variable.
- To discuss the theory and how to apply and use the theory for real life problem-solving and inquiry.
- To provide students with hands on experience in using the statistical theory and methods to perform the different statistical analyses and to interpret results.

Course Contents:

Introduction: Historical development of the subject, Collection of data-Primary data and secondary data.

Frequency distribution: Grouped frequency distribution and their presentation in the form of frequency polygon and Histogram.

Measures of central tendency: Mean (a) Arithmetic Mean (b) Geometric Mean, (c) Harmonic Mean, Median (iii) Mode, Their definition, computation, Advantage, Disadvantage and uses.

Measures of dispersion: Absolute measure, (a) Range (b) Mean deviation (c) Quartile deviation (d) standard deviation, Relative measure, Coefficient of variation, their definition, computation and uses.

Moment, skewness and kurtosis: Their definition, computation and uses.

Probability: Simple idea of probability, Different definitions related to probability, Addition law of' probability for mutually exclusive and not mutually exclusive events, Multiplication law of probabilities for dependent and independent events, Probability distribution (i) Binomial, (ii) Poisson, (iii) Simple idea about normal distribution and its probability curve.

Estimation: Simple idea about estimation

Correlation and Regression: Correlation-Ideas of correlation, Measurement of correlation. Pearsonian correlation co-efficient, and spearman's Rank correlation co-efficient. Multiple correlations, Regression-Ideas about simple regression, Equation of the regression line, Estimation of the parameters of the regression line.

Test of significance: some definitions related to test of significance

T-test:

(a) Comparison of a sample mean with a known population mean when S.D. is known and when S.D. is not known

(b) Comparison of two samples means when S.D. is known and also when it is unknown, (c) Paired t test, its practical use in Leather/Footwear/Leather Product Industry.
X^2 test-Simple application and its practical use in Industry.
Sampling: Definition of population, sample, parameter, census etc.
Simple Random Sampling, Stratified random sampling, their definition, computation, use, advantage & disadvantage.
Design of experiment: Basic principles of experimental design, Ideas about CRD, RBD.
Learning Outcomes:

- Demonstrate the ability to apply fundamental concepts in exploratory data analysis.
- Construct and analyze graphical displays to summarize data.
- Compute and interpret measures of center and spread of data
- Calculate, interpret and communicate the correlation coefficient and simple linear regression model.
- Utilize basic concepts of probability including independence and conditional probability to calculate, interpret and communicate event probabilities both for discrete and continuous random variables.
- Determine the appropriate probability distribution based on experiment conditions and assumptions.

Reference Books:

1. An introduction to Statistics and Probability, Dr. Nurul Islam
2. Business Statistics (Fourteenth Edition), Dr. S.P. Gupta & Dr. M.P. Gupta
3. Research Methodology (Methods & Techniques), C.R. Kothar

MSE-201: Fundamentals of Materials Science and Engineering		
Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives: The objective of this course is

- to highlight the students on the properties and behavior of various materials

Course Contents:
Materials: Basic concept of materials science and engineering, classification of materials, materials of the future, smart and intelligent materials, nanotechnology, an overview of material science and engineering and its recent developments.
Mechanical properties of materials: Concept of stress and strain, elastic deformation, stress-strain behavior, elasticity, elastic properties of materials, tensile properties, plastic deformation, tensile properties, true stress and strain, elastic recovery after plastic deformation, compressive, shear, and torsional deformations, hardness. Variability of material properties, design/safety factors, dislocation, characteristics of dislocations, slip, slip systems, generalized creep behavior, stress and temperature effect, viscoelastic deformation.
Thermal and electrical properties of materials: Heat capacity, thermal expansion, materials of importance invar and other low expansion alloys, thermal conductivity and thermal stresses, electrical conduction, semiconductivity, Hall effect, semiconductor devices, electrical conduction in ionic ceramics and in polymers, dielectric behavior, capacitance, field vectors and polarization, types of polarization, polaron, phonons, frequency dependence of the dielectric constant, dielectric strength, dielectric materials, ferroelectricity, piezoelectricity, conducting polymers, polymer electrolytes; interaction between polymer and salts, polymer in salt and salt in polymer electrolytes.
Magnetic properties materials: Basic concepts, diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism and ferrimagnetism. Influence of temperature on magnetic behavior, domains and hysteresis, magnetic anisotropy, soft and hard magnetic materials, magnetic storage, superconductivity.
Optical properties of materials: Light interactions with solids, atomic and electronic interactions, optical properties of metals, optical properties of nonmetals, refraction, reflection, absorption, transmission, color, opacity, and translucency in insulators, applications of optical phenomena, luminescence, materials of importance-light emitting diodes (LED), photoconductivity, lasers, optical fibers in communications; components, step index, graded index optical fiber design, free electron theory, energy bands, charge transport.
Characterization of materials: X-ray diffraction, structure determination from powder patterns, influence of crystal symmetry and multiplicities on powder pattern, limitation of powder methods, neutron diffraction, applications, advantages and disadvantages, electron microscope, electron diffraction applications, transmission electron diffraction applications, transmission electron microscopy (TEM), scanning electron microscopy (SEM), analytical electron microscopy (AEM), thermal analysis such as TGA, DSC, DTA, elemental analysis.
Metals and alloys (Nonferrous and ferrous): Properties and uses, Wrought iron, cast iron, steel, alloy steel, stainless steel. Aluminum and its alloys, copper and its alloys, nickel alloys- properties, uses and composition. Effects of alloying. Heat treatment of steel. Identification of metal. Metal joining. Oxidation and degradation, corrosion and corrosion protection.
Composite materials: Particle-reinforced composites: large-particle composites, dispersion-strengthened composites, fiber-reinforced composites, influence of fiber length, influence of fiber orientation and concentration, the fiber phase, the matrix phase, polymer-matrix composites, metal-matrix composites, ceramic-matrix composites, glass material, phase transition, interpretation of phase diagrams, carbon-carbon composites, processing of fiber-reinforced composites, hybrid composites, structural composites, laminar composites, sandwich panels, materials of importance-nanocomposites in tennis balls, biomaterials and advanced ceramics.
Learning Outcomes: At the end of this course, the students will

- Understand the properties of various materials.
- Have knowledge about the methods to characterize them.
- Aware about the selection criteria of synthetic material for Leather industries

Reference Books:

1. Introduction to Physical Metallurgy, Avner
2. Strength of Materials, Andrew Pytel, Ferdin and L. Singer

3. Strength of Materials,-R.S. Khurmi
4. An Introduction to Metallurgy, A.H. Cottrell
5. Materials Science and Engineering-An Introduction -W. D. Callister Jr.
6. The Science and Engineering of Materials -D. R. Askeland, P. Phulé.
7. Foundations of Materials Science and Engineering -W. F. Smith.
8. Solid State Chemistry and its Applications,2nd edition- John Wiley & Sons.
9. Solid Polymer Electrolytes -F. M. Gray.
10. Physical Chemistry -P. W. Atkins, J. D. Paula.
11. Ionic Liquids in Polymer Systems -R. D. Rogers, C. S. Brazel.

LE-209: Field Tour

Credit	Class/week (h)	Total Class (h)
1.0	-	-

The students shall have a daylong visit of one relevant industry.

Third Year (1st Semester)

LE-301: Post-Tanning and Finishing

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To know about the stages involved in post-tanning
- To get idea about mechanical operation before wet finishing
- To comprehend the significance of neutralization in post-tanning
- To learn the process of fatliqouring and re-chroming
- To familiarize with eco-friendly and cleaner leather finishing
- To know about combination tannage

Course Contents:

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

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

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

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

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

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

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

Mechanical and manual operations of re-tanned leather: Objectives of Setting out, Vacuum drying, Tunnel/overhead drying, Vibrating staking, Toggle drying, Trimming**,** Dry vacuum.

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

Pre-finishing operation: Conditioning, milling, staining, buffing and snuffing, dedusting, polishing, rolling.

Finishing: Definition of leather finishing, structure of finishes, classification of finishes-Classification according to finishing technique, classification according to finishing effect, classification according to finishing material used.

Basic products for finishing application: Leather Coating materials (pigment preparations), organic dyes for finishing preparation, Thermoplastic and cross-linking binders, Non-thermoplastic binders, Grain impregnation agents, Base coating agents, Top coating agents, Plasticizers, Finishing auxiliaries. General Composition of finishing floats.

Finishing operations: Application of finishes-padding, brushing, spraying, curtain coating, printing and laminating; plating, glazing, polishing, ironing and Finiflex.

Manufacture of different types of leather: Shoe upper, garments, upholstery, gloving, technical leather; physical and chemical requirements, classification, methodology, optimization of process, trouble shooting.

Learning Outcomes: After completing this course students will be able to

- understand the necessity of post-tanning processes
- perform eco-friendly and cleaner finishing process
- elucidate –tanning and combination tannage
- develop methods for effluent treatment and
- take initiative for zero discharge in effluent.
- manufacture different types of leather

Reference Books:

1. Anthony D. Covington- Tanning Chemistry The Science of Leather
2. Dutta S.S.-An introduction to the principles of leather manufacture.
3. KrystofBienkieuicz - Physical chemistry of leather making.
4. Flaharty, Roddy, Lollar-The chemistry and technology of leather (vol-2and3)
5. Sarkar K.T.-Theory and Practice of Leather Manufacture.

6. Reed R. -Science for Students of Leather Technology.
7. BASF Manual -Pocket Book for the Leather Technologist.
8. Sarphouse J.H.-Leather Technicians Handbook.
9. Heidenmann Eckhart - Fundamentals of Leather Manufacture.
10. Procter H.R.-The Principle of Leather Manufacture.

LE-302: Leather Finishing-I Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0 /Group	45.0/Group

Learning Objectives: The aim of this course is to:

- Introduce students to quantitative & qualities methods for conducting meaningful inquiry and practical.
- Enhance the students' ability to analyze and critically evaluate the issues of practical in the realm of leather manufacturing engineering.
- Enhance knowledge and skills of student for designing and conducting an academic practical independently.

Course Contents:

1. Manufacturing of corrected grain finish leather
2. Manufacturing of glaze/plate finish leather
3. Manufacturing of Embossed finish leather
4. Manufacturing of spray finish leather
5. Manufacturing of curtain coating finish leather
6. Manufacturing of Roll coating finish leather

Learning Outcomes: At the end of the course the students will be able to:

- Display familiarity with a broad array of methods and approaches that are used within the industry.
- Demonstrate practical competence in critical thinking by presenting and evaluating arguments in an academic fashion.
- Develop a manufacturing hypothesis and frame the manufacturing problem with the correct methodology.
- Know how to write a process recipe using mixed methods of practical.
- Apply practical mythological tools and techniques for conducting research & development in the areas of leather engineering.

Reference Books:

1. Dutta S.S.-An introduction to the principles of leather manufacture.
2. Krystof Bienkieuicz - Physical chemistry of leather making.
3. Flaharty , Roddy , Lollar-The chemistry and technology of leather (vol-2&3)
4. Sarkar K.T.-Theory and Practice of Leather Manufacture.
5. Reed R. -Science for Students of Leather Technology.
6. BASF Manual -Pocket Book for the Leather Technologist.
7. Sarphouse J.H.-Leather Technicians Handbook.
8. Heidenmann Eckhart - Fundamentals of Leather Manufacture.
9. Procter H.R.-The Principle of Leather Manufacture.
10. Mclaughlin.George D. - The Chemistry of Leather Manufacture.
11. Gustavson K.H.- The Chemistry of Tanning Processes.

LE-303: Fundamentals of Leather Products Manufacturing

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To get basic idea about various types of leather products
- To know the background of leather products
- To develop knowledge about fashion, art and design
- To learn about the patternmaking for leather goods
- To be introduced to various tools, equipment and machinery used in leather products manufacturing
- To get knowledge about the manufacturing process of different leather goods especially bags.

Course Contents:

Historical background and development of leather products: History of leather products, aspect of fashion, types of fashion, trends in fashion, leather products as apparel and types of leather products.

Color, Art and Design: Idea on art, design and color; motif, application of design.

Tools and equipment for leather products manufacture: Types of tools and their functions, tools and equipment for modern leather products manufacturing.

Pattern making: Concept of pattern making, types of pattern, indication of patterns, transferring the pattern, free hand drawing, 2D-3D concept, allowance, pattern making for leather products; different shaped pattern making and joining.

Cutting operations for leather products: Define cutting operations, types of cutting system, works to be done before cutting, during cutting and after cutting, pattern placement, cutting norms, wastage determination, advantage and limitation of cutting techniques.

Embossed, Printing and Attaching: Introduction, printing and cutting of small component part; printing perforating watchstraps; process control, procedure and acceptance criteria of embossing, printing and attaching.

Joining techniques: Definition and properties of stitch, seam, sewing; types of seam; cable stitching, glove stitching, moccasin stitching; lacing.

