DEPARTMENT OF LEATHER TECHNOLOGY

ANNA UNIVERSITY, CHENNAI

Vision:
To become a premier centre of learning and research in Leather and Allied Technology.

Mission:
1. To provide the quality education in the area of Leather Technology to transform students into graduates with high professional values.
2. To share and disseminate the expertise for use in the solution of problems faced by Leather industry.
3. To conduct need based research projects giving priority to the needs of industry
4. To build an expertise base capsule of delivering technology based solution to leather and allied sectors.
5. To provide a learning ambience for innovators, researchers and professional technology authors.
6. To foster development of advanced human capacity for translational research for solution science.
1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To build an expertise base capsule of delivering technology based solution to leather and allied sectors.
2. To foster development of advanced human capacity for translational research for solution science.
3. To equip learners with relevant knowledge and expertise system for professional consultation.
4. To enable learners in the areas of pedagogy and advanced research.
5. To provide a learning ambience for innovators, researchers and professional technology authors.

2. PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

<table>
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<tr>
<th>PO</th>
<th>Graduate Attribute</th>
<th>Programme Outcome</th>
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<tbody>
<tr>
<td>1</td>
<td>Engineering knowledge</td>
<td>Apply knowledge of mathematics, basic science and engineering science.</td>
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<tr>
<td>2</td>
<td>Problem analysis</td>
<td>Identify, formulate and solve engineering problems.</td>
</tr>
<tr>
<td>3</td>
<td>Design/Development of solutions</td>
<td>Design a system or process to improve its performance, satisfying its constraints.</td>
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<tr>
<td>4</td>
<td>Conduct investigations of complex problems</td>
<td>Conduct experiments &amp; collect, analyze and interpret the data.</td>
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<tr>
<td>5</td>
<td>Modern tool usage</td>
<td>Apply various tools and techniques to improve the efficiency of the system.</td>
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<tr>
<td>6</td>
<td>The Engineer and society</td>
<td>Conduct themselves to uphold the professional and social obligations.</td>
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<tr>
<td>7</td>
<td>Environment and sustainability</td>
<td>Design the system with environment consciousness and sustainable development.</td>
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<td>8</td>
<td>Ethics</td>
<td>Interact in industry, business and society in a professional and ethical manner.</td>
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<td>9</td>
<td>Individual and team work</td>
<td>Function in a multidisciplinary team.</td>
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<td>Communication</td>
<td>Proficiency in oral and written Communication.</td>
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<td>11</td>
<td>Project management and finance</td>
<td>Implement cost effective and improved system.</td>
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<td>12</td>
<td>Life-long learning</td>
<td>Continue professional development and learning as a life-long activity.</td>
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3. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES

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### SEMESTER I

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**PRACTICAL**

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**Total**: 28 hours (16 theory, 12 practical)

* Compulsory for non-leather graduates
**Audit Course is Optional

### SEMESTER – II

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**Total**: 29 hours (17 theory, 12 practical)

*Audit Course is Optional
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Total Credits: 70
## PROGRAM CORE COURSES (PCC)

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In order to develop professionals for academic research and development as well as for professional consultants/expert systems in area like Total Quality Management and project consultations, Environment and eco system services and Sustainability engineering and do ecology solutions, it is proposed to create four elective streams.

a) Professional Technology Services and Entrepreneurship,
b) Ecosystem services,
c) R&D and Pedagogy and
d) Do Ecology and sustainability engineering

Students are expected to choose any one the streams depending on their interest and capabilities. From the list of Professional Elective Courses, about 7 courses are proposed for each stream and students are expected to choose any 4 courses.

### a) Professional Technology Services and Entrepreneurship stream

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**OPEN ELECTIVE COURSES [OEC]**

*(Out of 6 Courses one Course must be selected)*

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**AUDIT COURSES (AC)**

*Registration for any of these courses is optional to students*

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
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<tr>
<td>1.</td>
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<td>Project Phase I</td>
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Total Credits: 20

SUMMARY

M.TECH – LEATHER TECHNOLOGY

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Subject Area</th>
<th>Credits per Semester</th>
<th>Credits Total</th>
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<tbody>
<tr>
<td>1.</td>
<td>PROGRAM CORE COURSES</td>
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<td>PROFESSIONAL ELECTIVES COURSES</td>
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<td>3.</td>
<td>OPEN ELECTIVE COURSES</td>
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<td>4.</td>
<td>EMPLOYABILITY ENHANCEMENT COURSES</td>
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<td>5.</td>
<td>RESEARCH METHODOLOGY AND IPR COURSE</td>
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<td>6.</td>
<td>AUDIT COURSE (Non Credit)</td>
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</table>

Total Credit 17 21 20 12 70
SYLLABI

SEMESTER I

LE5101 COLLAGEN SCIENCE AND TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE
This subject is to impart advanced physical and chemical concepts associated with the structure of collagen.

UNIT I BIOSYNTHESIS AND MOLECULAR STRUCTURE OF COLLAGEN 10


UNIT II CHEMISTRY OF COLLAGEN AND ITS DISTRIBUTION 5
Collagen chains – nomenclature- common and distinctive chemical features – pro and chains - carbohydrates - structure and functions of pro collagens.

UNIT III COLLAGEN CROSSLINKS 6
Chemistry and properties of crosslinks - intramolecular and intermolecular crosslinks – difunctional and multifunctional crosslinks - lathyrisim and (functional significance of) crosslinks - analysis of collagen crosslinks.

UNIT IV ISOLATION AND CHARACTERISATION OF COLLAGEN 8

UNIT V COLLAGEN DEGRADATION 8

UNIT VI BIOMATERIAL AND APPLICATION OF COLLAGEN 8

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course, the students
CO1. Have comprehensive knowledge on the chemistry and physics of collagen.
CO2. Understand the structure and stability of collagen.
CO3. Have knowledge on applications of collagen.

REFERENCES:
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
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<tbody>
<tr>
<td>CO1</td>
<td>Have comprehensive knowledge on the chemistry and physics of collagen.</td>
<td>PO1 2 3 2 2 3 3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the structure and stability of collagen</td>
<td>PO1 3 3 2 2 3 3</td>
</tr>
<tr>
<td>CO3</td>
<td>Have knowledge on applications of collagen</td>
<td>PO1 3 3 2 2 3 3</td>
</tr>
<tr>
<td>Collagen Science and Technology</td>
<td></td>
<td>PO1 3 3 2 2 3 3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management in leather and allied sector.

UNIT I  QUALITY ASSURANCE SYSTEM FOR LEATHER INDUSTRY  9
Introduction to QAS: Designing and developing quality assurance system for leather industry – Structure of QAS, Understanding system requirements, Designing QAS for Leather industry, Implementing QAS, Verification of QAS.

UNIT II  ISO 9001:2015 FOR LEATHER INDUSTRY  9

UNIT III  TOTAL QUALITY MANAGEMENT FOR LEATHER INDUSTRY  9
TQM Principles – Leadership, Supplier teaming, Customer focus, Employee empowerment, Continual improvement; Implementation of TQM principles in leather industry.

