Rules and Guidelines
for
M.Sc. Engineering in Footwear Engineering Programs

Institute of Leather Engineering and Technology
University of Dhaka

Dhaka-1209, Bangladesh

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Institute of Leather Engineering and Technology, University of Dhaka

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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

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 15 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;

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(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

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4. Course Credit Summary

(a) For B.Sc. Engineering Degree

Summary (B.Sc. Engineering in Footwear 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 Skills (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 FE**	**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 Footwear 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 M.Sc. Engineering in Footwear Engineering Program

The rules and guidelines of the M.Sc. Engineering in Footwear 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.

6.1 The Master of Footwear Engineering Program

The Master of Footwear 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

6.2 Admission

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

6.3 Definition of Credit

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

6.4 Credit Requirements for the Master of Engineering Degree

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

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 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:

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

(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) Thesis

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

(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

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 Institute.

(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 manage or coordinate all exam related activities as per university rules.

6.8 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.

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(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 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.

6.9 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.

6.10 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

6.11 Requirements for the Award of the M.Sc. Engineering in Footwear 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 readmit for another three semesters.

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 independently prepare the tabulation sheets and compare before submitting to office of the Controller of Examination through the Chairman of Exam Committee.

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6.13 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.

6.14 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.

6.15 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.

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

Semester-I

Course No.	Course Title	Credits
FE-501	Modernization of Footwear Manufacturing	3.00
FE-502	Optimization Techniques of Footwear Manufacturing	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
FE-510	Thesis	-
Total		**15.0**

Semester-II

Course No.	Course Title	Credits
FE-506	Sports and Pedorthic Footwear	3.00
FE-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
FE-510	THESIS	15.00
Grand Total		**36.00**

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DETAIL COURSE CONTENTS

Semester-I

Course No.	Course Title	Credits
FE-501	Modernization of Footwear Manufacturing	3.00
FE-502	Optimization Techniques of Footwear Manufacturing	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
FE-510	Thesis	-
Total		**15.0**

FE-501: Modernization of Footwear Manufacturing (3.0 Credits)

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

- To introduce students to the additive manufacturing techniques.
- To familiar students with sustainable footwear production practices.
- To equip students with footwear manufacture for cold weather condition.
- To provide an overview of shoe technical file, high performance footwear, structured casual footwear, water-resistant footwear, and platform shoe manufacture.
- To disseminate knowledge about special types of leather made footwear.

Course Contents:

Additive manufacturing (AM) techniques in footwear: Introduction to AM, AM in sports footwear, potential elements of AM, AM techniques: stereolithography (SLA), PolyJet (PJ), selective laser sintering (SLS) and three-dimensional printing (3DP), suitability of different AM techniques, and challenges of AM techniques.

Sustainability in footwear production: Footwear and its role in sustainability, Sustainable production practices from designing to packaging department, Waste accumulation, controlling volatile organic chemicals and CO_2, polymers, water, restricted substances. Implementation of labor law in footwear production, implementation of environment conservation rules in footwear production, reducing costs in footwear manufacture.

Footwear for cold weather conditions: Introduction, The feet in cold environments, Feet and footwear-related injuries in cold environments, Design requirements of footwear for cold environments, Footwear insulation, Footwear evaporative resistance measurements, Moisture management in footwear, Effect of socks on feet insulation, moisture management and comfort.

Compiling a technical file: Purpose, contents and requirements for Compiling a technical file in footwear business.

Maximizing upper permeability in production: Breathability and foot comfort, factors affecting thermoregulation, different climates, different materials to perform in permeability, selection of materials, upper construction.

High performance outdoor footwear: Importance of high performance outdoor footwear, essential features- comfort, thermo-regulation, moisture management and moisture disposal, protection, water resistance, durability etc. Manufacturing process- fit and digital last assessment, upper design, using membranes, bottom construction, assessing moisture management of materials, assessing moisture management of footwear, sole design, wearer expectations, labelling.

Structured casual footwear: Features of structured casual footwear-underfoot cushioning, lightweight flexible solings, soft upper materials, cosseting, moisture disposal, water resistance, durability etc. Manufacturing process- selecting last, upper and bottom design, pattern making, cutting, sewing, lasting, sole attachment, lacing systems and trims.

Water-resistant footwear: Difference between water-proof and water-resistant footwear, customer expectation, construction of water resistant footwear- footwear style/design, material selection, seam performance, sole attaching, finishing etc. **Platform shoe manufacture:** Advantages and disadvantages of platform shoe, importance of keeping stable in platform shoe, controlling of toe spring, positioning the shank, controlling waist strength, design and construction.

Shoe making with suede and nubuck leather: origins and structures of suede and nubuck leather, properties of suede and nubuck leather, Shoe making problems with suede and nubuck leather, sensitive surfaces, protection during shoemaking, other shoemaking operations, wear properties, dye fixatives, surface fixatives, acceptable levels of colour fastness, customer awareness.