Lining material and their uses: Silk, satin, velvet, rayon, poplin, moirette, fabric of mercerized cotton, printed cotton, drill, laminate, polyesters, wool and far, Polynesia.

Materials handling: Automated handling system, hand push movable trolleys, electromechanically power conveyors.

Product Development: Specification sheet, theme board preparation, material consumption and costing.

Sewing machines: Types of sewing machine and their properties, parts of sewing machine

and their functions; feeding system and mechanism; Theory of stitch formation.

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

Bags: Types of bag, materials, tools and equipment, types of different gussets of bag shape and joining; attaching straps to gussets, flap fastening, pockets, making a one-gusset bag pattern, making stitch holes, attaching gussets, general working order, bag fastening-tongue and loop, double tongue and loop, loop and toggle, loop and bead/toggle/button strap and buckle, turn lock, drawstring, zips, flaps and straps, Construction of different types of Gussets, leather consumption and costing for bag; Passport case: introduction, raw materials, perspective drawing, list of components, measurement instruction, total pattern making, leather consumption, splitting and skiving instruction, construction and assembling.

Learning Outcomes: After completing this course students will be able to

- make design for leather goods /articles
- develop patterns for various leather goods
- familiarize with different machinery used in leather products manufacturing
- get knowledge about the assembling procedure of different components for leather products
- comprehend the material consumption and costing

Reference Books:

1. Anne & Jane Cope-Leatherwork
2. Carr & Latham-The Technology of Clothing Manufacture
3. Kirsten Jorgensen-Making Leather Clothes
4. Ben and Elizabeth Morris-Making Clothes in Leather
5. Sylvia Grainger-Leatherwork
6. Mary and E.A. Manning-Leatherwork
7. Francesca Sterlacei-Leather Apparel Design
8. Martin M. Shoben & Janet P. Ward-Pattern Cutting and making Up
9. Moseley, G.C-Leather Goods Manufacture
10. Batsford-Fashion with Leather

LE-304: Leather Products Manufacturing Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0 /Group	45.0/Group

Lab based of the content of LE-303.

ME-301: Fundamentals of Mechanical Engineering

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

Institute of Leather Engineering and Technology, University of Dhaka

- Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
- Successfully apply fundamental mathematical, scientific, and engineering technology principles in formulating and solving mechanical engineering technology problems;
- Successfully implement theory in one or more core mechanical engineering technology areas of practice in a sustainable manner;
- Ability to work in teams on multi-disciplinary projects in industry and research organizations.
- Ability to self-learn modern engineering tools, techniques, skills and contemporary engineering practice, necessary for engineering work.

Course Contents:

Thermodynamics: Fundamental concepts and definitions, laws of thermodynamics, thermodynamic processes and cycles, introduction to steam generator units, detail study of boiler, vapor power cycles-Ranking, Reheat, internal combustion engines, steam turbines, compressor. Measurements and automatic control mechanism.

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

Fluid mechanics: Hydraulics properties of fluids, Surface tension and capillary tubes, basic hydrostatic equation, pressure head of a liquid, pressure gauges, flow of fluids, Bernoulli's equation, and equation of continuity. Laminar flow and turbulent flow, head loss due to friction in a pipe, fluid flow measurements.

Pumps- types: characteristics and application of reciprocating and centrifugal pumps.

Learning Outcomes: Upon completion of this course the students will be able to

- to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
- apply fundamental mathematical, scientific, and engineering technology principles in formulating and solving mechanical engineering technology problems;
- implement theory in one or more core mechanical engineering technology areas of practice in a sustainable manner;
- work in teams on multi-disciplinary projects in industry and research organizations.
- to self-learn modern engineering tools, techniques, skills and contemporary engineering practice, necessary for engineering work.

Reference Books:

1. Thermal Engineering, R.S. Khurmi
2. Heat Transfer, Holman
3. Engineering Thermodynamics, Rogers

ME-302: Mechanical Workshop

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives:

- To know about different pipe fittings
- To learn the steam generating unit
- To understand the application of pumps, compressor, generator, engine, turbines
- To know how to use power generator

Course Contents:

1. Introduction to different pipe fittings,
2. Study of Steam Generating Unit, Pumps, Compressor, Power Generator, Engines, (petrol, diesel and gas), Turbines.

Learning Outcomes: Upon completion of this course students will be able

- to identify and use different mechanical instruments.

Reference Books:

1. Thermal Engineering, R.S. Khurmi
2. Heat Transfer, Holman
3. Engineering Thermodynamics, Rogers

ENV-301: Environmental Science and Engineering

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To educate students about the importance of studying environmental science and engineering in leather practicing
- to create awareness in protection of environment.

Course Contents:

Concept of Environment: Definition and concept of environment; Types and components of Environment (Lithosphere, Atmosphere, Hydropshere, Biosphere); Scope and multidisciplinary nature of the subject; Man-environment relationships; Public awareness – Earth Summits, recent Conventions on climate change.

Environment, ecosystem, biodiversity and sustainable development: Scope and importance of environment, need for public awareness, concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Introduction to biodiversity definition: Genetic, species and ecosystem diversity. Bio-amplification of food chain. Sustainable development and significance of sustainable development in environmental related issues, toxic hazards and their control, controls of substance hazardous to health, hazard evaluation, risk assessment and control.

Environmental Pollution and Chemistry: Definition of pollution- different types of environmental pollution, classification of pollutants in water and wastewater, characterization of pollutants in water and wastewater, environmental significance, types of sampling, significance of sampling, precautions to be taken while sampling and preservation of samples.

Types, Causes, effects and control measures of: (a) air pollution, global warming, ozone hole, acid rain, climate change, photochemical smoke, (b) soil pollution (c) Marine pollution (d) noise pollution (e) thermal pollution (f) nuclear hazards.

Concept on environmental management and Environmental Management System (EMS); Management of water pollution, Environmental quality measurement (ISO:14000), Implication of Agenda-21; Functions of management--forecasting, planning, organizing, motivating, coordinating, controlling, and communicating, leadership, directing, and decision making

Environmental Policies and Legislation: Environmental legislations in Bangladesh, ECA-1995, ECR-1997; Enforcement, monitoring and auditing, government and industry policies, self-regulations by industry, environment protection act, air (prevention and control of pollution) act, water (prevention and control of pollution) act, wildlife protection act, forest conservation act, solid and hazardous waste management rules, biomedical waste rules, responsibilities of generators, role and responsibility of pollution control boards.

Environmental Impact Assessment: Concept, objectives, methodologies, screening, IEE, scoping, base line studies, impact evaluation, mitigation measures and monitoring.

Learning Outcomes: Upon completion of this course the students will be able to

- Understand the diverse environmental problems, looking at causal linkages between pollution sources, exposure pathways and impacts to environmental quality and human health.
- Know the adverse effect associated with different operations exposure to chemicals, biological and physical hazards, and proper management procedures required for personal safety from potential risks.
- Understand and design the type of effluent treatment plant that is required for treating the wastes for their reuse or safe disposal to the environment.
- Illustrate the safety recommendation and regulations for the workers working in the leather products industries.

References Books:

1. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).
1. Sawyer, C.N., MacCarty, P.L. and Parkin, G.F., Chemistry for Environmental Engineering and Science, Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, New Delhi, 2003.
3. Peavy HS, Rowe DR, Tchobanoglous G (1985) Environmental Engineering. (Eds: McGraw-Hill International Editions), Civil Engineering Series, 577.
4. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science, London, 1999.

ENV-302: Environmental Science and Engineering Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Lab based of the content of ENV-301.

HUM-301: Industrial Sociology

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To obtain sociological knowledge of core areas and substantive topics and the ability to think critically about them
- To introduce students to the basic social processes of society, social institutions and patterns of social behavior.
- To train students to understand and to interpret objectively the role of social processes, social institutions and social interactions in their lives.
- To demonstrate advanced understanding of key linkages between ecosystem and social processes and how they relate to human-nature interactions, and to integrate this understanding with knowledge drawn from their own degree backgrounds.

Course Contents:

Introduction to Sociology: Definition, nature, scope, importance, Social Interactions, Social Groups, Social Institutions.

Culture and Related Concepts: Definition of Culture, Types, Elements, Role of Culture in Organization, Socialization and Personality.

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

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

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

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

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

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

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

Learning Outcomes:

Institute of Leather Engineering and Technology, University of Dhaka

- Explain the major methods and concepts it used in the systematic study of society.
- Describe various social structures in societies and methods and degrees of social stratification.
- Explain the major social groups that function in society, including racial and ethnic groups.
- Explain processes of socialization, and how socialization operates in different societies and cultures.
- Explain major methods of social control, including political and legal systems, and be able to explain the concept of deviance.
- Explain the role of gender in society.
- Describe how the tools of analysis and methods of sociology are applicable to work and involvement in their community.
- Identify and connect basic ideas and terminology found in the study of human ecology.
- Critically evaluate sources of information about human ecology.
- Associate specific relations between science and/or technology and human population growth, and place them in a historical context.

Reference Books:

1. A Text Book of Sociology, Dealey, James Quayle and Ward, Lester, Frank
2. Engineers in Britain: A Sociological Study of the Engineering Dimension, Ian Glover
3. Introduction: Sociology and Engineering, Ian A. Glover, Michael P. Kelly
4. Human Ecology: Basic Concepts for Sustainable Development, Gerald G Marten
5. Allport, G. W. (1985). UThe Historical Background of Modern Social PsychologyU. New York, Random House.
6. Bernard, A. and T. Burgess (2004). USociologyU, Cambridge University Press.
7. DuBrin, A. J. (2007). UHuman Relations: Interpersonal Job Oriented SkillsU. New York, Prentice Hall.

LE-305: Field Tour

Credit	Class/week (h)	Total Class (h)
1.0	-	-

The students shall have a daylong visit of one relevant industry.

Third Year (2nd Semester)

LE-306: Eco-Friendly Leather Processing

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To impart knowledge on eco-friendly options for leather processing.

Course Contents:

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

Cleaner Processing- Tanning: Less chrome and chrome-free tanning systems. Latest concepts and trends in leather processing.

Cleaner Processing: Post Tanning- Formaldehyde, Phenol, AOX free post tanning systems; Latest concepts and trends in leather processing. Cleaner processing based on Eco-labelling. Integrated strategies to achieve permissible BOD, COD and TDS standards of tannery effluents.

Cleaner Finishing Techniques: Role of finishing equipment such as HVLP spray, foam finishing, etc. in cleaner perspective. Aqueous finishing concepts and formulation; Other novel finishing techniques to reduce VOC. Cleaner finishing of splits for shoe suede, garment suede, grain finished effect and specialty finishes - processing technologies and finishing techniques specially suited for the purpose. Upgradation of lower ends for better utilization.

Learning Outcomes: At the end of the course the students would have gained knowledge on the cleaner process technology in the leather processing during tanning, post tanning and finishing systems. The emphasis on the course content will be on the fundamentals of bio beam house processing.

Reference Books:

1. P.S. Briggs, "Gloving, Clothing and special leathers" products Institute, London, 1981.
2. J.H. Sharphouse, "Leather Technicians Hand Book", Leather Producers Association, Northampton NN3 1JD, Reprinted 1995.

LE-307: Eco-Friendly Leather Processing Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0 /Group	45.0/Group

Lab based of the content of LE-306.

LE-308: Quality Assurance of Leather and Allied Materials

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To interpret the knowledge and skill of different tests
- to assess the quality of leather and allied materials.

Course Contents:

Introduction: Object of carrying out physical testing of leather, few popular thumb tests, disadvantages of thumb tests, physical testing methods.

Sampling: Introduction, statistical aspects of the sampling problem, determination of sample size selection of a sampling location, hide to hide variability for various tests, acceptance sampling, collection of sample section of raw hides and skins and leather, sampling positions for full hide and skins, bends or butts, shoulder, belly.

Strength and stretch of leather: Tensile strength and percentage of elongation at break, stitch tearing strength, tearing strength, tongue tearing strength, buckle tear strength, split tear strength, distension and strength of grain by the ball burst test, relationship between different strength, puncture resistance, effect of splitting on strength, area stability, effect of relative humidity, effect of oil content, effect of kind of tannage and method of finishing, measurement of the initial strain energy of leather, temper of leather, resilience properties of leather.

Physical tests: Physical tests essential for leather, footwear and leather products manufacture, principles of different physical tests such as flexing endurance test, vamp flexing, water vapor permeability test, air permeability of leather, dynamic water proof ness test, apparent and real densities, scuffing and abrasive resistance, absorption of water, water penetration, resistance to cracking of grain and crack index, perspiration resistance of leather, leather softness, fogging tendency of leather.