UNIT IV  STATISTICAL TECHNIQUES FOR QUALITY MANAGEMENT IN LEATHER INDUSTRY  9

UNIT V  STATISTICAL TECHNIQUES AND TOOLS  9
(a) Capability Analysis – Process capability, Process capability analysis using control charts, Process capability using designated experiments, Process capability with attribute data; application of process capability for leather.
(b) DMAIC - Basic concept and techniques of DMAIC – application of DMAIC for leather.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students can
CO1. Describe key elements of effective quality control and improvement programs.
CO2. Apply structured problem-solving statistical techniques and tools to improve quality in the leather sector.
CO3. Identify current trends and benchmark organizations related to quality management.
REFERENCES:
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Describe key elements of effective quality control and improvement programs.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply structured problem-solving statistical techniques and tools to improve quality in the leather sector.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Identify current trends and benchmark organizations related to quality management.</td>
<td>3</td>
</tr>
<tr>
<td>Quality Management and Assurance</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
The purpose of this subject is to identify; formulate; foresee or predict problems as possible; and to plan, organize, control activities of the project to complete it successfully in spite of all risks.

UNIT I PROJECT IDENTIFICATION AND FORMULATION

UNIT II PROJECT BUDGETING AND FINANCING


UNIT III PROJECT APPRAISAL AND RISK ANALYSIS
Project Appraisal: Time Value of Money; Project Appraisal Techniques – Payback Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return, Benefit Cost Ratio; Social Cost Benefit Analysis; Effective Rate of Return.
Risk Analysis: Measures of Risk; Sensitivity Analysis; Stimulation Analysis; Decision Tree Analysis.

UNIT IV PROJECT DESIGN AND EVALUATION

UNIT V PROJECT SCHEDULING TOOLS AND TECHNIQUES
Critical Path Method (CPM); Critical Chain Method; Schedule Compression Techniques – Crashing – Fast Tracking; Resource Optimization Techniques – Leveling – Balancing; Modelling Techniques – What- if Analysis – Simulation; Leads and Lags; Scheduling tools; Schedule network Analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the student can
CO1. Successfully develop and implement all project’s procedures.
CO2. Achieve project’s main goal within the given constraints.
CO3. Develop techniques to manage and coordinate project managers, subcontractors, customers, team members and vendors.
CO4. Identify various implementation techniques.
CO5. Describe ways to manage scope in a rapidly changing business environment.
REFERENCES:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Successfully develop and implement all project’s procedures.</td>
<td>–</td>
</tr>
<tr>
<td>CO2</td>
<td>Achieve project’s main goal within the given constraints.</td>
<td>–</td>
</tr>
<tr>
<td>CO3</td>
<td>Develop techniques to manage and coordinate project managers, sub contractors, customers, team members and vendors.</td>
<td>–</td>
</tr>
<tr>
<td>CO4</td>
<td>Identify various implementation techniques.</td>
<td>–</td>
</tr>
<tr>
<td>CO5</td>
<td>Describe ways to manage scope in a rapidly changing business environment.</td>
<td>–</td>
</tr>
<tr>
<td>Project Management System</td>
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<td>3</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
## ORIENTATION TO LEATHER MANUFACTURE

[Bridge Elective Course for Non-Leather UG Graduates]  
“Syllabus is Common with M.Tech (Footwear Engineering and Management) Programme”

### OBJECTIVE

This course objective is to orient the non-leather students on the fundamental science and technology of leather manufacture.

### UNIT I  HIDES, SKINS AND PRESERVATION

<table>
<thead>
<tr>
<th>Origin and characteristics of hides and skins; Categories of livestock; Grading systems; Defects in hides and skins; Various preservation techniques and their principles.</th>
</tr>
</thead>
</table>

### UNIT II  PRETANNING PROCESSES AND OPERATIONS

<table>
<thead>
<tr>
<th>Principles and objectives of beam house processes viz., soaking, liming, reliming, deliming, bating, pickling, depickling and degreasing; Various unit operations in pretanning.</th>
</tr>
</thead>
</table>

### UNIT III  TANNING

<table>
<thead>
<tr>
<th>Definition and objectives of tanning; Types and basic chemistry of vegetable tannins; Basic chemistry of basic chromium sulfate; Principles involved in vegetable and chrome tanning and their mechanism in brief; Combination tannages.</th>
</tr>
</thead>
</table>

### UNIT IV  POST TANNING PROCESSES AND OPERATIONS

<table>
<thead>
<tr>
<th>Principles and objectives of post tanning processes viz., neutralisation, retanning, dyeing and fatliquoring; Various unit operations involved.</th>
</tr>
</thead>
</table>

### UNIT V  FINISHING TECHNIQUES

<table>
<thead>
<tr>
<th>Types of binders; Basic chemistry of protein, resin and PU binders; Types of pigments; Basic characteristics of pigments; Basic theory of coating; Principles and objectives of finishing; Classification of finishing; Types of auxiliaries and finishes.</th>
</tr>
</thead>
</table>

TOTAL : 45 PERIODS

### COURSE OUTCOME

Through this course the student

**CO1.** Understand the application and alternatives to leather in current global scenario  
**CO2.** Have knowledge on pretanning, tanning and post tanning processes.  
**CO3.** Comprehend the process rational for making specific leather.

### REFERENCES:

## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the application and alternatives to leather in current global scenario</td>
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<tr>
<td>CO2</td>
<td>Have knowledge on pretanning, tanning and post tanning processes.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Comprehend the process rational for making specific leather.</td>
<td>3</td>
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<tr>
<td>Orientation to Leather Manufacture</td>
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<td>3</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:
To impart knowledge and skills required for research and IPR:
• Problem formulation, analysis and solutions.
• Technical paper writing / presentation without violating professional ethics
• Patent drafting and filing patents.

UNIT I        RESEARCH PROBLEM FORMULATION  6
Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II        LITERATURE REVIEW  6
Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III        TECHNICAL WRITING/PRESENTATION  6
Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV        INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)  6

UNIT V        INTELLECTUAL PROPERTY RIGHTS (IPR)  6

COURCE OUTCOMES:
1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

TOTAL: 30 PERIODS
<table>
<thead>
<tr>
<th></th>
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</table>

REFERENCES:

OBJECTIVE
To provide practice on the principles, practices, tools and techniques of Total quality management in leather and allied sector.

Students will be oriented on Quality control and Management practice requirements in leather manufacture for converting raw hides/skins into finished leather. To provide this practical orientation, any two types of leather (upper, garment etc.) will be used. The practice would involve preparation of charts used in tannery.

TOTAL: 90 PERIODS

COURSE OUTCOMES:
At the end of the course students will be:
CO1. Able to apply quality management practice in leather manufacture
CO2. Able to analyses quality feature associated with leather manufacture
CO3. Able to understand quality check and quality assurance involved during leather manufacture
Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Able to apply quality management practice in leather manufacture</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO1  PO1  PO1  PSO1  PSO2  PSO3  PSO4</td>
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<td>CO2</td>
<td>Able to analyses quality feature associated with leather manufacture</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>−   3   −   2   3   3   −   −   −   −   −   −   −   3   −   −   3</td>
</tr>
<tr>
<td>CO3</td>
<td>Able to understand quality check and quality assurance involving during leather manufacture</td>
<td>−   3   −   2   3   3   3   −   −   −   −   −   −   3   −   −   3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>−   3   −   2   3   3   −   −   −   −   −   −   −   3   −   −   3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
To provide practical knowledge in characterizing various leather chemicals and handle advanced instrumental techniques.

UNIT I LEATHER CHEMICALS LABORATORY 45
Analysis and characterization of natural and synthetic fatliquors in terms of charge, fat content, stability to acids and electrolytes - Evaluation of dyes and pigments in terms of hue, brilliance, particle size determination - Analysis of chrome and formaldehyde in syntan and leather.

UNIT II PHYSICAL TESTING LABORATORY 45
Analysis of Strength Properties (Tensile Strength and Elongation at break, Tongue tear strength, Stitch tear and slit tear strengths) of leather - Water vapour permeability – perspiration resistance – Abrasion resistance – Grain crack resistance - Evaluation of fastness properties (Rub fastness, Light fatness, Colour fastness) on wet and dry condition.