Shoe making with non-bovine leather: Types and properties of non-bovine, pig, peccary, capybara, goat, wool sheep, hair sheep, deer, kangaroo, horse, exotic leathers, ostrich and emu, fish, alligators and crocodiles. Manufacturing process of footwear with non-bovine leathers with advantages and disadvantages.

Producing footwear with patent leather: Properties of patent leather, problems that may arise in the use of patent leathers- tear strength problem, orange-peel' effects, heat stress cracking, flexing problem, coating peeling, abrasion damage, surface friction effects. Care taken for producing footwear with patent leather

Shoemaking with oily leathers: Properties of oily finished leather, surface appearance, problems that may arise in the use of oily finish leathers for shoe making and wearing- soiling and cleaning, adhesion may be affected.

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

- To know about sustainable footwear production practices.
- To learn theoretical knowledge about making footwear for cold weather condition.
- To prepare a shoe technical file.
- To gather knowledge about high performance footwear, structured casual footwear, water-resistant footwear, and platform shoe manufacture.
- To know about footwear made of suede, nubuck, patent, non-bovine and oily leather.

Reference Books:

1. ROSSI, W. A. and TENNANT, R. (1984) *Professional Shoe Fitting*, New York, Pedorthic Footwear Association.
2. STELLA, S. (2002) *The Innovation Notebooks for the Footwear Industry*, *Last*, Italy, AssomacServizisrl.
3. Miller, R.G (1966) *Manual of Shoe Making*, 5th ed. Printing Department, Clarks Ltd. C. & J. Clark Ltd.

FE-502: Optimization Techniques of Footwear Manufacturing (3.0 Credits)

Learning Objectives: Students have to get the idea on

- Advanced knowledge of inventory management,
- Aggregate Planning and Master Scheduling, MRP, MRPII and ERP, Managing Project,
- Decision Modeling, Linear Programming Models, Transportations Modeling, Integer Programming and Dynamic Programming and Network Techniques and Problem-solving tools and improvement strategies.
- Students also will get knowledge on how to implement the advanced tools and techniques of operation research to manage the production in the footwear industry supply chain.

Course Contents:

Advanced Inventory Management: Demand and control system characteristics, inventory concept, inventory cost, inventory modeling, optimization and inventory control, Dynamic EOQ Models, probabilistic models and safety stock, probabilistic demand, probabilistic example, Single-Period Models, Multiperiod Models.

Aggregate Planning and Master Scheduling: Basic Strategies for Meeting Uneven Demand, Techniques for Aggregate Planning, Disaggregating the Aggregate Plan, Master Scheduling, The Master Scheduling Process, Methods for Aggregate Planning: Graphical Methods, Mathematical Approaches, Comparison of Aggregate Planning Methods.

MRP, MRPII and ERP: Basic ideas of inventory MRP, benefits of MRP, inputs to MRP, bill of material (BOM), BOM examples for footwear manufacture, Master Production Schedule (MPS), MPS examples for footwear manufacture, time-phased product structure, MRP structure, determining gross requirements, gross requirements plan for footwear manufacture, gross requirements schedule, MRP management, Lot-sizing techniques, Lot-for-Lot examples, EOQ lot size examples, POQ lot size examples, material requirements

planning II, distribution resource planning (DRP), enterprise resource planning (ERP), SAP's ERP modules.

Decision Modeling: The Decision Process in Operations; Fundamentals of Decision Making; Types of Decision-Making Environments; Decision Making under Uncertainty, Decision Making under Risk, Decision Making under Certainty, Expected Value of Perfect Information (EVPI); Decision Trees; A More Complex Decision Tree, Using Decision Trees in Ethical Decision Making.

Linear Programming Models: Why Use Linear Programming? Requirements of a Linear Programming Problem, Formulating Linear Programming Problems, Graphical Solution to a Linear Programming Problem, Sensitivity Analysis, Solving Minimization Problems, Linear Programming Applications, The Simplex Method of LP.

Transportations Modeling: Transportation Modeling; Developing an Initial Solution: The Northwest-Corner Rule, The Intuitive Lowest-Cost Method, The Stepping-Stone Method; Special Issues in Modeling: Demand Not Equal to Supply, Degeneracy; Using Software to Solve Transportation Problems; Case Studies.

Integer Programming and Dynamic Programming and Network Techniques: Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

Problem solving tools and improvement strategies: Problem solving process, quality control tools, new management tools, quality function deployment, Deming wheel, zero defect concept, benchmarking, six- sigma.

Learning Outcomes: From learning this course the students can understand the advanced knowledge on

- How to manage inventory using advanced Operations Research tools
- How to make aggregate Planning and Master Scheduling for footwear industry
- How to use MRP, MRPII and ERP for materials management
- How to manage new Project related to new products or business
- How decision Modeling, Linear Programming Models, Transportations Modeling, Integer Programming and Dynamic Programming and Network Techniques and Problem-solving tools and improvement strategies help to improve footwear companies' performance and profitability.
- How to implement the advanced tools and techniques of operation research to manage the production in the footwear industry supply chain.