Important Tests for specific types of leather: Upper leather, lining leather, sole leather, clothing leather, upholstery leather, belting leather, car automotive leather, chamois leather, football leather, book binding leather, glace kid leather, glove leather, varnished leather, oil-pull up leather, aniline, semi aniline and pigment finished leather, etc.

Tests for finish film: Introduction, bond strength between the leather surface and the finish film, how to improve this bondage, heat resistance of finish film, cold crack resistance, light fastness of finish film, wet and dry rub fastness, test for bleeding, water fastness, elasticity of finish film, resistance to solvent, resistance to washing and cleaning agents, resistance to dressing agents, resistance to water stains, moisture fastness, resistance to plasticizer, resistance to buffing of suede leather, resistance to ageing.

Tests for Sole leather: Apparent and real densities, abrasion resistance, absorption of water, resistance to cracking of grain crack index, Flexing test - SATRA BATA flexing test, Ross flex, Bennewart flex, adhesion test oil swelling resistance test.

Test for Insole leather: Flexing Index, Tensile strength and extension at break, Tear strength, Adhesion strength.

Learning Outcomes: After completion of this unit the Students will able to:

- Identify the quality of upper and lining leather, sole, insole and other allied materials.
- Learn different international SOP of different tests for upper leather, lining leather, sole, insole and other allied materials.

Reference Books:

1. Society of Leather Technologists and Chemists-Official Methods of Analysis-1996.
2. Dutta S.S. - An Introduction to the Principles of Physical testing of Leather.
3. O'Flaherty, William. And Roddy-The Chemistry and Technology of Leather, Vol-IV
4. Heidemann E. -Fundamentals of Leather Manufacturing.
5. Dutta S.S. - An Introduction to the Principles of Leather Manufacture.

Institute of Leather Engineering and Technology, University of Dhaka

6. John Arthur Wilson-Modern Practice In Leather Manufacture.
7. Venkatachalam P.S. - Lecture Notes on Leather.
8. SATRA Owner's Manual – SATRA, UK

LE-309: Quality Assurance of Leather and Allied Materials Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0 /Group	45.0/Group

Lab based of the content of LE-308.

LE-310: Fundamentals of Footwear Manufacturing

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning objectives: The learning objectives of this course are:

- To learn about the anatomy of human foot and its importance for the body.
- To know the functions of foot and footwear.
- To learn different types and styles of footwear.
- To know about foot problems.
- To learn manufacturing sequences of footwear.
- To know about the machines required for footwear manufacturing.
- To learn most commonly used shoe sizing systems in the world.
- To gather knowledge of different types of upper and lining materials of footwear.
- To get overall idea about foot, last and footwear.

Course Contents:

Foot and Last: Foot, anatomy of human feet, foot comfort, foot care and their relationship to footwear, common defects of foot and their remedy; Last, different types of last, last specification, relationship between foot and last, design, pattern making, concept of design and pattern making, 2D-3D concept, marking.

Shoe sizing and Fitting: Principle of shoe sizing, history of shoe sizing, length size , shoe size classification- UK shoe sizing, parish point, American shoe sizing, centimeter scale, Mondo point, comparison among different shoe sizing systems, conversion of sizes from one scale to another, standardize shoe sizes, fitting- definition and Principles, different fitting systems.

Cutting: Introduction, qualities required for clicker, materials, characteristics and variations in leather, methods of cutting, leather measurement systems.

Closing: Introduction, preparation, top line and edge treatments, stitch formations, type of seam, finishing off, punching, eyeleting and perforation.

Lasting: Definition, principle of lasting operation, different techniques of lasting, shape retention, sole, heel and top-piece attaching techniques.

Lasting and making: The need of machine lasting, upper preparation for machine lasting, adjustment of machine, machine parts and function and its parameters setting, problems finding in machine lasting and remedies, detail controlling of forepart, seat and side lasting operation for different types footwear, lasting procedure for flat lasted, force lasted, string lasted, veldtschoen, slip lasted, strobel constructed footwear. Operational sequence in lasting line for oxford, derby, Moccasin, Slipper, Mule, boot, sports shoe, court shoe, monk shoe, sandal.

Moulding Technique: Injection Moulding (Direct), Direct Vulcanizing, Casting (Direct) direct moulded footwear construction stitch down, veldtschoen method, turn shoe and little way method, machine welted construction, Californian slip lasted construction.

Specific types of footwear: Safety footwear- purpose of safety footwear, required standards for safety, protective and occupational footwear and application field of safety footwear, construction and operational procedure of safety footwear. Welted footwear- General features of welted footwear, preparation of insole, position of lip in relation to insole edge, preparation of uppers, last for welted footwear, attachment of welt and sole for making welted footwear. Sports footwear- The need of footwear for sports, special features of sports footwear for specific sports, types of sports footwear, fitting of footwear. orthopedic footwear, turn shoe.

Shoe rooming/Finishing: The aims and objects of finishing and their utility, the relation between heel pairing and heel scouring, edge trimming and setting, characteristics of bottom finishes, edge and heel finishes, upper leather dressing, cleaning and shoe lacing, heel attaching and top piece attaching by hand and machine, different types of edge trimming, forepart and waist trimming, heel scouring, heel front buffing, bottom finishing, upper leather cleaning and dressing, fitting the sock, shoe lacing, various tools, equipment and machinery employed for finishing, their use and general maintenance, inspection, recognition and elimination of faults.

Learning Outcomes: After completion of this course students will be able to:

- Learn about the structure of human foot, last and footwear.
- Introduce the necessity and objectives of foot and footwear.
- Classify footwear based on materials, purposes, styles etc.
- Introduce the sequence of operations for different shoe construction.
- Gather knowledge about different footwear materials (both upper and lining).
- Acquire idea about different shoe sizing systems.
- Get overall knowledge about footwear manufacturing.

Reference Books:

1. Venkatappaiah B. -Introduction to The Modern Footwear Technology-
2. Miller R.G. (Editor) -Manual of Shoe Making
3. Korn J. (Editor) -Boot and Shoe Production
4. Thornton J. H. -Text Book of Footwear Manufacture
5. SATRA Bulletin
6. Spencer Crookenden -K Shoes -The first 150 years 1842-1992
7. Ruth Thomson -Making Shoes
8. Swayam Siddha -Product Knowledge
9. Swayam Siddha -The Skill of Seam Reducing
10. Thornton J. H. -Text Book of Footwear Materials

LE-311: Footwear Manufacturing Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0 /Group	45.0/Group

Lab based of the content of LE-310.

LE-312: Dyeing and Finishing-II

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To enhance knowledge in dyeing and finishing
- To comprehend the dyes behaviour in solution
- To learn the thermodynamics of dyeing
- To understand the color system and thermoplastic coatings
- To know the mechanism of film formation

Course Contents:

Behavior of Dyes in Solution: Nature of dye solution, aggregation of dyes; determination of aggregation number- Nernst-Husckel equation, Fick's law of diffusion; Activation energies of diffusion, factors effecting diffusibility, measurement of diffusion co-efficient; Dyeing with ionized dyes on substrate without sites; Affinity of dyes, determination of affinity in dyeing system, influence of affinity.

Thermodynamics of Dyeing: Thermodynamics laws, activity of dyes, standard affinities of dyes for fibres, equilibrium state on affinity; Adsorption isotherms, adsorption-at surface and dye bath-fibre interfaces; Dyeing equilibrium, electrical effect, half-time, velocity constant, heat , entropy and enthalpy of dyeing.

Colour and Vision: Theories of colour vision; Attributes of color, discrimination of color attributes; Colour space; Sensitivity of retinal cones; Method of investigating the perception of color; Color appearance phenomena.

Colorimetry and Colour System: Principle, additive and subtractive colour mixing; Different colour system, colour specification system, colour difference and evaluation; Kubelka-Munk equation, CMC method of colour matching, Properties and sources of artificial light; Color matching booth, visual color matching; Different fastness properties.

Rheology and Performance Properties of Coatings: Concept of rheology, rheological measurements and processes associated with coatings; Low VOC coatings- flow problems and solutions; mechanical performance, ageing processes and the retention properties; Chemical exposure.

Physics of film formation: Introduction, thermoplastic coatings, solutions of cross linking polymers, solvent less cross linking systems, disperse phase systems.

Learning Outcomes: After completing this course students will be able to

- determine the behaviour of dyes in solution
- measure different color system
- identify the fastness properties of leather
- analyze the rheological processes of coatings

Institute of Leather Engineering and Technology, University of Dhaka

- apply solvent less crosslinking systems

Reference Books:

1. Eco-Friendly Textile Dyeing and Finishing. Edited by: Melih Günay
2. Advances in the Dyeing and Finishing of Technical Textiles Edited by: M. L. Gulrajani

LE-313: Leather Finishing-II Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0 /Group	45.0/Group

Course Objectives: Specific objectives of this course are:

- To prepare leather before finishing.
- To identify different types of film forming materials and their application.
- To know the characteristics of finishing film and different layers in finish coat.
- To carry out processing steps involved in leather finishing.
- To acquaint the students with different machineries involved in leather finishing.
- To enable the students to apply various techniques in making leather.
- To make the students competent in the field of leather manufacturing process of shoe upper, lining, suede and nappa leather, army boot upper leather, semi-chrome upper leather, glaze kid, chamois, upholstery leather, grain garments leather, book binding leather, vegetable /chrome tanned belting leather, vegetable tanned firm sole leather, hand glove leather, mesh leather, fur skin, reptile leather, picker band and shrunken grain leather.

Course Contents:

1. Manufacture of full chrome/semi chrome/full veg. shoe upper leather.
2. Manufacture of suede/nubuck/nappa/chamoise leather.
3. Manufacture of picker/picking band/belting leather.
4. Manufacture of sole/ insole leather.
5. Manufacture of shrunken/zug-grain leather.
6. Manufacture of book binding leather.
7. Manufacture of garments/clothing/gloving leather.
8. Manufacture of lining leather.
9. Manufacture of football leather.
10. Manufacture of upholstery leather.
11. Manufacture of saddle/harness skin leather.
12. Manufacture of glace kid/ corrected grain/aniline finish leather.
13. Manufacture of army boot leather.
14. Manufacture of screen/block/boutique printed leather.
15. Manufacture of industrial and technical leather.

Learning Outcomes: After completion of this unit the students will be able to:

- Demonstrate manufacturing of full chrome/semi chrome/full veg. shoe upper leather.
- Perform manufacturing of picker/picking band/belting leather

- Perform manufacture of suede/nubuck/nappa/chamoise leather.
- Perform manufacturing of sole/ insole leather.
- Perform manufacturing of book binding leather
- Perform manufacturing of garments/clothing/gloving leather.
- Perform manufacturing lining leather.
- Demonstrate manufacturing of football leather.
- Demonstrate manufacturing of upholstery leather.
- Demonstrate manufacturing of saddle/harness skin leather.
- Demonstrate manufacturing of glace kid/ corrected grain/aniline finish leather.
- Perform manufacturing of army boot leather.
- Perform manufacturing of screen/block/boutique printed leather.
- Perform manufacturing of industrial and technical leather.

Reference Books:

1. Anthony D. Covington- Tanning Chemistry The Science of Leather
2. Dutta S.S.-An introduction to the principles of leather manufacture.
3. Krystof Bienkieuicz - Physical chemistry of leather making.
4. Flaharty , Roddy , Lollar-The chemistry and technology of leather (vol-2and3)
5. Sarkar K.T.-Theory and Practice of Leather Manufacture.
6. Reed R. -Science for Students of Leather Technology.
7. BASF Manual -Pocket Book for the Leather Technologist.
8. Sarphouse J.H.-Leather Technicians Handbook.
9. Heidenmann Eckhart - Fundamentals of Leather Manufacture.
10. Procter H.R.-The Principle of Leather Manufacture

BUS-301: Supply Chain Management for Leather and Leather Products

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- Understand the fundamentals of Supply Chain Management (SCM) including its role in an organization and in integrating firms in a supply chain.
- Understand the various concepts in SCM like coordination, planning for uncertainty, supply contracts, logistics management, outsourcing and procurement management.
- Apply various analytical methods and tools so that students are able to measure and evaluate various facets of supply chain performance.
- Understand practices in SCM that differentiate successful firms from others.
- Understand the challenges in SCM through a real industry project.

Course Contents:

Understanding the Supply Chain: supply chain, supply chain 4.0, types of supply chains and examples, strategic, tactical, and operational decisions in supply chains, process view of a supply chain, the importance of supply chain flows, examples of supply chains.

Institute of Leather Engineering and Technology, University of Dhaka

Supply Chain Performance and drivers: Competitive and supply chain strategies, Achieving strategic fit, Expanding strategic scope, a framework for structuring drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing, Obstacles to achieving fit.