TOTAL: 90 PERIODS

OUTCOMES:
Students will
CO1. Have the practical skill to use advanced instruments associated with leather science and technology
CO2. Have analytical skill to characterize the leather chemicals
CO3. Have practical knowledge in physical testing of leather
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
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<th>PSO3</th>
<th>PSO4</th>
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<tbody>
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<td>Have the practical skill to use advanced instruments associated with leather science and technology</td>
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<td>–</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Have analytical skill to characterize the leather chemicals</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>–</td>
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<td>–</td>
<td>3</td>
<td>–</td>
<td>–</td>
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<tr>
<td>CO3</td>
<td>Have practical knowledge in physical testing of leather</td>
<td>3</td>
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<td>Chemical and Physical Testing Laboratory</td>
<td>3</td>
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</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
This subject is to impart advanced physical, chemical and biological concepts associated with the leather manufacture.

UNIT I MATERIALS SCIENCE ASPECTS OF SKIN AND LEATHER
Pore size distribution, hydration and swelling phenomenon; Various transport processes into multiphasic systems; Steady and non-steady state diffusion; Leather as a composite material – bulk and surface properties, stiffness and damping/energy; Viscoelastic and dynamic mechanical properties; Ordering and long range order – concepts.

UNIT II PRINCIPLES INVOLVED IN PRETANNING AND TANNING OPERATIONS
Preservation towards salt less/less salt methods - Swelling mechanisms; Diffusion of lime and sharpening agents into skin; Osmotic and lyotropic opening of fibres. Mechanisms of unhairing based on chemical and enzymatic methods – concepts; Principles of deliming, bating and degreasing in designing eco-benign processes; Role of mineral acids, neutral salts and non-swelling acids in pickling; Changes in porosity of hides and skins during processing; Aqueous chemistry of Chromium (III), Aluminium (III), Iron (II) and (III), Titanium (IV), and Zirconium (IV) - coordinative interactions and hydrolytic behavior of coordinated ligands, and their relevance to mineral tanning. Transport of tanning materials into pelt, diffusion equilibria and mechanism of vegetable, mineral and combination tannages; Role of crosslinking and fibre coating in matrix stability.

UNIT III PRINCIPLES INVOLVED IN POST TANNING AND FINISHING

UNIT IV SUSTAINABILITY OF LEATHER MAKING
Sustainability concepts; Triple bottom line approach; Do-Undo concepts in leather processing; Effect of pH alternations; Do-ecology concepts; Narrow pH and reverse leather processing concepts; Bio-catalytic concepts to replace chemicals; Process integration; Waterless and low-water leather processing; Input-output process audit for atom economy.

COURSE OUTCOMES:
At the end of this course, the students will be able to
CO1. Understand the underpinning science in leather manufacture
CO2. Understand the advanced concepts and principle involved in the leather manufacture.
CO3. Have knowledge on sustainable leather making.

REFERENCES:
Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
<th>PO 6</th>
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<th>PSO 2</th>
<th>PSO3</th>
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<tbody>
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<td>CO1</td>
<td>Understand the underpinning science in leather manufacture</td>
<td>3</td>
<td>3</td>
<td>2</td>
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<td>–</td>
<td>–</td>
<td>3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the advanced concepts and principle involved in the leather manufacture</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>–</td>
<td>3</td>
<td>–</td>
<td>–</td>
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<td>CO3</td>
<td>Have knowledge on sustainable leather making.</td>
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<tr>
<td>Science of Leather Manufacturing</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
This course aims at imparting knowledge on the technology of making different types of leathers with cleaner and greener approach.

UNIT I SPECIALITY LEATHERS
Different types of raw materials used, properties required, physical and chemical standards required and process details to achieve the specifications of different types of leathers such as upholstery, washable garment, water resistant leathers, chamois, glove and fashion leathers. Processing of exotic leathers such as reptiles, crocodiles, lizards, fish, ostrich etc.

UNIT II 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 beam house processing.

UNIT III CLEANER PROCESSING: TANNING, POST TANNING AND FINISHING
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-labelling requirements and trend integrated strategies to achieve permissible BOD, COD and TDS standards of tannery effluents;

UNIT IV ADVANCED FINISHING TECHNIQUES
Role of following finishing equipments; techniques for newer and novel finishing system viz., aqueous based patent finishing, cationic finishing, foam finishing. Shoe suede, garment suede, grain finished effect and specialty finishes at split leather -processing technologies and finishing techniques specially suited for the purpose. Upgradation of lower ends for better utilisation. New textures with enhanced properties; Transfer foil/coating, lamination techniques, etc., in split finishing. Latest trends.

UNIT V NEWER CONCEPTS IN LEATHER MANUFACTURE

TOTAL : 45 PERIODS

COURSE OUTCOMES
At the end of the course, the students will be in a position to
CO1. Understand the conceptual design to make leather.
CO2. Have knowledge in cleaner leather processing.
CO3. Have knowledge in newer concepts in leather manufacture.
REFERENCES:
Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
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<td>Understand the conceptual design to make leather.</td>
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<td>CO2</td>
<td>Have knowledge in newer concepts in leather manufacture.</td>
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<tr>
<td>CO3</td>
<td>Have knowledge in cleaner leather processing.</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
To have thorough understanding on the theory of instrumentation and applications of analytical equipment used for characterization of various products with special reference to leather technology.

UNIT I SPECTROSCOPIC TECHNIQUES
Electromagnetic spectrum and spectroscopic techniques, principles of electronic vibrational and rotational spectroscopic techniques, principles of magnetic resonance, mass and microwave spectroscopic techniques, block diagram of the instruments involved, the fields of application of spectroscopic techniques including study of solid surfaces.

UNIT II CHROMATOGRAPHIC TECHNIQUES
Theory and application of different chromatographic techniques such as paper, TLC, HPLC, ion exchange, gel permeation, gel filtration, GLC and affinity chromatography.

UNIT III APPLICATIONS OF SPECTROSCOPIC AND CHROMATOGRAPHIC METHODS IN LEATHER SCIENCE
Application of spectroscopy to the analysis of mineral tanning salts, formaldehyde, dyes, pigments and effluents, NMR techniques in the characterization of synthetic tanning agents, fatliquors, finishing agents - Application of chromatographic techniques in separation, analysis and characterization of mixtures containing compounds such as biocides, peptides, proteins, mineral tanning salts, vegetable tannins, dyes and finishing agents with special emphasis on the characterization of polymers.

UNIT IV ELECTROANALYTICAL METHODS
Theory and applications of electroanalytical techniques like - Polarography, coulometry, cyclic voltammetry and chrono-potentiometry.

UNIT V PRINCIPLES OF MICROSCOPIC AND OTHER TESTING METHODS IN LEATHER SCIENCE
Principles involved in the morphological investigation on leather and polymers (conventional, core shell morphologies), various microscopic techniques including electron microscopy, mechanical testing devices and criteria for the measurement of mechanical properties – Imaging techniques for surface applications. Differential Scanning Calorimetry (DSC) / Hyper DSC. Thermo Gravimetric Analysis (TGA).

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course the students can
CO1. Gain fundamental knowledge on various instrumental methods.
CO2. Understand the underpinning science behind various instrumental techniques.
CO3. Aware of advanced analytical techniques.
REFERENCES:
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
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<tr>
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<tr>
<td>CO1</td>
<td>Gain fundamental knowledge on various instrumental methods.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the underpinning science behind various instrumental techniques.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Aware of advanced analytical techniques.</td>
<td>3</td>
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<tr>
<td>Advanced Instrumental Methods</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

To impart practical exposure in
- Designing and applying processes for making different types of leathers using cleaner approaches.