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. Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997
4. Gideon Halevi- Handbook of Production Management Methods
5. R. Panneerselvam, "Operations Research", Prentice Hall of India Private Limited, New Delhi 1 – 2005
6. Larry P. Ritzman, Lee J. Krajewski, and Manoj K. Malhotra- Operations Management: Processes and Supply Chains
7. Nicholas J. Aquilano and Richard B. Chase- Production and Operations Management
8. 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
9. Kim Hua Tan and Rupert Matthews- Operations Strategy in Action: A Guide to the Theory and Practice of Implementation

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:

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.

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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.*

Semester-II

Course No.	Course Title	Credits
FE-506	Sports and Pedorthic Footwear	3.00
FE-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**

FE-506: Sports and Pedorthic Footwear (3.0 Credits)

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

- To provide an overview of sports footwear manufacturing technologies.
- To equip students with materials and design considerations of sports footwear.
- To disseminate knowledge about different types of foot problems.
- To understand foot and footwear biomechanics.
- To familiar students with diabetic foot problems.
- To provide an overview of diabetic footwear, orthopedic footwear, and geriatric footwear.

Course Contents:

Sports footwear manufacture: Types of sports footwear, essential requirements for sports footwear, product and process development of sports footwear, patterns for sports footwear, manufacturing process of sports footwear, and technologies involved in sports footwear manufacturing.

The shoe in sports: General considerations, materials, lasting techniques, upper designs and cuts, bottoming process, the outer sole, midsole and wedges, other component parts, new component and designs, sports-specific shoes, current use of textiles in sports shoes.

Functional sports footwear: Functional design of sports footwear, functional fit and comfort of sports footwear, shape of the last, fastening systems, sports shoe size system, functional materials and components in sports footwear, properties of materials and components, and injuries related to sports footwear.

Foot problems: Skin lesions- calluses, corns, plantar warts, ingrown nail, etc., arch problems- flat foot, claw foot, arch strains, metatarsalgia, foot fatigue, burning feet, rigid feet, aching in calf, toe problems- hallux valgus, bunion, tailor's bunion, hammer toe, children foot problems- in toeing, out toeing, pronation, crooked toes.

Biomechanics: Basic concept of biomechanics, basic concept of foot barograph, characteristics of the foot, muscles and joints, pressure points and load distribution, foot dynamics, foots motions, gait analysis, phases of gait, primary goals of walking, stance phase, swing phase, running, movements of joints during dynamic phase, muscles work during static and dynamic condition, abnormal gait patterns, body weight distribution (%) over different segments of feet, force platforms, angle of flexion at the joints, electromyography.

Diabetic footwear: Diabetes, types of diabetes, diabetic foot, The relationship between footwear and the vulnerable foot, foot complications due to diabetes, impact of diabetes on foot structure, foot pressure and gait, epidemiology of diabetic foot syndrome, the neuropathic foot, the neuroischaemic foot, prevention, treatment, diabetic footwear, development of diabetic footwear, necessity of diabetic footwear, features of diabetic footwear, design for diabetic footwear, materials selection, construction of diabetic footwear, orthotics, classification of orthotics, application and functions of orthotics, footgear, types, diabetic socks, physiological mechanism of diabetic footwear, diabetic foot and footwear care, and an algorithm for footwear and foot orthoses options for people with diabetes.

Orthopedic footwear: Introduction, classification, Impact of rheumatoid arthritis on foot structure, foot pressure and gait, orthotic men's and women's sandle with arch support, basic measurements for orthopedic footwear, modular footwear measurements, fitting of modular footwear, anatomical insole, in-socks and sole, design and development of orthopedic footwear, specially designed shoes for plantar facilities, bone structure of the foot and complication due to bone structure, materials selections, constructions, orthotics and insertions, design of foot orthoses, foot orthoses for people with rheumatoid arthritis and diabetes, planter facilities, foot care products, turf toe, supination, pronation, foot odors and prevention.

Geriatric Footwear: The impact of aging and systematic diseases, Introduction to geriatric footwear, Geriatric foot problems: etiological and epidemiological factors, Changes in the foot in relation to age, Complicating foot problems, Psychosocial and psychological considerations, Considerations in shoe design, and Therapeutic footwear.

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

- To learn about different types of sports footwear.
- To gather knowledge on sports footwear design considerations.
- To know about foot and footwear biomechanics.
- To know about diabetic foot problems.
- To know about diabetic footwear, orthopedic footwear, and geriatric footwear.

Reference Books:

1. Footwear and Foot Orthoses by Anita Williams and Chris Nester
2. Therapeutic footwear by Wendy Tyrrell and Gwenda Carter
3. The Science of Footwear by Ravindra S. Goonetilleke

	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 course is aimed 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.

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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.
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

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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.
- 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:

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- 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", 5th Edition, Pearson Education, 2009.
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
FE-510	THESIS	15.00
Total		**36.00**