Designing the Distribution Network Design in the Supply Chain: the role of distribution in the supply chain, factors influencing distribution network design, design options for a distribution network, e-business and the distribution network, distribution networks in practice, A strategic framework for facility location, Multi-echelon networks, Gravity methods for location, Plant location models, The Impact of Uncertainty on Network Design Decisions, Discounted Cash Flow Analysis, Representations of Uncertainty, Evaluating Network Design Decisions Using Decision, Evaluation of Supply Chain Design Decisions Under Uncertainty, Making Supply Chain Decisions Under Uncertainty in Practice.

Demand Forecasting in a Supply Chain: The role of forecasting in a supply chain, Characteristics of forecasts, Components of forecasts and forecasting methods, Basic approach to demand forecasting, Time series forecasting methods, Measures of forecast error, Forecasting in practice.

Sourcing Decisions in a Supply Chain: The Role of Sourcing in a Supply Chain, Supplier Scoring and Assessment, Supplier Selection and Contracts, Design Collaboration, The Procurement Process, Sourcing Planning and Analysis, Making Sourcing Decisions in Practice.

Strategic Lead Time Management: Time based competition, time based process mapping, logistics pipeline management. Lean thinking,

JIT and Quick Response Logistics: The philosophy, logistics implication, Vendor Managed Inventory;

Agility and Agile Supply Chain: the concept of market winner and market qualifier, How to combine lean and agile mindsets (pareto curve, decoupling point),

Managing the Global Pipeline: The tradeoffs among the logistics costs, concepts of Centralization, Focused Factories and Postponement.

Advanced planning and scheduling in supply chain Management: Understanding and solving logistics and supply chain problems. Advanced Planner and Scheduler.

Learning Outcomes:

- To learn the strategic importance of goods supply, chain design, planning, and operation for every firm.
- To convey how supply chain drives may be used on a conceptual level during supply chain design, planning and operation to improve performance.
- To gain knowledge of logistics and supply chain methodologies
- To understand how logistical decision and impact on the performance of the firm as well as the entire supply chain.

Reference Books:

1. K.Shridhra Bhat, “Logistics and Supply Chain Management”.
2. S. Chopra and Mendil, “Supply chain management, strategy, planning and operation”, Pearson Education, Asia, 2/2004.

3. B.S. Sahay, "Supply Chain Management, for Global Competitiveness", Macmillan Bangladesh Limited, 1999.
4. G. Raguram and N. Rangarajan, "Logistics and Supply Chain Management-Cases and concept", Macmillan.

Fourth Year (1st Semester)

LE-401: Leather Processing Chemicals

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives: The aim of this course is to:

- provide manufacturing technology of different chemicals used in leather manufacturing process.
- impart knowledge on reactions involved in the preparation of different leather chemicals.

Course Contents:

Beamhouse chemicals: Manufacturing technology of wetting agents, bating agents, basic chromium sulfate

Tanning and retanning chemicals: Chemistry and technology for the manufacture of vegetable tanning agent: synthetic tanning agents, unit operations, manufacturing technology, process control and application.

Syntans: Chemistry and Technology for the manufacture of synthetic tanning agents based on phenol formaldehyde, urea-formaldehyde, melamine-formaldehyde, sulphones, metal-complex, polymeric retains like acrylic, styrene- maleic and polymeric lubricating syntans. New trends with Hyper branched Polymers (A2B, AB2) / Dendrimers.

Fat liquors: Importance of HLB balance and Role of Surfactants in the manufacture of leather chemicals particularly fat liquors, acrylic binders and lacquer emulsions. General chemistry and technology for the manufacture of fat liquors based on natural and synthetic oils, AOX free i.e. Absorbable Organic Halogen free fat liquors, odour free fish oil/cod oil based fat liquors, sulfo succinate, chloro sulfonates /sulfonates /phosphated fat liquors, and silicone based water proof fat liquors. Microemulsion Windsor Phases and its importance for fatliquor preparation. Linker chemistry. Importance of emulsion particle size for stability. Additives role for enhanced softness / touch.

Binders: Technology for the manufacture of casein binders, casein-wax binders and cationic protein binders. Emulsion binders based on acrylates (Batch /One shot/ Semi batch/Core Shell) and urethanes. Hybrid's Urethane acrylics / Organic-Inorganic Adhesives used in the fabrication leather products. Physical properties and performance levels of binders and adhesives.

Institute of Leather Engineering and Technology, University of Dhaka

Dyes: Chemical and application orientated classification of dyes used in leather manufacture and properties thereof. Arylamines and health hazards.

Pigments Classification of pigments and their properties. Surfactant demand - Pigments Manufacture of pigments dispersions with and without casein. Use of ball mill, triple roll mill and bead mill in the manufacture of pigment dispersions. Cationic pigment dispersions and their role in leather finishing.

Topcoats: Manufacture of nitro-based lacquers and lacquer emulsions; manufacture of nitro free lacquers and lacquer emulsions. Role of solvents in the manufacture of lacquers and lacquer emulsions and VOC (Volatile Organic Compounds) restrictions in the use of such products in leather finishing. Aqueous poly urethane top coats – use and importance. Manufacture of wax emulsions, type of waxes used, cationic wax emulsions, slip agents, feel modifiers, and pull-up oils. Manufacturing methods, properties and uses of waxes, shoe creams and finishes for leather goods.

Learning Outcomes: At the end of this course students will be able to:

- explain the process flow chart of manufacturing different leather chemicals
- know the materials used in the preparation of chemicals used for leather manufacture
- understand the chemistry and technology of manufacturing process of different leather chemicals.

Reference Books:

1. K.M. Shah, Handbook of Synthetic Dyes and Pigments, Vol. I – Synthetic Dyes, Vol. II –
2. Pigments, Multi-tech Publishing Company, 1994.
3. Colour Index Directory of Dyes and Pigments published by Society of Dyers and Colourists.
4. Groggins, "Unit processes in Organic Synthesis", McGraw-Hill Book Company, New York,1958.
5. Weber W.J., (1975) "Physico - Chemical Processes for Water Quality Control".

LE-402: Products Quality Analysis Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0 /Group	45.0/Group

Learning Objectives: This course will assist the students to know about

- How to develop specification sheet of various leather products
- How to design layout for various products using computer programming.
- How to develop BOM sheet of various leather products
- How to allocate resources of various leather products
- Ho to develop production planning and scheduling using computer program for various leather products

- How to carry out Time study & Motion study for various leather products to improve productivity.
- How to develop MRP sheet of various leather products

Course Contents: Experiments and computational work involving:

1. **Spec sheet development:** Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts etc.
2. **Computerized layout design**: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts etc.
3. **BOM sheet development**: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts etc.
4. **Production planning:** Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts etc.
5. **Production scheduling**: Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts etc.
6. **Resources allocation, machine loading and optimization:** Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts etc.
7. **Time study & Motion study:** Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts etc.
8. **Development of MRP sheet:** Various leather goods and garments like wallets, bags, purses, card holders, jackets, trousers, waist coats, skirts etc.

Learning Outcomes: This course will assist the students to skill on

- How to develop specification sheet of various leather products
- How to design layout for various products using computer programming.
- How to develop BOM sheet of various leather products
- How to allocate resources of various leather products
- Ho to develop production planning and scheduling using computer program for various leather products
- How to carry out Time study & Motion study for various leather products to improve productivity.
- How to develop MRP sheet of various leather products

Reference Books:

1. Jay Heizer, Barry Render, Chuck Munson- Operations Management: Sustainability and Supply Chain Management (13th Edition)
2. Jay Heizer, Barry Render- Operations Management (11th Edition)
3. Gideon Halevi- Handbook of Production Management Methods
4. Larry P. Ritzman, Lee J. Krajewski, and Manoj K. Malhotra- Operations Management: Processes and Supply Chains
5. Nicholas J. Aquilano and Richard B. Chase- Production and Operations Management
6. Edward S. Pound, Jeffrey H. Bell, and Mark L. Spearman- Factory Physics for Managers: How Leaders Improve Performance in a Post-Lean Six Sigma World
7. Kim Hua Tan and Rupert Matthews- Operations Strategy in Action: A Guide to the Theory and Practice of Implementation
8. K.C Jain, L.N Aggarwal.- Production planning control and Industrial Management,
9. Martand Telsang- Industrial Engineering and Production Management,
10. Panneer Selvam.- Production and Operation Management

Institute of Leather Engineering and Technology, University of Dhaka

LE-403: Tannery Solid Waste Management

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To enhance knowledge about solid waste management
- To know the types of solid waste produced in tannery
- To develop idea about recycling and disposal of solid waste
- To know the preparation of glue and adhesive from solid waste
- To convert the solid waste into value added products

Course Contents:

Reuse, Recycling and Disposal of Solid Wastes: Waste generation from leather, footwear and leather goods industries; Waste minimization, material reuse, material recycling, energy recovery, Utilization of leather wastes; Disposal of solid wastes.

Types of solid waste in tanning industry: De-dusted salt, raw hides trimming, hair, fleshing, splitting, pickle trimming, chrome shaving, crust trimming, finished leather trimming, sludge from ETP.

Solid waste management: Landfill-transportation, advantages and disadvantages, Incineration- advantages and disadvantages.

Integrated solid waste management-

Bioremediation of tannery waste: Anaerobic digestion, methane and biogas formation, biodiesel, heat and electricity production, biochemical conversion, gasification, plasma cracking, advantage of gasification.

Phytoremediation: Preparation of glue and adhesive, collagen fiber from split leather, filter materials.

Conversion of solid waste into value added products: Gelatin from flesh, Glue and thicker, biopolymer, fat for saponification, collagen, adsorbent materials, protein source for fish and poultry feed, bone paste powder, health care products, industrial raw materials dental pad and fertilizer.

Learning Outcomes: After completing the course the students will be able

- To perform solid waste management
- To utilize different types of solid waste produced in tannery
- To develop idea about recycling and disposal of solid waste
- To prepare of glue and adhesive from solid waste
- To convert the solid waste into value added products

Reference Books:

1. Assessment of Tannery Solid Waste Management and Characterization by Abajihad Zulfikar
2. Handbook of Solid Waste Management by Frank Kreith and George Tchobanoglous
3. Solid Waste Management: Principles and Practice by Diganta Bhusan Das and Ramesha Chandrappa

LE-404: Lean Manufacturing of Leather and Leather Products

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To implement lean manufacturing concepts in the factories.
- To gather idea on tools of lean manufacturing.

Course Contents:

Introduction: The mass production system; Origin of lean production system; Necessity; Lean revolution in Toyota; Systems and systems thinking; Basic image of lean production; Customer focus; Muda (waste).

Stability of Lean System: Standards in the lean system; 5S system; Total Productive Maintenance; standardized work; Elements of standardized work; Charts to define standardized work; Man power reduction; Overall efficiency; standardized work and Kaizen; Common layouts.

Just in Time: Principles of JIT; JIT system; Kanban; Kanban rules; Expanded role of conveyance; Production leveling; Pull systems; Value stream mapping.

JIDOKA (Automation with a Human Touch): Jidoka concept; Poka-Yoke (mistake proofing) systems; Inspection systems and zone control; Types and use of Poka-Yoke systems; Implementation of Jidoka.

Worker Involvement and Systematic Planning Methodology: Involvement; Activities to support involvement; Quality circle activity; Kaizen training; Suggestion Programmes; Hoshin Planning System (systematic planning methodology); Phases of Hoshin Planning; Lean culture

Learning Outcomes: The student will be able to practice the principles of lean manufacturing like customer focus, reduction of MUDA, just in time, Jidoka and Hoshin planning.

Reference Books:

1. Dennis P.," Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York,2007.

Institute of Leather Engineering and Technology, University of Dhaka

2. Liker, J., "The Toyota Way: Fourteen Management Principles from the World's Greatest Manufacturer", McGraw Hill, 2004.
3. Michael, L.G., "Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production Speed",McGraw Hill, 2002.
4. Ohno, T., "Toyota Production System: Beyond Large-Scale Production", Taylor & Francis, Inc., 1988.
5. Rother, M., and Shook, J.,' Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA", Lean Enterprise Institute, 1999.

LE-405: Production Planning and Control for Leather and Leather Products

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives: Students have

- to get the idea on production systems, how to select the facility location, how to make the efficient production layout, how to conduct an analysis to demand forecasting for production management, how to manage inventory, how to carried out the work and method study in the leather products industry, and how to conduct operations scheduling and sequencing for leather products industry. Students also will get knowledge on how to implement the tools and techniques to manage the production in the leather products industry supply chain.

Course Contents:

Introduction to production management: production, production system, essential functions of manufacturing firms, basic production management function, the strategies of decision making in the leather production industry, productivity challenge, strategies of improving productivity in leather goods industry, concept of productivity, productivity calculations, multi-factor productivity, productivity variables, key variables for improved labor productivity, ethics, social responsibility, and sustainability.