Advanced processing techniques with emphasis on eco friendly leather manufacture. Case studies for specific product mix (upper, garment, upholstery, glove) with details of chemical audit, energy audit, water consumption during processing.

TOTAL: 90 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be in a position.
CO1. Make different types of leather using cleaner methods.
CO2. Analyze process efficiencies.
CO3. Construct process strategy for speciality leathers.
### Course Articulation Matrix:

<table>
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<tr>
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<td>PO1</td>
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<tr>
<td>CO1</td>
<td>Make different types of leather using cleaner methods.</td>
<td>–</td>
</tr>
<tr>
<td>CO2</td>
<td>Analyze process efficiencies.</td>
<td>–</td>
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<tr>
<td>CO3</td>
<td>Construct process strategy for speciality leathers.</td>
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<tr>
<td>Leather Process Design Engineering Laboratory</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
To provide practical knowledge in characterizing various leather chemicals and handle advanced instrumental techniques.

INSTRUMENTAL LABORATORY
UV and visible spectrophotometric techniques and their applications in the determination of chromium, iron, formaldehyde, dyes, NMR methods for fatliquors - Functional group identification in polymers using IR and NMR techniques. $^{13}$C spectra of polymeric syntans. GPC for molecular weight determination of polymeric syntans - Leather surface examination by electron microscope. Protein Purification techniques - Characterization of proteins viz., SDS-Page, Circular Dichroism, FTIR.

TOTAL: 90 PERIODS

COURSE OUTCOMES:
At the end of the course, the students would
CO1. Have practical knowledge on various instrumental methods.
CO2. Understand the underpinning science behind various instrumental techniques.
CO3. Have knowledge on advanced analytical techniques.
Course Articulation Matrix:

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<tr>
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<td>Have practical knowledge on various instrumental methods.</td>
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<td>CO2</td>
<td>Understand the underpinning science behind various instrumental techniques.</td>
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<td>CO3</td>
<td>Have knowledge on advanced analytical techniques.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
The course provides advanced concepts on the technology of making different auxiliaries viz., fatliquors, syntans, dyes and finishing chemicals used for leather manufacture.

UNIT I INTRODUCTION
Definition and function of leather auxiliaries, role of wetting agents, syntans, fatliquors, dyes, pigments, binder, top coats, feel modifiers and matting agents in leather processing. Surface tension and principles of wetting, importance of HLB, Chemical classification of wetting agents.

UNIT II SYNTANS
Chemical classification of syntans, sulphonation of naphthalene, phenols, Naphthols, Phenol formaldehyde condensation reactions, chemistry of light fast syntans, chemistry of amino resins and PU, Unit operations in syntan manufacture.

UNIT III FATLIQUOR AND DYEING
Composition of fatliquors; Functionalisation of oils for surface active function, chemical classification natural and synthetic oils, sulphation, sulphonation, sulphitiation reactions of oils, role of double bonds and iodine value in functionalisation of oils, sulphochlorination, sulphoamidation, transesterification, phosphorylation reactions for fatliquor preparation. Stability of emulsions, grain and particle sizes of emulsions, factors controlling grain sizes of emulsions. Fatliquor manufacturing technology. Theory of colors, chromphoric groups, structural features of dyes; acid, basic and reactive dye classification. Chemistry and technology of dye manufacture.

UNIT IV PIGMENTS AND BINDERS
Definition of pigments, groups of polymer bases for color. Classification, formulations of pigments, particle size, refractive index, density, opacity criteria for the choice of pigment bases, Different techniques in particle size reduction and importance of particle size on functional properties of pigment formulation. Functional definition of binders, chemical classification of binders, acrylic, protein, polyurethane, introduction to manufacturing of binder formulations.

UNIT V FINISHING
Different types of top coat formulations, choice of polymers for surface protection, role of plasticizers, internal and external plasticizers. Principles of feel modification of polymer surfaces, types of feel modifiers and matting agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES
At the end of the course, students would
CO1. Understand the structure and properties of various leather auxiliaries
CO2. Have knowledge on the chemistry of finishing chemicals
CO3. Aware of various application in leather processing.
REFERENCES:
5. Samir Dasgupta, Treatise on Fatliquors and Fatliquoring of Leather, Indian Leather Technologists Association Publications, Kolkatta
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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<td>CO2</td>
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<td>CO3</td>
<td>Aware of various application in leather processing.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
The industrial internship is expected to enhance the technical employability skills of the students.

Students are expected to undertake industrial internship programme during the summer vacation. Minimum duration of this should be 1 month. During their internship programme, the students are expected to resolve at least one of the problems faced by the industry. Students pursuing R&D elective stream will be allowed to take up their internship at a research lab. As a part of this course students are expected to make presentations and report on the work they have carried out during their internship.

COURSE OUTCOMES:
At the end of this course, the students will have confidence in handling practical aspects in Leather and allied sector and also to improve the presentation skills of the students.
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<tbody>
<tr>
<td>CO1</td>
<td>Have confidence in handling practical aspects in Leather and allied sector and also to improve the presentation skills of the students</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
The objective of this course is to facilitate the students to identify innovative projects that promotes creativity.

Under Project Phase I the students are expected to pursue preliminary work on a project undertaken by and assigned to him/her by the Department. A report should be submitted based on the information available in the literature or data determined in the laboratory/industry. The objective of the project work is to make use of the knowledge gained by the student at various stages of the degree programme. Project Phase I is intended to facilitate the better completion of project extended through Project Phase II in Semester IV.

VIVA VOCE
The object of the viva-voce examination is to determine whether the objectives of the Project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the Project Work.

TOTALS:: 180 PERIODS

COURSE OUTCOMES:
At the end of the Project Phase I period, students should be familiar with current thinking in their field, and able to apply the concepts by taking up a suitable research/industry problem.
Course Articulation Matrix:

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<tr>
<td>CO1</td>
<td>At the end of the Project Phase I period, students should be familiar with current thinking in their field, and able to apply the concepts by taking up a suitable research / industry problem.</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
The objective of the project is to make use of the knowledge gained by the student at various stages of the degree programme. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the programme.

The students should continue their work proposed in Project Phase I and are expected to complete the proposed work. A report should be submitted based on the data determined in the laboratory/industry. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the programme.

VIVA VOCE
The object of the viva-voce examination is to determine whether the objectives of the Project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the Project Work.

TOTAL: 360 PERIODS

COURSE OUTCOMES:
The project work is expected to shape the student to think originally, plan/execute work properly, analytical abilities and reporting/communication skills.
# Course Articulation Matrix:

<table>
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<tr>
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<th>Program Outcome</th>
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<td>PO1  PO 2  PO 3  PO 4  PO 5  PO 6  PO 7  PO 8  PO 9  PO1  PO1 1  PO1 2  PSO 1  PSO 2  PSO3  PSO 4</td>
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<tr>
<td>CO1</td>
<td>The project work is expected to shape the student to think originally,</td>
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<tr>
<td></td>
<td>plan/execute work properly, analytical abilities and reporting/</td>
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<td>communication skills.</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

This objective of the course is to present the students on the advanced concepts associated with coordinate covalent complexes.

UNIT I CONCEPTS IN CHEMICAL BONDING

Concepts and types of chemical bonding, group theoretical approach molecular symmetry elements, symmetry operation, point groups, application. Pi back bonding, organic metallic compounds, synthesis bonding and structure.