Demand Forecasting: basic concept of forecasting, types of forecasts, strategic importance of forecasting for leather products industry, steps in forecasting, forecasting approaches, overview of qualitative methods, overview of quantitative approaches, time-series forecasting, methods of forecasting, common measures of error, least squares method for demand forecasting, multiple-regression analysis, monitoring and controlling forecasts, tracking signal, adaptive smoothing, advanced forecasting techniques.

Facility planning and layout design: strategic importance of layout decisions, layout design considerations, layout strategies, types of layout, warehousing and storage layouts, fixed-position layout, process-oriented layout, problems related to process oriented layout, staffing and balancing work cells, repetitive and product-oriented layout, problems related to product-oriented layout, assembly-line balancing, line-balancing heuristics.

Inventory management: basic ideas of inventory, importance of inventory, functions of inventory, types of inventory, managing inventory, ABC analysis, terms used in inventory management, cycle counting, inventory models, inventory models for independent demand,

basic economic order quantity (EOQ) model, production order quantity model, quantity discount model, probabilistic models and safety stock, probabilistic demand, probabilistic example.

Capacity planning: definition, design capacity, effective capacity, determinants of effective capacity, capacity requirement, developing capacity alternatives, evaluating alternatives.

Operation scheduling and sequencing: basic concepts of short time scheduling, importance of short-term scheduling, scheduling flow, forward and backward scheduling, scheduling criteria, Gantt charts, assignment method, sequencing jobs, FCFS, SPT, EDD, LPT, critical ratio, Johnson's rule for sequencing, linear programming, transportation model, network analysis, critical Path Method (CPM), programme evaluation and review technique (PERT), critical path and determination of minimum member of works.

Work Study: Method study, Purpose and Techniques used, Procedure of select, Record, Examine, Develop, Install and Maintain. Precautions when introducing new methods, Relationship with work measurement. Work measurement, purpose and techniques used, Rating, Elements, Break points, Basic time, Use of allowances.

Activity sampling, definition, purpose and procedures, use of pilot study, Interpretation of results.

Production studies, machine utilization and operator performances, Hok (operator hours per 100kg production), Machine interference.

Production cost concept and break- even analysis: cost of production, concept of cost, cost unit, classification of cost, analysis of production cost, break –even analysis, break – even point, cost-volume- profit (CVP) analysis.

Learning Outcomes: From learning this course the students can understand the basic of production systems, capacity planning, facility planning and layout design demand forecasting, leather products industry's inventory management, work and method study for productivity improvement and line balancing, materials resource planning and operation scheduling and sequencing.

Reference Books:

1. Jay Heizer, Barry Render, Chuck Munson- Operations Management: Sustainability and Supply Chain Management (13th Edition)
2. Jay Heizer, Barry Render- Operations Management (11th Edition)
3. Gideon Halevi- Handbook of Production Management Methods
4. Larry P. Ritzman, Lee J. Krajewski, and Manoj K. Malhotra- Operations Management: Processes and Supply Chains
5. Nicholas J. Aquilano and Richard B. Chase- Production and Operations Management
6. Edward S. Pound, Jeffrey H. Bell, and Mark L. Spearman- Factory Physics for Managers: How Leaders Improve Performance in a Post-Lean Six Sigma World
7. Kim Hua Tan and Rupert Matthews- Operations Strategy in Action: A Guide to the Theory and Practice of Implementation
8. K.C Jain, L.N Aggarwal.- Production planning control and Industrial Management,
9. Martand Telsang- Industrial Engineering and Production Management,
10. Panneer Selvam.- Production and Operation Management

Institute of Leather Engineering and Technology, University of Dhaka

LE-406: Application of Computer in Leather Products Design

Credit	Class/week (h)	Total Class (h)
2.0	4.0 /Group	60.0/Group

Learning Objectives:

- To know how to design various types of leather goods using CAD software
- To know how to design various types of leather garments using CAD software
- To know how to design various types of footwear using CAD software
- To understand how to make various types of pattern using plotter.

Course Contents:

Computer Aided Design Techniques of the following items-

Leather Goods:

2. Address-card holder
3. Leather Money Bag
4. Leather Belts for Gents
5. Leather Bags

Leather Garments:

1. Men's wear preparation and Grading techniques:
    a. Block preparation.
    b. Bolero type waistcoat
    c. Gilet type waistcoat
2. Women's wear preparation and Grading:
    a. Block preparation.
    b. Ladies jacket
    c. Skirt grading.
3. Preparation of various types of bags.
4. Different Size Modifications

Leather Footwear:

1. Design and pattern making of various types of footwear.
2. Different Size Modifications

Learning Outcomes: Upon completion of this course students will be able-

- To know how to design various types of leather goods using CAD software
- To know how to design various types of leather garments using CAD software
- To understand how to make various types of pattern using plotter.

Reference Books:

1. Pattern Cutting & Making up- Martin M. Shoben
2. Leather Apparel Design – Francesea Sterlacci
3. Clothing Technology- Europa Lehrmittel
4. Fashion With Leather- Bastford
5. Making Leather Clothes- Jongensen.

6. Pattern Cutting for Women's Outerwear- Gerry Cooklin.
7. Metric Pattern Cutting for Children's Wear and Baby Wear- Winifred Aldrich
8. Grading for the Fashion Industry- Taylon Shoben
9. Pattern Drafting and Making up- Bella kapoor
10. Pattern Grading for Men's Cloths- Cooklin
11. Pattern Grading for Women's Cloths- Cooklin

LE-407: Industrial Utility and Maintenance

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- Define and explain the maintenance function and its objectives.
- Understand the main forms of maintenance and their application.
- To optimize the reliability of equipment and infrastructure.
- To train personnel in specific maintenance skills.
- To improve operational safety.

Course Contents:

Air conditioning: Comfort condition, Principle of air conditioning, Application to Leather Product industry; Refrigeration equipment, Refrigerant.

Psychometric chart and psychometric processes; calculation of simple air conditioning system, Distribution system, Humidifier, De-humidifier, Cooling tower.

Thermal power plants: Basic principles and cycles used; Steam power plants; Diesel power plants; gas power plants; combined cycle power plant, regeneration.

Boiler: Boiler types, mountings, accessories, boiler efficiency.

Material handling equipment: Issues and importance of material handling, selection and classification of material handling equipment, various types of conveyors equipment- belt, screw, chain, flight, bucket elevator, pneumatic, hydraulic, cranes and forklifts.

Lubrication: Lubricant, types, general properties, functions, lubrication system.

Machine erection: Floor preparation, foundation, machine fixation, leveling.

Maintenance: Types of maintenance, planning and organizing maintenance, preparation of maintenance schedule. maintenance of various machineries of tannery/foot wear and other leather product industries.

Learning Outcomes:

- Discuss the field of industrial maintenance and describe its role in manufacturing
- Explain the skills and preparation needed for jobs in industrial maintenance
- Describe specific procedures for ensuring safety in the workplace
- Describe types of maintenance strategies and their purpose
- Explain the purpose of mechanical drive systems used in manufacturing
- Identify the most common machine tools and their uses
- Describe how electric devices work and identify common electrical tests and maintenance tasks
- Describe how industrial process systems work, including inputs, outputs, and safety considerations

Reference Books:

1. Sharphouse - Leather Technicians Hand books.
2. Pivecka J. - Practical Handbook on Shoe Production.
3. Boothroyd G.- Assembly Automation and Product Design
4. Miller R. G. (Editor) - Manual Of Shoe Making
5. Miller R.G. (Editor) -Manual of Shoe Making
6. Thornton J. H. -Text Book of Footwear Manufacture
7. G. R. Nagpal, G R. Khanna- Power Plant Engineering
8. V. Ganesan-Internal combustion engines
9. W.F.Stoecker & J.W. Jones-Air Conditioning and Refrigeration
10. Assomac-The Innovation Notebooks for The Leather Industry

LE-408: Maintenance Workshop

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives: Specific objectives of this course are as follows.

- To practice how to create comfort working condition in different season during the production.
- To demonstrate different power generation unit this can support the production floor.
- To demonstrate different material handling equipment.
- To give idea how to check machine comfort by spirit level.
- To demonstrate different leather machineries maintenance.

Course Contents:

1. Study the Air Conditioning and controlling system to create comfort.
2. Study the distribution of conditioned air through ducts or pipes.
3. Study the Humidifier, Dehumidifier and cooling tower.
4. Study the control and maintenance of emergency power supply unit (Diesel power unit) of our institute.
5. Study the use of different material handling equipments like belt-conveyor, wooden horses and forklifts etc.
6. Study the use of different Lubricants and hydraulic oils which are directly used in leather machineries.
7. Use of spirit level to check the comfort machine operations.
8. Check and fill the hydraulic oil up to the level of the different machines using the processes from raw hides & skins to finished leather.
9. Check and clean the Leather fleshing machine.
10. Check and clean the felt regularly of Sammaying machine.
11. Check and sharp the band saw of the Wet-blue splitting machine.
12. Check and adjust the roller of Sammaying-Setting machine.

13. Check the adjustment regularly the operating condition of Vaccum Dryer.
14. Maintain the Toggle dryer.
15. Study and control the Vibration-Staking Machine
16. Study and control the Manual and Auto-spray.
17. Study and control the Ironing and Embossing machine.
18. Study and control the Hydraulic press control Ironing and Embossing.

Learning Outcomes: Upon completion of this course students will be able-

- To control air conditioning system and create production floor comfort.
- To understand the use of different kind of ducts and pipes.
- To know the appropriate use of Humidifier, Dehumidifier and cooling tower.
- To know the appropriate use of different kind of power units.
- To understand different types of materials handling equipments.
- To know the use of different Lubricants and hydraulic oils.
- To know the Use of spirit level.
- To know the maintenance of the machines of Leather Manufacturing.

Reference Books:

1. Sharphouse - Leather Technicians Hand books.
2. Pivecka J. - Practical Handbook on Shoe Production.
3. Boothroyd G.- Assembly Automation and Product Design
4. Miller R. G. (Editor) - Manual Of Shoe Making
5. Miller R.G. (Editor) -Manual of Shoe Making
6. Thornton J. H. -Text Book of Footwear Manufacture
7. G. R. Nagpal, G R. Khanna- Power Plant Engineering
8. V. Ganesan-Internal combustion engines
9. W.F.Stoecker & J.W. Jones-Air Conditioning and Refrigeration
10. Assomac-The Innovation Notebooks for The Leather Industry

HUM-401: Employability Skills-II

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Learning Objectives:

- To develop ability to gain key strategies and expressions for communicating with professionals and non-specialists.
- To improve the skills of writing, for example, business plan.
- To improve the presentation skills.
- To gain insight on how to deliver good presentation.

Course Contents:

Writing Concept of Business Plan: Writing of business plan for various types of leather and leather products.

Presenting business plan: Making interactive presentation slides and presenting the business plan.

Institute of Leather Engineering and Technology, University of Dhaka

Learning Outcomes: Upon completion of this course students

- Will be able to develop key strategies and expressions for communicating with professionals and non-specialists.
- Will be able to improve the skills of writing, for example, business plan.
- Will be able to improve the presentation skills.
- Will be able to gain insight on how to deliver good presentation.

Reference Books:

1. Joseph A. Covello And Brian J. Hazelgren, The Complete Book of Business Plan-Secrets to Writing Powerful Business Plans.

Fourth Year (2nd Semester)

LE-409: Tannery Wastewater Management

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To describe methods of advanced effluent treatment for higher discharge standards and effluent re-use.

Course Contents:

Principal industries attributed for water pollution: Types of water pollution – physical, chemical and biological pollution. Hazardous effects of water pollution on land, ground water, surface water, aquatic life and sea. Ecological system and water pollution.

Types of tannery effluent: Effluent from beam house operations, tan yard processes and finishing processes, their nature, most toxic ingredients in tannery waste water.

Tannery Effluents: Source of liquid wastes in tanneries; Characterization and assessment of critical environmental parameters. Chemistry and Characteristics of Environmental Parameters-Total solids, total dissolved solids, volatile matters, BOD_5, COD, TOC, TDS, ammonia, nitrogen, protein content, chlorides, alkalinity, pH, sulphide, DO, total coliform count, polyphenol, metal content.

Processes for the treatment of industrial wastewater - principles of physical treatment: screening, mixing, equalization, sedimentation, filtration - principles of chemical treatment: coagulation, flocculation, precipitation, ion exchange, use of alkali, CaO, neutralization, flotation, oxidation/reduction, distillation - objectives of biological wastewater treatment and various process.

Primary Treatment: Main objects of primary treatment- primary Treatment units- Collection system of discharged waste water in tanneries- screening- equalisation of waste water.

Secondary Treatment: Principles of secondary treatment- Different processes involved in secondary treatment system- Lagoon treatment- aeration system- trickling filter- systematic design of these systems- bio-technology in effluent treatment.

Tertiary Treatment: UV treatment, ozonolysis, chlorination, reverse osmosis. Concept of CETP, disposal of sludge.

Principle of biological treatment: derivation of bacterial growth kinetics. Process design and operation of attached growth, suspended growth and hybrid process: activated sludge process - its modifications, trickling filter, RBC, oxidation ditch, aerated lagoon, biofilter, anaerobic baffled reactor, UASB reactor. Waste stabilization pond, design and operation of biological nitrification, de-nitrification system; Floating aquatic plant system.

In-Plant Management for Pollution Reduction: House-keeping, segregation of waste streams, reduction of water use, chemical use. Recycling and reuse of chemicals and water, water foot print.

Learning Outcomes:

- Understand the role of each unit process within typical treatment process trains, their interaction and the context of when they are applied.
- Appreciate the advantages, disadvantages and limitations of the technologies and new developments.

Reference Books:

1. Arceivala S.J. "Waste water treatment and disposal" Marcel Dekkar Inc., New York, 1981.
2. Metcalf and Eddy,H `Tchobanoglous, G. and Burton, F.L. (Ed), Waste water Engineering,treatment, disposal and reuse, 3rd edn. Tata-McGraw Hill Publishing, New Delhi 1991.
3. Besselievie, B.E. and Schwartz, M. "The Treatment of Industrial wastes", 2nd edn., McGraw Hill.
4. McCarty, P., Parkin, G.F. and Sawyer, C.N., "Chemistry for Environmental Engineering4th Edition", McGraw Hill, 1994.
5. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, New Delhi, 2003.
6. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).
7. Infogate, GTZ, Treatment of Tannery Waste Water, GmbH, Frankfurt, Germany, 2002.

LE-410: Wastewater and Solid Waste Management Lab

Credit	Class/week (h)	Total Class (h)
1.5	3.0/Group	45.0/Group

Lab based of the content of LE-409.

BUS-401: Total Quality Management (TQM) for Leather and Leather Products

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management.

Institute of Leather Engineering and Technology, University of Dhaka

- To understand the need for quality, its evolution, basic concepts, contribution of quality
- TQM framework, Barriers and Benefits of TQM.
- To understand the TQM Principles.
- To learn and apply the various tools and techniques of TQM.
- To understand and apply QMS and EMS in any organization.

Course Contents:

Introduction: Modern concept of quality and its measurement, quality redefined, identification of quality characteristics: quality of design conformance and performance, Deming's principles on quality and productivity, Quality costs and their interpretation, Basic concepts of TQM, TQM Framework

Statistical Quality Control: Control and measurement of quality, Elementary SPC tools: Control charts, Process capability analysis, Design of experiments, Acceptance sampling plans: OC curves, single and double sampling plane, rectifying inspection, AOQ.

TQM Principles: Quality statements, Customer focus, Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Continuous process improvement, PDCA cycle, 5S, Kaizen, Supplier partnership, Partnering, Supplier selection, Supplier Rating.

TQM Tools & Techniques I: The seven traditional tools of quality, New management tools, Six-sigma: Concepts, methodology, applications to spinning, weaving, chemical processing and garment industries, Bench marking, Reason to bench mark, Bench marking process, FMEA, Stages, Types.

TQM Tools & Techniques II: Quality circles, Quality Function Deployment (QFD) Taguchi quality loss function, PM Concepts, improvement needs, Performance measures, BPR; application of TQM tools in Leather/Footwear/Leather Product industry, BSTI, ASTM.

Quality Systems: Need for ISO 9000- ISO 9000-2000 Quality System, Elements, Documentation, Quality auditing- QS 9000, ISO 14000 Concepts, Requirements and Benefits, Quality Council, Leadership, Employee involvement Motivation, Empowerment, Team and Teamwork, Recognition and Reward.

Strategic Lead Time Management: Time based competition, time-based process mapping, logistics pipeline management. Lean thinking, Lean operations, Push-pull production concepts, KANBAN, Kaizen, Toyota Approach, Seven elements of JIT system for planning and control

Learning Outcomes:

- Ability to apply TQM concepts in a selected enterprise.
- Ability to apply TQM principles in a selected enterprise.
- Ability to apply the various tools and techniques of TQM.
- Ability to apply QMS and EMS in any organization.

Reference Books:

1. Dale H. Besterfiled, et al., "Total Quality Management", Pearson Education Asia, Third Edition, Indian Reprint, 2006.

2. Suganthi, L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. James R. Evans and William M. Lindsay, "The Management and Control of Quality", (6th Edition), South-Western (Thomson Learning), 2005.
4. Oakland, J.S. "TQM-Text with Cases", Butterworth, Heinemann Ltd., Oxford, Third Edition, 2003.
5. Janakiraman, B and Gopal, R.K, "Total Quality Management-Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
6. Quality management in Clothing & Leather/Footwear/Leather Product Industry, Chuter, A.J

BUS-402: Cost and Management Accounting

Credit	Class/week (h)	Total Class (h)
3.0	3.0	45.0

Learning Objectives:

- To know about cost accounting for leather products industry
- To know about Cost Behaviour and Terminology
- To know about Cost Elements
- To know about Cost Accounting system
- To know about Costing Techniques
- To know about Management Accounting

Course Contents:

Cost Accounting:

Introduction: meaning, scope, objective, advantages Financial Accounting vs Cost Accounting, Factors influencing the design of a cost, limitation, characteristics of an ideal Cost Accounting, System, Installation of costing system-steps, difficulties, Measures to overcome the difficulties, Cost unit, Methods of costing types, Development of Cost Accounting.

Cost Behaviour and Terminology: Basic cost behavior patterns, Economic, Accounting and other cost patterns, product Costing Concept Need for Knowledge of cost behavior, Methods of estimating cost relationship.

Cost Elements: Costing for materials, Costing for labour, and costing for Overheads.

Cost Accounting system: Job order costing, Contract Costing and Process Costing.

Costing Techniques: Standard Costing, Costing of by products and joint products, Direct Costing. Costing of leather and leather products, material, labour, power and overhead expenses, Foreign exchange mechanisms, exchange rates; foreign exchange exposure management – risks, strategies to reduce risk,

Budget, types of budgets, budgeting and control in tanneries and leather products industry

Management Accounting:

Introduction-Definition, Difference from Financial Accounting & Cost Accounting, Relationship with Financial Accounting, Uses in planning and control.

Institute of Leather Engineering and Technology, University of Dhaka

Analysis of Cost Behaviour-Variable, Fixed and Mixed. Cost-Volume-Profit Analysis. Analysing cost for Pricing and short-rum decision: BEP Analysis, Cost for decision making, Differential cost analysis.

Evaluation Performance: Variance analysis, financial statement, analysis & Interpretation.

Business Economic

The role of engineers in business and corporation. time value of money, simple and compound interest, types of investment; Types of Economic Analysis: Present, future and annual worth analysis, Cost, Benefit Analysis, Internal Rate of Return Analysis, Incremental Analysis, Depreciation: Straight Line Depreciation, Declining Balance Method, MACRS, Sum of years method etc.; After tax cash flow analysis; Inflation and its impact on economic decision; Capital budgeting and rationing; Sensitivity Analysis.

Learning Outcomes: Upon completion of this course students will be able-

- To know about cost accounting for leather products industry
- To know about Cost Behaviour and Terminology
- To know about Cost Elements
- To know about Cost Accounting system
- To know about Costing Techniques
- To know about Management Accounting

Reference Book:

1. Accounting Principles, Kieso and Kimmel.

LE-411: Project

Credit	Class/week (h)	Total Class (h)
3.0		

Each student is required to submit a report on the project assigned to him/her by the department. Prior to the submission of the project report, each student should present a seminar based on the work done.

LE-412: Comprehensive Viva

Credit	Class/week (h)	Total Class (h)
2.0		

LE-413: Internship

Credit	Class/week (h)	Total Class (h)
3.0		

Each student will have 2 months intensive training in the industry relevant to their study.

Curriculum
M.Sc. Engineering in Leather Engineering
Institute of Leather Engineering and Technology (ILET)
UNIVERSITY OF DHAKA

Semester-I

Course No.	Course Title	Credits
LE-501	Modernization of Leather Processing and Finishing	3.00
LE-502	Life Cycle and Quality Assessment	3.00
RM-503	Research Methodology	3.00
ENV-504	Industrial Hazards and Modern Waste Management	3.00
EIS-505	Ergonomics and Industrial Safety	3.00
LE-510	Thesis	-
Total		**15.0**

Semester-II

Course No.	Course Title	Credits
LE-506	Advanced Leather Biotechnology	3.00
LE-510	Thesis	-
	Optional Course (Anyone from the following List)	
ENV-507	Environmental Management and Impact Assessment	3.00
ENV-508	Nanotechnology for Leather and Leather Products	3.00
CSIT-509	Industrial Automation	3.00
Total		**6.00**

Semester-III

Course No.	Course Title	Credits
LE-510	THESIS	15.00
Grand Total		**36.00**

Institute of Leather Engineering and Technology, University of Dhaka

DETAIL COURSE CONTENTS

Semester-I

Course No.	Course Title	Credits
LE-501	Modernization of Leather Processing and Finishing	3.00
LE-502	Life Cycle and Quality Assessment	3.00
RM-503	Research Methodology	3.00
ENV-504	Industrial Hazards and Modern Waste Management	3.00
EIS-505	Ergonomics and Industrial Safety	3.00
LE-510	Thesis	-
Total		**15.0**

LE-501: Modernization of Leather Processing and Finishing (3.0 Credits)

Learning Objectives: The major purposes of this course are-

- To make the students to gain knowledge about the recent advanced technologies used in the leather tanning process.
- To be able to recognize the regulations of leather industry wastes.
- To determine the classification of the wastes, storage conditions, utilization and disposal methods.
- To acquire modern concept of environmentally friendly tanning.
- To implement advanced technology in leather processing.

Course Contents:

Cleaner processing (pre tanning): Biobeam house**,** eco-friendly process technologies, salt free curing options, sulphide free unhairing systems, ammonia-free deliming, salt free pickling systems, solvent free degreasing systems, paradigm shift from chemical processing of hides and skins to beam house processing, recent techniques and technologies; improved beam house agents and their interaction with hides/skins; effects of beam house processes on the structure and properties of hides/skins.

Cleaner processing: Tanning, post tanning, less chrome and chrome-free tanning systems, avoidance of eco sensitive substances viz., formaldehyde, APE, Cr(VI), VOX, AOX free post tanning, solvent free finishing systems, latest concepts and trends in leather processing. ECHA/REACh guidelines, Brand/Eco-labeling requirements and trend integrated strategies to achieve permissible BOD, COD and TDS standards of tannery effluents, recent techniques and technologies; collagen-tanning agent interaction at molecular level-thermodynamic and kinetic conditions; role of surface charge and importance of electrostatic and hydrophobic interactions.

Advanced finishing techniques: Role of finishing equipment; techniques for newer and novel finishing system viz., aqueous based patent finishing, cationic finishing, foam

finishing. Shoe suede, garment suede, grain finished effect and speciality finishes at split leather - processing technologies and finishing techniques specially suited for the purpose, upgradation of lower ends for better utilization, new textures with enhanced properties, transfer foil/coating, lamination techniques, etc. in split finishing, latest trends in leather finishing, recent development in techniques and technologies; different current and novel finishing techniques; upgradation of lower ends for better utilization; advanced theory of finishing.

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

Specialty 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, and glove and fashion leathers. Processing of exotic leathers such as reptiles, crocodiles, lizards, fish and ostrich.

Learning Outcomes: After completions of the course, the students will be able

- To improve skill on the application and alternatives to leather in current global scenario.
- To apply newly developed techniques on special leather manufacturing process and advanced finishing techniques.
- To classify the new cleaner processing technologies according to the stages of leather processing.
- To analyze in-stage technologies in the manner of purpose, method and result.
- To recognize the hazardous and non-hazardous wastes.
- To evaluate the regulations of industrial wastes and to be able to recognize the environmentally friendly utilization methods.
- To meet the national and international standards of tannery wastes.