UNIT II THEORIES OF CO-ORDINATION

Valance bond theory, ligand field theory, molecular orbital theory, importance of ligand field stabilization energy, coordination geometrics and various oxidation states of metal ions.

UNIT III SYNTHESIS, STRUCTURE AND SPECTROCOPY OF TRANSITION METALCOMPLEXES

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 behaviour.

UNIT IV REACTIVITIES OF TRANSITION METAL COMPLEXES

Ligand substitution process and their kinetics and mechanisms. Electron transfer reactions of metal complexes. Stability constant and equilibrium constants

UNIT V METAL PROTEIN INTERACTIONS

Metal - protein interactions and their role in structural stability of protein. Bio inorganic chemistry, characterization of inorganic compounds by IR, NMR, UV-Vis and Mass spectroscopy

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students would be in a position to
CO1. Understand chemical bonding and coordination chemistry of transitions metals
CO2. Understand the synthesis, structure and reactivity of transition metal complexes
CO3. Understand metal-protein interactions

REFERENCES:

Course Articulation Matrix:

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand chemical bonding and coordination chemistry of transitions metals</td>
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<td></td>
<td>3 3 2</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the synthesis, structure and reactivity of transition metal complexes</td>
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<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand metal-protein interactions</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

Objective of this course is to understand the advanced biotechnology concepts in various unit processes and operations in leather manufacture.

UNIT I  MICROBIAL BIOTECHNOLOGY  8

Microbial fermentation methods. Types of fermentations. Fermentation equipment, preparation of media, preparation of inoculum, sterilization, separation and purification of products. Examples of microbial biotechnology in industry.

UNIT II  PROTEIN AND ENZYME CHEMISTRY  10

Protein classification, separation, chromatographic and electrophoretic techniques, criteria of homogeneity. Enzyme classification, methods of estimation, sources of enzymes, purification and properties, specificity, activation, inhibition. Immobilization of enzymes and microbial cells for industrial applications.

UNIT III  MOLECULAR BIOLOGY  8


UNIT IV  BIOCHEMICAL ENGINEERING  12

Basic principles, kinetics of growth. , batch, fed-batch, continuous, well-mixed, plug flow, tubular, mass and enthalpy balances, choice of reactor - Transport phenomena in biosystems-mass transfer in gas liquid systems, Design of fermentor and other fermentation vessels - instrumentation and control - downstream processes - application of various systems.

UNIT V  BY-PRODUCT UTILISATION  7

Animal based raw materials for Industries with particular reference to India; Role of enzymes and micro organisms in animal wastes utilization. Biological treatment of waste water.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students are expected to
CO1. Gain knowledge on the role of biotechnological approaches in leather manufacture.
CO2. Understand the concepts of molecular biology
CO3. Aware of by product utilization technology
REFERENCES:
4. A. Wiseman, "Topics in Enzyme and Fermentation Biotechnology" (Several volumes). Vol.5, 1982
## Course Articulation Matrix:

<table>
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<th>Course Outcomes</th>
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<td>Understand the significance molecular biology</td>
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<td>CO3</td>
<td>Aware of by product utilization technology</td>
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<td>Advanced Leather Biotechnology</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
To impart advanced knowledge on inorganic and organic chemistry that is essential for leather technologists.

UNIT I  BONDING MODELS

Ionic compounds
Crystal systems, Structures of crystal lattices, Lattice energy and the Born-Haber Cycle, Atomic size revisited - ionic radii

Covalent compounds
Lewis structures: (1) resonance, (2) formal charges
VSEPR theory ; Valence Bond Theory, hybridization
Molecular orbital theory
Linear combination of atomic orbitals: (1) delocalization, (2) antibonding orbitals
Symmetry and overlap
Homonuclear diatomic molecules
Heteronuclear diatomic molecules
Bond order and bond strength
Polyatomic molecules

UNIT II  ORGANIC REACTION TYPES ENCOUNTERED IN LEATHER SCIENCE

Free radical reactions, addition to carbon- carbon, carbon – oxygen multiple bonds, elimination reactions, molecular rearrangements, oxidation and reduction reactions.

UNIT III  MECHANISM OF ORGANIC REACTIONS USED IN THE MANUFACTURE OF LEATHER CHEMICALS

Methods of determining reaction mechanism, factors influencing SN1 and SN2, E1, E2 reactions. Electron displacements, inductive effect, induct metric effect, mesomeric effect, electrometric effect, hyper conjugation, steric inhibition of resonance. Aromatic electrophilic and nucleophilic substitution reactions.

UNIT IV  CHEMISTRY OF TRANSITION METALS


UNIT V  REACTION MECHANISMS OF METAL COMPLEXES

Ligands in a metal ion complex; ligand substitution mechanisms; oxidative addition” or “reductive elimination” of ligands, election transfer reactions, redox reaction.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1. Gain knowledge on some of the advanced aspects of organic and inorganic chemistry.
CO2. Understand the mechanism of organic reaction
CO3. Understand the chemistry of transition metals
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<td>Gain knowledge on some of the advanced aspects of inorganic and organic chemistry.</td>
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<td>CO2</td>
<td>Understand the mechanism of organic reaction</td>
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<tr>
<td>CO3</td>
<td>Understand the chemistry of transition metals</td>
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<td>Advanced Organic and Inorganic Chemistry</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
This objective of the course is to present the students on the advanced concepts associated with colloids and surface chemistry.

UNIT I  SURFACE TENSION, INTERFACIAL TENSION AND SURFACE ACTIVITY  9
Definition, effect of temperature, spreading, wetting etc. - Young Laplace and Kelvin equations - Gibbs Law and its application - Critical evaluation of methods of surface tension determination.

UNIT II  BULK PROPERTIES OF SURFACTANT SOLUTIONS AND MONOLAYERS  9
Critical micelle concentration (CMC) - Shape, Size, Aggregation, Hydration, Correlation times, Weight of micelles, etc. Different models and thermodynamics of micelle formation. Factors affecting CMC, Monolayers, types, their behaviour and industrial application. Lyophobic sols, Lyophilic systems and stability.

UNIT III  ADSORPTION BY SOLIDS  9
Solid-liquid interfaces (changing of surfaces, Electrical Double Layer, adsorption) Particle-particle interactions : Electrostatic forces; Analysis of surface change and surface chemistry (electro kinetics electrophoresis, streaming potential, electro-osmosis, sedimentation potential, electroacoustic, surface spectroscopy, ESR) Particle-particle Interactions: steric forces & polymer-mediated forces; Particle-particle interactions: hydrophobic forces; Analysis of particle interactions (rheometry, AFM, CFM, MASSIF, SFA) Flocculation& coagulation – Schulze-Hardy rule, inorganic coagulants, polymeric flocculants, wastewater treatment; Surface Active Agents & Association Structures of Amphiphilic Molecules

UNIT IV  SURFACTANTS  9
Surface activity – adsorption at interfaces, Gibbs, Traube’s rule, Rose-Nishioka rule structure of a surfactant Measuring surfactant adsorption – by difference, SPR, TIRF, FTIR, ellipsometry association structures a micelles, vesicles, surface micelles, giant worm-like micelles Structure of adsorbed films, SAMS, L-B films, surface micelles An extra unit on Bubbles and Foams (gases dispersed in liquids) may be introduces Foam stability Film Drainage Film rupture Film rheology Emulsion and pseudo-emulsion films Phase diagrams Measuring thin film properties – disjoining pressure, thin film balance Frothing agents Foam breaking Antifoaming agents & mechanisms Measuring foam properties Flotation Purification of surface active agents using foams
UNIT V APPLICATION TO LEATHER TECHNOLOGY

Wetting, cohesion & adhesion, contact angle, foams, detergency, emulsions, stability, surface properties and membrane technology.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students are expected to
CO1. Understand the role of colloid and surface chemistry in leather applications.  
CO2. Gain knowledge on bulk properties of surfactant solutions and monolayers.  
CO3. Understand the adsorption phenomena of solids.