Reference Books:

1. Gloving, Clothing and special leathers - P.S. Briggs, Products Institute, London 1981.
2. Leather Technicians Hand Book- J. H. Sharphouse, Leather Producers Association, Northampton NN3 1JD, Reprinted 1995.
3. Tanning Chemistry: The Science of Leather -Anthony D. Covington.
4. An introduction to the principles of leather manufacture -Dutta S. S.
5. Physical chemistry of leather making –Krystof Bienkieuicz.
6. The chemistry and technology of leather (vol-2 and 3)-O' Flaharty, Roddy, Lollar.
7. Theory and Practice of Leather Manufacture -Sarkar K.T.
8. Science for Students of Leather Technology -Reed R.
9. Pocket Book for the Leather Technologist -BASF Manual.
10. Fundamentals of Leather Manufacture -Heidenmann Eckhart

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LE-502: Life Cycle and Quality Assessment (3.0 Credits)

Learning Objectives: The aim of this course is to:

- introduce the concept of LCA structure, potentialities, and limitations
- provide LCA methods and applications
- define and discuss essential concepts in the field of LCA
- provide necessary skills for sound application of LCA method and proper interpretation of its results
- provide appreciation for the strengths and limitations of LCA in practice
- provide basic knowledge of tools for environmental assessment of technology

Course Contents:

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

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 Assessment: origins, principles and context, The development of life cycle assessment methods and applications, Main characteristics of LCA, Role of LCA in wider applications, Limitations of LCA, LCA as part of a tool box, Management of LCA projects: procedures, International developments (SETAC, ISO, UNEP), Goal and scope definition

Life Cycle Inventory Analysis: Scientific Principles, Fundamentals of the Inventory Analysis, The Unit Process as the Smallest Cell of LCI, 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 (Environmental Problem Fields), Impact Categories, Impact Indicators and Characterisation 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 Assessment Applications: LCA of Chemicals and Chemical Products, LCA of Wastewater Treatment, LCA of Soil and Groundwater Remediation, LCA of Solid Waste Management Systems, Prospects for life cycle assessment development and practice in the

quest for sustainable consumption, The Three Dimensions of Sustainability, State of the Art of Methods, Life Cycle Costing, Product-Related Social Life Cycle Assessment, conclusions.

Application: Building LCA model using spreadsheet software, application in leather and its sub-sectors.

Learning Outcomes: At the end of this course students will be able to:

- understand why LCA systems perspective is important
- develop a better understanding of life cycle thinking for products, services, product systems
- know how to construct LCA studies that provide transparent results
- collect, analyze, and interpret environmental data in a structured manner for better decisions
- interpret the results of the LCA
- describe the weaknesses and strengths of LCA and transparency of LCA report
- gain knowledge of applicability of LCA to design better environmental policy

Reference Books:

1. Life Cycle Assessment (LCA): A Guide to Best Practice by Walter Klöpffer
2. Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards by Jeroen B. Guinée
3. Life Cycle Assessment: Principles, Practice and Prospects, by Ralph Horne, Tim Grant and Karli Verghese, Published by CSIRO Publishing, 2009
4. Life Cycle Assessment Theory and Practice, by Michael Z. Hauschild, Ralph K. Rosenbaum, Stig Irving Olsen © Springer International Publishing AG 2018

RM-503: Research Methodology (3.0 Credits)

Learning Objectives:

- To identify the overall process of designing a research study from its inception to its report.
- To learn about the methods used for the educational research.
- To familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- To identify a research problem stated in a study.
- To analyze critical problem and finding a suitable solution.
- To improve skill on statistical data analysis by ANOVA and computational system.
- To acquire knowledge on conducting literature review for doing educational and industrial research.
- To enlarge knowledge in generating a research report with appropriate reference.

Course Contents:

Institute of Leather Engineering and Technology, University of Dhaka

Meaning of Research: Definitions of Research, Objectives of Research, Motivation in Research, General Characteristics of Research, Criteria of Good Research, Types of Research

The Research Problem, Scientific Thinking, What is a Research Problem, Selecting the Problem, Sources of the Problem, Defining a Problem, Statement of a Problem, Delimiting a Problem, Evaluation of a Problem

The Review of Literature: Meaning of Review of Literature, Need of Review of Literature, Objectives of Review of Literature, Sources of Literature, The Functions of Literature, How to Conduct the Review of Literature, Some Hints for the Review of Literature, Precautions in Library Use, Reporting the Review of Literature

The Research Hypotheses: Meaning of Hypothesis, Definitions of Hypothesis, Nature of Hypothesis, Functions of Hypothesis, Importance of Hypothesis, Kinds of Hypothesis, Characteristics of a Good Hypothesis, Variables in a Hypothesis, Formulating a Hypothesis, Testing the Hypothesis

The Research Approach: The Philosophical Background, The Qualitative Approach, The Quantitative Approach, The Mixed-Methods Approach, Criteria for Selecting a Research Approach.

The Research Strategies: What are the Research Strategies? Which Strategy to Choose? Case Studies, Experiments, Ethnography, Phenomenology, Ground Theory (GT), Action Research, Mixed-methods, Longitudinal.

Research Methods and Tools: Methods of data collection, observation, questionnaire, Interview. Data Processing, Collection, Classification, Tabulation, Graphical representation and data analysis.

Report Writing: Research Report, Format of research report, main body of the report, references and appendices, style of writing, typing the report, pagination, tables and figures, bibliography, footnotes, margins, quotations, evaluating the report.

Statistical Methods: Hypothesis testing, significance and correlation. Correlation.

Linear models and regressions. Pearson and other correlation coefficients. Multiple regressions. Distribution- Normal, t and chi square test.

Difference among means: F-test: 1 way ANOVA; F-test: 2 ways ANOVA. Computer applications in environmental modeling. Computer-based modeling: Linear, regression, validation and forecasting. Computer-based modeling for population and population studies.

Matrices, simultaneous linear equations; tests of hypothesis and significance.

Time series analysis - moving averages (3 and 5 unit cycles)

Learning Outcomes: At the end of this course, the students would be able to:

- Formulate research problem
- Carry out research analysis and follow research ethics

- Understand some basic concepts of research and its methodologies
- Prepare a project proposal (to undertake a project)
- Organize and conduct research (advanced project) in a more appropriate manner
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
- Write a research report and thesis

Reference Books:

1. C R Kothari Research Methodology, Methods and Techniques, New Age International (P) Ltd, Delhi, 2011.
2. J. Medo Statistical Method- An Introductory text, New Age publishers, Delhi, 2005.
3. Santosh Gupta Research Methodology and Statistical Techniques, Deep and Deep Publications, 1999.
4. S P Gupta An Introduction to Statistical Methods, Vikas publishing House, Delhi, 2009.
5. Lucy Jacobs, D.A. Introduction to Research in Education,Christine Sorensen, Cengage Learning, 2009.
6. Stuart Melville, W.G. Research Methodology, an Introduction, Jut and Company Ltd, 2004.
7. Zar, Jerrold H. (1998). Biostatistical Analysis. Prentice Hall, N.J.
8. Sokal, Robert and James Rohlf (1997). Biometry, Freeman Press, N.Y.
9. Walpole, R. and R. Myers (1993). Statistics for Engineers and Scientists, 5th edn. MacMillan, N.Y.
10. Wayne, R. Ott (1995). Environmental Statistics and Data Analysis, CRCPress.

ENV-504: Industrial Hazards and Modern Waste Management (3.0 Credits)

Learning Objectives:

- To learn about the methods used for the treatment of wastewater biologically.
- To make the students understand modeling and design aspects of biological techniques available.
- To provide comprehensive overview of solid, biomedical and hazardous waste management.
- To provide knowledge on solid waste management design aspects.
- To learn about the different methods of solid waste management.

Course Contents:

Industrial Hazard: Hazard, Industrial Hazards, Types, identifying of a hazardous waste, 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 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, Uses as Protein hydrolysate, feed, and fertilizer, Glue and Adhesive, Additives in cosmetic industry.

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. Materials used in assembling technology: 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 processing, recovery, recycle and reuse, 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. Heterocatalytic systems using metal oxides, activated carbon – Removal of Inorganic Compounds through electro dialysis, reverse osmosis, multiple effect evaporator, ion-exchange

Learning Outcomes:

- After completion of this course the students will be able to
- Explore their knowledge on industrial hazard and waste.
- Understand the methods and means to manage tannery wastes.

- Gain knowledge on advanced wastewater treatment.
- Aware of various treatment option for solid waste management.
- Learn adverse impact of industrial hazard on the environment as well as on human body.
- Evaluate the regulations of industrial wastes and to be able to recognize the environmentally friendly utilization methods.
- Convert tannery solid waste into a valuable product.

Reference Books:

1. Arceivala S. J. "Waste water treatment and disposal" Marcel Dekkar Inc., New York, 1981.
2. Besselievie, B. E. and Schwartz, M. "The Treatment of Industrial wastes", 2nd edn., McGraw Hill.
3. Introduction to Environmental Engineering -Mackenzie L. Davis, David A. Cornwell.
4. M.C.Carre, A Vulliermet and B.Vulliermet, "Environment and Tannery", Centre TechniqueduCuir, Lyon, France, 1983.
5. Assessment of Tannery Solid Waste Management, a case study Sheba Leather Industry, UNIDO, 2018
6. Tchobanoglous G., Theissen H., and EIiassen R. (1991), "Solid Waste Engineering - Principles and Management Issues", McGraw Hill, New York.
7. PavoniJ.L(1973)., "Handbook of Solid Waste Disposal".
8. Peavy, Rowe and Tchobanoglous (1985), "Environmental Engineering", McGraw Hill Co. 4th Edition
9. Vesiland A. (2002), "Solid Waste Engineering", Thompson Books.
10. Hazardous waste (management and handling) rules, 2001
11. Peavy, H.S., Rowe and Tchobonoglous, G., (1985), "Environmental Engineering", McGraw Hill
12. Metcalf and Eddy Inc., (2003), "Wastewater Engineering - Treatment and Reuse", 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
13. Benefield R.D., and Randal C.W., (1980), "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, New Jersey.
14. Karia G.L., and Christian R.A., (2001), "Wastewater Treatment Concepts and Design Approach", Prentice Hall of India Pvt. Ltd., New Delhi.

EIS-505: Ergonomics and Industrial Safety (3.0 Credits)

Learning Objectives:

- 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.
- To identify potential workplace safety and health hazards and determine how to mitigate the hazards through engineering controls, administrative controls and personal protective equipment.
- To conduct basic safety inspections using strategies that they have developed though hazard identification and job hazard analysis.
- To explain the causal relationship between accidents and liability including the no fault workers compensation system and the third-party liability type lawsuit.
- To Identify the requirements of training programs in the workplace under the existing OSHA and State-OSHA Requirements.
- To understand essential elements of an occupational safety and health program and the components of international standard organizations in safety and health.
- To describe basic components of an effective company safety and health program including management commitment, employee involvement, hazard recognition and control and training.

Course Contents:

Ergonomics: Introduction, history of development, goal of ergonomics, man-machine system and its components. Anthropometry in work station design (design of work surfaces and seat), stress and strain, over use, metabolism; *Measure of Physiological Functions:* workload and energy consumption, biomechanics, types of movements of body members, strength and endurance, speed of movements; NIOSH lifting equation, Lifting index, Maximum acceptable weights and forces, Distal upper extremities risk factors, Strain index, RULA, REBA, and Office ergonomics; Visual displays for static information, visual displays of dynamic information, auditory, displays and controls, effect of vibration, radiation, bio hazardous materials, chemical hazards, noise, temperature and illumination on performance.

Industrial Safety: History of the safety movement, Safety and health programs, Accident causes and types of accidents, Types of injuries, Record-keeping, Occupational safety and health performance measurement, Responsibility for occupational safety and health, Organization of the safety and health function, Safety inspections, Occupational safety and health training Occupational safety and health standards, OSHA's role in occupational safety and health, Role of the promotional program and its implementation, Safety committees and safety teams, Accident investigation, The role of insurance and risk management/ loss control in occupational safety and health.

Safety Management: Principle of safety management, Safety policy, Benefit of zero incident safety policy, Importance of incident free working environment, Incident investigation, Root cause analysis, Medical evaluation, Preventive action, Work place

safety training, Machineries safety, Standard operating procedures of modern equipment's, Personal protection equipment's (PPE), PPE compliance, Occupational safety training, Emergency drill for worker, Occupational health and safety management in Leather and Footwear industry.

Learning Outcomes: At the end of this course, the student will be able 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.
- Analyze safety and health issues resulting from worker complaints or OSHA violations and suggest potential remedies.
- Identify potential workplace safety and health hazards and determine how to mitigate the hazards through engineering controls, administrative controls and personal protective equipment.
- Demonstrate research skills necessary for mastery of the topic, which will entail a presentation on a specific industry. Worker compensation claims in the industry selected by the student will be evaluated and injury prevention methods reviewed in the report.
- Conduct basic safety inspections using strategies that they have developed though hazard identification and job hazard analysis.
- Review the principles for developing and implementing a successful occupational health and safety program and evaluation of a work site.