REFERENCES:

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<td>Understand the role of colloid and surface chemistry in leather applications</td>
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<td>CO2</td>
<td>Gain knowledge on bulk properties of surfactant solutions and monolayers</td>
<td>3 3 2</td>
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<tr>
<td>CO3</td>
<td>Understand the adsorption phenomena of solids</td>
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<td>Colloid and Surface Chemistry</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES

➢ To equip individuals with knowledge and skills undertaking Corporate Social Responsibility.
➢ To develop competencies for effective field interventions, research and management of CSR interventions.
➢ To develop an insight into present CSR strategies of model business organization.
➢ To enable students with conceptual clarity on need, purpose and relevance of research applicability in CSR practice.

UNIT I  INTRODUCTION

Introduction to CSR - Meaning & Definition of CSR, History & evolution of CSR. Concept of Charity, Corporate philanthropy, Corporate Citizenship, CSR-an overlapping concept. Concept of sustainability & Stakeholder Management.
CSR through triple bottom line and Sustainable Business; relation between CSR and Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India; models of CSR in India, Carroll's model; drivers of CSR; major codes on CSR; Initiatives in India.

UNIT II  PRINCIPLES OF CSR

International framework for Corporate Social Responsibility, Millennium Development goals, Sustainable development goals, Relationship between CSR and MDGs. United Nations (UN) Global Compact 2011. UN guiding principles on business and human rights. OECD CSR policy tool, ILO tri-partite declaration of principles on multinational enterprises and social policy.

UNIT III  LEGISLATION AND ACTS

CSR-Legislation In India & the world. Section 135 of Companies Act 2013.Scope for CSR Activities under Schedule VII, Appointment of Independent Directors on the Board, and Computation of Net Profit’s Implementing Process in India.

UNIT IV  REGULATORY REFORMS

The Drivers of CSR in India, Market based pressure and incentives civil society pressure, the regulatory environment in India Counter trends. Performance in major business and programs. Voluntarism Judicial activism.

UNIT V  GUIDELINES OF CSR

Identifying key stakeholders of CSR & their roles. Role of Public Sector in Corporate, government programs that encourage voluntary responsible action of corporations. Role of Nonprofit & Local Self-Governance in implementing CSR; Contemporary issues in CSR & MDGs. Global Compact Self-Assessment Tool, National Voluntary Guidelines by Govt. of India. Understanding roles and responsibilities of corporate foundations.
UNIT VI CSR REVIEW AND INITIATIVES


TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students are expected to
CO1. Gain comprehensive knowledge on the relate and describe the multidisciplinary, strategic, and evolving nature of corporate social responsibility.
CO2. Able to apply ethical decision making principles in a professional or business context.
CO3. Aware of guidelines of CSR.

REFERENCES:
3. Innovative CSR by Lelouche, Idowu and Filho
5. Handbook on Corporate Social Responsibility in India, CII.
10. Blowfield, Michael, and Alan Murray, Corporate Responsibility, Oxford University Press, 2014
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<td>Gain comprehensive knowledge on the relate and describe the multidisciplinary, strategic, and evolving nature of corporate social responsibility.</td>
<td>PO1 2 3 4 PO5 6 7 PO8 PO9 PO10 PO11 PO12 PSO1 PSO2 PSO3 PSO4</td>
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<tr>
<td>CO2</td>
<td>Able to apply ethical decision making principles in a professional or business context.</td>
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<tr>
<td>CO3</td>
<td>Aware of guidelines of CSR</td>
<td>- 3 3 3 3 3 - 2 - 2 3 - - 3 3</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
LE5005 ENERGY MANAGEMENT IN INDUSTRIES

OBJECTIVE

This objective of the course is to orient the students to assess the energy requirement and management in leather manufacture.

UNIT I ENERGY SCENARIO


UNIT II ENERGY FORMS

Energy forms: (a) thermal (b) Electricity (c) Non-Conventional Sources Thermal: Different Fuels & its Energy Contents, Temperature & Pressure, Heat Capacity. Steam and Moist Air. Electricity: AC & DC, Load Management, Maximum Demand Control, Aggregated Technical & Commercial Losses (ATC); Non-Conventional: Various Forms; Some Applications related to Non-Conventional Energy Sources.

Different types of energy forms – SI units, Basics of heat, Power and Pressure, AC & DC motors, Basic of Pump and its types, Refrigeration and Air conditioning, Compressor and Boiler used in leather units and treatment system.

UNIT III ENERGY MANAGEMENT


UNIT IV ENERGY AUDIT

Requirements for Energy Audit, Different Approaches viz, Preliminary and Detailed Energy Audit, Case Studies for Real Systems.

UNIT V ENERGY MANAGEMENT AND AUDITING IN LEATHER INDUSTRY

Energy requirement – management – auditing in Leather and Leather Products Manufacturing Industry. Performance evaluation of Motor, Pump and Air compressor used in leather production and treatment units

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1. Understand the energy requirements in leather manufacture.

CO2. Gain knowledge in energy controls in leather manufacture.

CO3. Make case studies for real systems.
REFERENCES:
# Course Articulation Matrix:

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<td>Understand the energy requirements in leather manufacture</td>
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<td>CO2</td>
<td>Gain knowledge in energy controls in leather manufacture</td>
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<td>CO3</td>
<td>Make case studies for real systems</td>
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<td>Energy Management in Industries</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
The objective of this course is to present students on project feasibility analysis, management, organization and budgeting that will enable the students to perform as efficient managers.

UNIT I PROJECT IDENTIFICATION AND PREPARATION
10
General considerations - choice of project between alternative propositions - engineering aspects - cost estimates and demand forecasting for leather tanning industry.

UNIT II PRINCIPLES OF PROJECT APPRAISAL
10
Investment appraisal and financial analysis through the measurement of project return – by discounted cash flow method - net present value of a project - internal rate of return - project payback period - cash flows accounting profit - intangible returns - Inflation and project appraisal.

UNIT III IMPLEMENTATION AND MANAGEMENT
9
Methodological and organisational aspects of implementation - pert and other methods - risk and uncertainty - probability theory.

UNIT IV SOURCES OF FINANCE AND BUDGETING
9
Different sources of finance - ownership finance - ordinary share, short, medium and long term loan - budget preparation - annual cost, variable costs - allocation of costs.

UNIT V METHODS OF BUDGETING
7
Marketability method - benefit method - use of facilities method - special cost method, alternative single purpose expenditure method.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students are expected to
CO1. Understand the financial management and economics in the leather industry
CO2. Understand the profit value analysis
CO3. Have knowledge in organizational aspects of implementation

REFERENCES:
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<td>CO1</td>
<td>Understand the financial management and economics in the leather industry</td>
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<tr>
<td>CO2</td>
<td>Understand the profit value analysis</td>
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<tr>
<td>CO3</td>
<td>Have knowledge in organizational aspects of implementation</td>
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<td>Engineering Economics in Leather Production</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
LE5007 GREEN CHEMISTRY APPROACHES AND PRINCIPLES  L  T  P  C
3 0 0 3

OBJECTIVE
To impart knowledge on green chemistry options for cleaner leather processing.

UNIT I INTRODUCTION TO GREEN CHEMISTRY 8
Principles and Concepts of Green Chemistry-Atom Economy-Life Cycle Assessment-Use of Renewable Resources

UNIT II PRINCIPLES OF GREEN CHEMISTRY IN LEATHER PROCESSING 12
Prevent waste-Maximize atom economy-Design less hazardous chemical syntheses-Design safer chemicals and products-Use safer solvents and reaction conditions-Increase energy efficiency-Use renewable feedstocks-Avoid chemical derivatives-Use catalysts, not stoichiometric reagents-Design chemicals and products to degrade after use-Analyze in real time to prevent pollution-Minimize the potential for accidents

UNIT III GREENER APPROACHES IN PRETANNING PROCESSES 8
Saltless curing technology - Enzymes in leather processing - Role of ionic liquids in unhairing and fibre opening – Supercritical Carbon dioxide based deliming

UNIT IV CLEANER OPTIONS IN TANNING 10
Role of water in tanning - Alternative solvent system for cleaner leather processing - Waterless chrome tanning - Metal free tanning system - Strategy for high exhaustion Chrome Tanning - Mass balance, diffusion and reactivity of Tanning agent – Pickle free chrome tanning - Zero liquid discharge tanning system

UNIT V GREENER TECHNOLOGY FOR POST TANNING AND FINISHING 7
Formaldehyde, Phenol, AOX free post tanning systems – Biopolymers based retanning agent - Role of finishing equipments such as HVLP spray, foam finishing, etc in cleaner perspective. Aqueous finishing concepts and formulation; Other novel finishing techniques to reduce VOC emission - Nano technology in post tanning and finishing

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students are expected to
CO1. Gain knowledge on the various concepts of greener chemistry involving in the leather process (viz., pre-tanning, tanning, post-tanning and finishing systems).
CO2. Understand the various cleaner options for leather manufacturing.
CO3. Aware of recent greener technological options.
REFERENCES:

Books

Journals
### Course Articulation Matrix:

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<td>CO3</td>
<td>Aware of recent greener technological options</td>
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OBJECTIVE
This course will make the students to understand the regulations and practices associated with safety and occupational health.

UNIT I SAFETY PHILOSOPHY
Place of industry in society industrial management role - supervisors role - role of workers – role of trade unions - role of govt. and various other agencies - Factory Act 1948 and the rules. Hazardous Industry - need for safety, legal humanitarian, economic safety and productivity. Factors impeding safety.

UNIT II ACCIDENT PREVENTION & SAFETY TRAINING
Methods - developing safety training programme - training of supervisors - training of workers- Inplant& External courses - training of new workers - role of supervision - need for re-training.

UNIT III SAFE GUARDING OF MACHINERY AND MATERIAL HANDLING

UNIT IV FIRE HAZARDS AND CONTROL
Chemistry of fire, classification of fire, portable fire extinguishers and their operation – Industrial fire. Types of all fire protection equipment. Hazard Identification: Fire, explosions, indices consequence analysis, HAZOP, likelihood analysis, risk concepts and criteria, risk management Toxicity.

UNIT V OCCUPATIONAL HEALTH
Physical hazard, noise vibration, x-rays - ultra violet radiation - permissible exposure limits -effects of exposure - preventive & control measures. Chemical Hazards: toxic chemicals, dirt gases, furies, mists, vapours. Noise pollution, exposures evaluation, common occupational diseases, etc.

COURSE OUTCOMES:
At the end of the course, the students will be in the position to understand the
CO1. Legal framework of safety and health in India and international conventions.
CO3. Productive machine safety in the leather industry.
CO4. Emergency prevention and preparedness safety and health management.
REFERENCES:
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<td>Legal framework of safety and health in India and international conventions</td>
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<td>CO2</td>
<td>Hazard identification and assessment</td>
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<tr>
<td>CO3</td>
<td>Productive machine safety in the leather industry</td>
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<tr>
<td>CO4</td>
<td>Emergency prevention and preparedness safety and health management</td>
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<td>Industrial Safety and Occupational Health</td>
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OBJECTIVE
The knowledge on marketing of leather and leather chemicals in international market and foreign trade policies will be gained from this course.

UNIT I  MARKETING CONCEPTS  8
Definition of basic management and marketing concepts - role of marketing in the production function - marketing concepts relevant to consumer durable like leather and leather chemicals.

UNIT II  HIDES AND SKINS - LEATHERS  8
Indian livestock population over two decades - hides and skins availability, their sizes, marketing centres, channels, prices over two decades - leather production centres - channels, prices -leather products - centres and marketing channels.

UNIT III  MARKETING FUNCTION  9
Market classification and segmentation - consumer market and buying behaviour - market management and forecasting - market planning and control - competition marketing strategy - product life cycle strategy - product and price strategy - sales promotion, publicity, advertising, packaging - marketing organisations - techniques of marketing research for consumer products.

UNIT IV  INTERNATIONAL TRADE  10
General concepts of international marketing, principles relevant to leather and leather chemicals - global market for leather and leather chemicals - important production and consumption centres, product wise in the world - major world suppliers of leather chemicals.

UNIT V  EXPORT TRADE INDIA  10
India’s export trade in leather. India’s share in the global level - India’s competitors and their strength. International prices. Indian Government policies in the export promotion. Role of Indian and overseas promotional institutions for export growth - strategies for export promotion. Market constraints - quality, image, brand name, merchandising methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1. Understand the international trade, government policies in export aspects of world trade related to leather sector, custom tariff and international marketing.
CO2. Gain knowledge on concepts of international marketing.
CO3. Aware of India’s share in the global level.
REFERENCES:
5. Employment and working conditions and competitiveness in Leather and Footwear Industry (ILO of UN).
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<td>Understand the international trade, government policies in export aspects of world trade related to leather sector, custom tariff and international marketing</td>
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</tr>
<tr>
<td>CO2</td>
<td>Gain knowledge on concepts of international marketing</td>
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<td>CO3</td>
<td>Aware of India’s share in the global level</td>
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<td>Marketing of Leather and Leather Chemicals</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
This objective of the course is to present the students on nano technology concepts and their applications in leather manufacture.

UNIT I  NANOTECHNOLOGY
The nanoscale. What is nanotechnology? Consequences of the nanoscale for technology and society. Beyond Moore’s Law.

UNIT II  NANOMATERIALS: FABRICATION
  - Structure and bonding
  - Electronic band structure
  - Electron statistics
  - Bottom-up vs. top-down
  - Epitaxial growth
  - Self-assembly
  - Chemical Synthesis
  - Green Synthesis

UNIT III  NANOMATERIALS: CHARACTERIZATION
  - Scanning and Transmission Electron Microscopy
  - Scanning Probe Microscopies: Atomic Force, Scanning tunneling microscopy
  - Diffraction and scattering techniques
  - Vibrational Spectroscopy
  - Surface techniques

UNIT IV  APPLICATION OF NANO TECHNOLOGY IN TANNING, POST TANNING AND FINISHING

UNIT V  NANO LEATHER CHEMICALS
Manufacture of Nano based materials for leather manufacture: syntans, fatliquor, coloring and finishing chemicals.

UNIT VI  ENVIRONMENTAL ASPECTS OF NANOTECHNOLOGY
Synthesis, Water purification, Beneficial and adverse effect of nanomaterials.

TOTAL: 45 PERIODS
COURSE OUTCOMES:

On the completion of the course students are expected to
CO1. Understand the advancements in nano technology and their impact in leather manufacture.
CO2. Gain knowledge on nanomaterial and its characterization.
CO3. Aware of environmental aspects of nanotechnology.