Reference Books:

1. The Occupational Ergonomics Hand Book, Edited by Waldemar Karwowski and William S. Marras, CRC Press, New York, USA.
2. Workplace Ergonomics Reference Guide, 3rd Edition, 2016, A Publication of the Computer/Electronic Accommodation Program.
3. Hathaway, Gloria J., Nick H. Proctor, and James P. Hughes. Proctor and Hughes' Chemical Hazards in the Workplace. 4th Ed. New York, NY: Van Nostrand Reinhold, 1996.
4. The Occupational Environment Its Evaluation and Control. 2nd Ed. Dinardi, Salvatore. Fairfax, VA: American Industrial Hygiene Association, 2003.
5. Occupational Medicine. 3rd Ed. Zenz, Carl, O. Bruce Dickerson, Edward P. Horvath. Milwaukee, Wisconsin: Mosby, 1994.
6. Physical and Biological Hazards in the Workplace. Wald, Peter and Gregg M. Stave. New York, NY: Van Nostrand Reinhold, 2001.
7. On the Practice of Safety. Manuele, Fred A. 3rd Ed. New York, NY: Wiley-Inter Science, 2003.
8. *Recognition of Health Hazards in Industries: A Review of Materials and Processes.* 2nd Edition. Burgess, William A. New York, NY: John Wiley and Sons, Inc., 1995.

Institute of Leather Engineering and Technology, University of Dhaka

Semester-II

Course No.	Course Title	Credits
LE-506	Advanced Leather Biotechnology	3.00
LE-510	Thesis	-
	Optional Course (Anyone from the following List)	
ENV-507	Environmental Management and Impact Assessment	3.00
ENV-508	Nanotechnology for Leather and Leather Products	3.00
CSIT-509	Industrial Automation	3.00
Total		**6.00**

LE-506: Advanced Leather Biotechnology (3.0 Credits)

Learning Objectives: The aim of this course is to:

- Understand the basic DNA and RNA structure of Bacterial genetics.
- Explore knowledge on the application of enzyme technology in leather manufacturing.
- Improve skill on the instrumental control techniques of fermentation process.
- Acquire biological treatment of tannery effluents.

Course Contents:

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

Bacterial genetics: Chemical nature of hereditary material: experiments with bacteria and bacteriophages indicating DNA to be the material of heredity, the Watson and Crick model of DNA structure, different types of RNA molecules, replication of the DNA molecule. Transcription & Translation of genetic information, the process of protein synthesis. Mutation- types of mutation, how mutations occur, how mutations are repaired, bacterial recombination, bacterial conjugation, bacterial transduction, bacterial transformation, recombinant DNA technology, DNA cloning.

Enzyme technology applications in leather processing: Conventional leather processing, application of enzymes in curing, soaking, dehairing, bating, degreasing, tanning.

Instrumentation and control of fermentation process: 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: 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.

Bioinformatics: Basic, 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.

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 cellsin 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, bacteriocides and other controlling agents for leather.

Learning Outcomes: At the end of this course students will be able to:

- gain knowledge on the role of biotechnological approaches in leather manufacture
- understand the enzyme extraction procedure, identification and their application in leather manufacturing processes
- apply biotechnological approaches for the preparation of bio fertilizer, biofuel from tannery solid waste
- apply enzymatic product in various unit operation in leather manufacture

Reference Books:

1. Principles of Genetics, 6th Edition- D. Peter Snustad, Michael J. Simmons.
2. Gene Cloning and DNA Analysis: An Introduction, 6th Edition- Terence A. Brown.
3. Microbial Ecology: Fundamentals and Applications - Ronald M. Atlas & Richard Bartha.
4. Principles of Fermentation Technology-Peter F. Stanbury, Allan Whitaker and Stephen J. Hall.
5. Enzymes in Industry: Production and Applications, 3rd Edition - Wolfgang Aehle (Editor).

Institute of Leather Engineering and Technology, University of Dhaka

	Optional Course (Anyone from the following List)	
ENV-507	Environmental Management and Impact Assessment	3.00
ENV-508	Nanotechnology for Leather and Leather Products	3.00
CSIT-509	Industrial Automation	3.00

ENV-507: Environmental Management and Impact Assessment (3.0 Credits)

Learning Objectives: The aims of the course are to:

- Appreciate the purpose and role of EIA in the decision-making process;
- Understand strengths & limitations of environmental management;
- Know procedures
- Understand screening & scoping processes
- Interpret options for evaluating environmental and social impacts;
- Know formats of EIA Report (Environmental Impact Statement, or Environmental Statement);
- Understand the purpose of developing follow-up procedures, and options for designing these procedures

Course Contents:

Environmental Audit: Principles of environmental auditing, cleaner technologies in industrial processes and evaluation of processes. Auditing techniques in preparation of EA, Basic Concept of Disaster- Definition of hazard, vulnerability, risk, disaster, Causative factors of disaster, Classification of disasters.

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.

Hazard Mitigation: Identification of hazard prone belts, hazard zonation and risk assessment; risk reduction in vulnerable areas, developing warning systems, forecasting, emergency preparedness, education and training activities, planning for rescue and relief works.

Natural Hazards: earthquakes, tsunami, volcanoes, floods, landslides, avalanche, cyclone, drought, fire – causes, perception, mitigation and management.

Man-made hazards: Hazards due to dams and reservoirs, nuclear power plants, industrial hazards, occupational hazards, mitigation measures.

Environmental health hazard and risk assessment: biological, chemical, physical and psychological health hazard; health risk assessment and management.

Environmental Impact Assessment (EIA): Definition, purpose 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.

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

Learning Outcomes: At the end of the course the students will be able to

- Explain the concepts about the Environmental Impact Assessment (EIA).
- Express environment law, aim and concept.
- Explain the necessity of EIA.
- Evaluate the subjects which must be considered in EIA projects.
- Know important plant or animal groups.
- identify these species or have these species identified

Reference Books:

1. Bregman, J.I. and Mackenthum, K.M. 1992. Environmental impact statements. Chelsia Michigan: Lewis.
2. Calow, P. 1997. Handbook of environmental risk assessment and management. Oxford: Blackwell Science.
3. Canter, W. Larry. 1996. Environmental impact assessment. McGraw-Hill International editions. 660p.
4. Fortlage, C. 1990. Environmental assessment: a practical guide. Aldershot: Gower
5. Geological Hazards- A Source Book on Hazards and Disasters. Kushy, T. M., Green wood Press, Westport, Conn. London.
6. Gupta and Harsh, K. 2003. Disaster Management, Universities Press (India) Pvt. Ltd.
7. Hunter Collin and Green Howard, 1995. Tourism and the environment. A Sustainable relationship. London. Routledge.
8. Morris, P and Therivel, R. 1995. Methods of environmental impact assessment. London. UCL press.

Institute of Leather Engineering and Technology, University of Dhaka

9. Munn, R.E.1979. Environmental impact assessment: principles and procedures, 2 ndEdn. New York: Wiley.
10. Vaidya, K.S. 1987.Environmental Geology, Tata McGraw-Hill Publishers.

ENV-508: Nanotechnology for Leather and Leather Products (3.0 Credits)

Learning Objectives:

- To elucidate emerging needs in nanotechnology environment, health; and safety, and incorporate them into basic education that can be immediately employed in industry.
- To promote interdisciplinary interactions among engineering, engineering technology, science, and industrial management/technology majors.
- To develop knowledge of the fundamental structure of matter, in order to control its behavior at the nanometric scale,
- To use nanometric knowledge to design and develop new products and systems that could have a major bearing on a wide range of areas of special socioeconomic significance in Leather sector.

Course Contents:

Introduction to Nanotechnology: Importance of nanotechnology, history of nano technology, properties of nanomaterials, difference between bulk and nanomaterial, molecular building blocks for nanostructure systems. Influence of Nano structure on mechanical, optical, electronic, magnetic and chemical properties.

Overview of different nanomaterials available, nanoscale, electromagnetic spectrum, particle size, chemistry and physics of nanomaterials, electronic phenomenon in nanostructures, optical absorption in solids, quantum effects.

Nanomaterials Synthesis: "Top-Down" and "Bottom-Up" approaches of nanomaterial (nanoparticles, nanoclusters and quantum dots) synthesis. Top-down techniques: photolithography, particle-beam lithographies (e-beam, FIB, shadow mask evaporation), probe lithographies. Bottom-up techniques: self-assembly, self-assembled monolayers, directed assembly, layer-by-layer assembly. Pattern replication techniques: soft lithography, nanoimprint lithography. Quantum dots, gold, silver, different types of nano-oxides, Al2O3, TiO2, ZnO etc. Carbon nanotubes, preparation properties and applications like field emission displays.

Characterization Techniques Related to Nanoscience and Nanotechnology: Compositional surface analysis; XPS. Microscopies; optical microscopy, fluorescence, TEM, SEM, Probe techniques; scanning tunneling microscopy (STM), atomic force microscopy (AFM), Neutron Scattering and XRD. Spectroscopic Techniques; UV-visible, FT-IR, Raman, NMR, ESR.

Application of Nanomaterials: Molecular motors, energy storage, electronic-nano particles for molecular diagnostics, nano biosensors, nano pharmaceuticals, nanoparticle-based drug delivery, nanostructures for tissue engineering/regenerative medicine etc. Ethical safety and regulatory issues of nanomedicine.

Application of Nanomaterials in leather: Collagen – Skin Matrix – Association of nano materials with collagen matrix at various stages of processing – Pre tanning. Tanning. Post Tanning and Finishing.

Manufacture of Nano based materials for leather manufacture: Syntans, fatliquor, coloring and finishing chemicals.

Handling, Safety and Hazard of Nanomaterials Processing: Safety precautions at lab and manufacturing level; Temperature-Pressure and other physical effects. Effect of nanomaterial exposure on human and living stock, long term and short term effects-Case studies of Titania-Asbestos and Carbon nanoparticle exposure. Effect of Nano particles on air, water and soil; food and food supplements and cosmetics.

Learning Outcomes:

- Determine the nanotechnology and actual working areas and applications.
- Can distinguish between nanomaterials depending on their technological applications.
- Describe and explain Nanotechnology based on their dimensionality.
- Explain the importance of reduction in materials dimensionality, and its relationship with materials properties.
- Describe and discuss Nanotechnology tools.

Reference Books:

1. Nanotechnology: An Introduction by Jeremy Ramsden
2. Introduction to Nanotechnology by Charles P Poole and Frank J Owens
3. Nanotechnology For Dummies: A Fun and Easy Way to Explore the Science of Matter's Smallest Particles by Earl Boysen and Richard Booker

CSIT-509: Industrial Automation (3.0 Credits)

Learning Objectives:

- To provide knowledge and skills useful in identifying the concepts of automated machines and equipment.
- To provide the terms and phrases associated with industrial automation.
- To introduce the importance of automation techniques manufacturing and process Industries.
- To impart the role of PLC in industry automation.
- To expose to various control techniques employed in process automation.

Institute of Leather Engineering and Technology, University of Dhaka

- To develop automation system for manufacturing and process industries.

Course Contents:

Introduction: Basics of Industrial Automation, Principles and strategies of automation, Basic elements of an automated system, Advanced automation functions, Levels of automations, Automated flow lines and transfer mechanisms, Analysis of transfer lines without storage, Automated flow lines with storage buffers.

Boolean Algebra and Logic Circuits: Logic gates: AND, OR, NAND, NOR, NOT, XOR, XNOR, Truth tables, Logic functions, Boolean Laws, Karnaugh maps, State Machines.

Programmable Logic Controller (PLC)-: Block diagram of PLC, Programming languages of PLC, Basic instruction sets, Design of alarm and interlocks, Networking of PLC, Overview of safety of PLC with case studies. Process Safety Automation: Levels of process safety through use of PLCs,

Controllers: Control Modes, PID and Digital Controllers, Velocity Control, Adaptive Control, Microprocessor and Microcontrollers

Sensors: Important characteristics, Main industrial sensors (Overview), Classification of sensors and their usage, Description of different kinds of sensors, for example, proximity, magnetic, electronic, inductive, capacitor sensors, etc.

Actuators: 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.

Design of Automated Systems: Steps of an automated System Design, Possible Design Solutions. Case Studies on Application of an automated Systems.

Human-machine-interaction: The overview of Human and Machine Interaction.

Learning Outcomes:

- Student will be able to identify or solve problems in machines, and other technologies.
- Students will have knowledge on how an automated machine works.
- Students will be able to demonstrate competence in maintaining and troubleshooting technology
- Students will be familiar with various automation technologies in manufacturing and process industries.
- Student will understand various automation tools and methods in industry.

Reference Books:

1. Industrial Control Electronics 3rd Edition by Terry L.M. Bartelt.
2. M.P.Groover,"Automation, Production Systems and Computer Integrated Manufacturing", 5 th Edition, Pearson Education, 2009.

Institute of Leather Engineering and Technology, University of Dhaka

3. John W. Webb and Ronald A. Reis, “Programmable Logic Controllers: Principles and
Applications”, 5th Edition, Prentice Hall Inc., New Jersey, 2003.
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering - W. Bolton, Prentice Hall.

Semester-III

Course No.	Course Title	Credits
LE-510	THESIS	15.00
Total		**36.00**