REFERENCES:
## Course Articulation Matrix:

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<td>Understand the advancements in nano technology and their impact in leather manufacture</td>
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<td>Gain knowledge on nanomaterial and its characterization</td>
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<td>CO3</td>
<td>Aware of environmental aspects of nanotechnology</td>
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<td>Nanotechnology and its Applications in Leather</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
The objective of this course is to present concepts of polymerization of various polymers used. Analytical skills on testing of polymers will be emphasized that will enable them to understand various polymer properties and manufacturing methods.

UNIT I POLYMERS
Polymer and rubber industries in India. Chemistry and Technology of the most common polymeric materials used in leather industry as supplements.

UNIT II POLYMERIZATION TECHNIQUES
Concept of a macromolecule, natural and synthetic polymers, modes of polymerization, radical, condensation, stereo-regular polymerization, polymerization kinetics, mechanism, anionic and cationic polymerization. Polymers with linear, branched and cross linked structure, thermoplastic and thermosetting polymers, bulk, solution, suspension and emulsion polymerization.

UNIT III ANALYSIS AND TESTING OF POLYMERS
Molecular weight and distributions of polymers, different methods of molecular weight determinations, colligative properties, viscometry, light scattering techniques, thermal analysis of polymers, crystallinity, glass transitions and other mechanical properties, spectral analysis such as IR, UV and NMR of polymers.

UNIT IV POLYMERS FOR INDUSTRIAL APPLICATIONS
Manufacture of industrially important polymers for plastics, fibres and elastomer - Polyethylene, polypropylene, polyvinyl chloride, polyvinyl acetate, copolymers, formaldehyde resins, polyvinyl alcohol, polyacrylonitrile, polystyrene, polyurethane, fluoro-carbon polymers, epoxy resins, polyamides, polyesters, alkyd resins, silicone polymers, cellulosics.

UNIT V FABRICATION
Fabrication of polymeric materials, compounding and mixing, casting, extrusion, fibre spinning, moulding, coating foam fabrication. Manufacture of rubber and elastomers, Natural rubber, processing, vulcanizing synthetic elastomers, butadiene copolymer, nitrile rubber, polyisoprene, polybutadiene.

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1. Have knowledge on the chemistry of most common polymeric materials used in leather industry as supplements.
CO2. Understand the importance of polymers for industrial application.
CO3. Understand the fabrication process of polymer.
REFERENCES:
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<td>Have knowledge on the chemistry of most common polymeric materials used in leather industry as supplements</td>
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<td>Understand the importance of polymers for industrial application</td>
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<td>CO3</td>
<td>Understand the fabrication process of polymer</td>
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<td>Science and Technology of Leather Supplements and Synthetics</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
LE5073 SELF MANAGEMENT AND ENTREPREUNERSHIP  L  T  P  C
“Syllabus is in Common with M.Tech (Footwear Engineering and Management) Programme”

OBJECTIVE
To provide understanding on the need to self-manage and other management competency for a successful entrepreneurship.

UNIT I SELF-MANAGEMENT 12
Defining self-management - Writing a mission statement - Self-discipline - Self-evaluation - Self-analysis by personal SWOT; Planning & Goal setting; Developing a career plan.

UNIT II BUSINESS DEVELOPMENT 9
Intellectual property and copyright; Trademarks and patents; Types of businesses – Pvt, Public, Partner; Business development report - Institutions & organization for business development.

UNIT III FINANCE MANAGEMENT 9
Pricing your work & budgeting; Building an online portfolio; Branding; Networking and Partnership building; The elevator pitch Fundraising; Establishing a value network.

UNIT IV TIME MANAGEMENT 6
Time management; Project management; Time map and project management plan; Reflection on perfectionism.

UNIT V MARKETING MANAGEMENT 9
Publicity and advertising; Press releases; Digital and social media marketing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, one can
CO1. Differentiate between multiple leadership styles and ways of managing individuals
CO2. Recognize the various roles of managers and types of business management
CO3. Identify the fundamentals of managing the time and finance
CO4. Recall methods of communication, working in groups and stages of leadership

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<td>Differentiate between multiple leadership styles and ways of managing individuals</td>
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<td>Recognize the various roles of managers and types of business management</td>
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<td>Identify the fundamentals of managing the time and finance</td>
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<td>Recall methods of communication, working in groups and stages of leadership</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

This subject is to learn about holistic overview of the environmental, social and economic aspects of sustainability management and how to address them strategically to achieve the sustainable industry.

UNIT I INTRODUCTION TO SUSTAINABILITY 12
Definition, Concept and challenges of Sustainability, Pillars of sustainability – Environment, Economic and Social, Values and principles of sustainability, Integrated sustainability into business – System Thinking, value chain perspective and sustainability strategy & planning and stakeholder engagement, Integrated sustainability management - Sustainable performance management, Continuous improvement and integrated sustainability management systems, Sustainability measurement and tools – ISO standards and Life cycle Assessment.

UNIT II ENVIRONMENTAL SUSTAINABILITY 9

UNIT III ECONOMIC SUSTAINABILITY 8
Economic sustainability – Strategy, Technology Innovation, current and future economic prospects and market position; Types of economic contribution impact to the industry (Direct, Indirect and Induced impact.

UNIT IV SOCIAL SUSTAINABILITY 8
Social sustainability – Safety, health, community involvement, tax issues and corruption; Social sustainable management; Organizational behavior and sustainable Human Resources (HR); Measuring social impacts and benefits.

UNIT V SUSTAINABLE INDUSTRIAL DEVELOPMENT 8

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon successful completion of this course, students are expected to
CO1. Gain a fundamental knowledge of issues, principles, concepts, processes related to sustainability, describe how core technologies in the industry relate to sustainability.
CO2. Understand the sustainability in environment, economic and social.
CO3. Aware of strategy for sustainable leather industry development
REFERENCES:
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<td>CO2</td>
<td>Understand the sustainability in environment, economic and social</td>
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<td>Aware of strategy for sustainable leather industry development</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
This subject is to impart knowledge on primary, secondary and tertiary treatment associated with the management of waste water and safe disposal of solid wastes.

UNIT I WASTE GENERATION AND ENVIRONMENTAL LEGISLATION 5
Sources of waste water generation, Characteristics of effluent and pollution load from tanneries, significant pollutants in tanneries, Environmental discharge norms.

UNIT II INTRODUCTION TO BIOLOGICAL TREATMENT OF WASTEWATER 6
Screening – Flow Equalization – Theory on Coagulation & Flocculation – Sedimentation – Filtration – Detail study and design of these primary treatment unit.

UNIT III BIOLOGICAL TREATMENT OF WASTEWATER 12
Introduction to microbial metabolism – Bacterial growth – Kinetics of Biological Growth. Aerobic suspended growth system - Aerobic attached growth system - Anaerobic suspended growth system - Anaerobic attached growth system – Advanced Biological System – UASB – EGSB.

UNIT IV ADVANCED WASTEWATER TREATMENT FOR THE REMOVAL OF REFRACTORY ORGANIC COMPOUNDS AND WASTE MINIMIZATION 12

UNIT V SOLID WASTE DISPOSAL 10

COURSE OUTCOMES:
At the end of the course, the students will be in a position to
CO1. Understand the methods and means to manage tannery wastes.
CO3. Aware of various treatment option for solid water management.

REFERENCES:
## Course Articulation Matrix:

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<td>Gain knowledge on advanced wastewater treatment</td>
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<td>Aware of various treatment option for solid water management</td>
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<td>Tannery Waste Management and Engineering</td>
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OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS  L T P C  3 0 0 3

OBJECTIVES:
- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS


Suggested Activities:
- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:
- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS


Suggested Activities:
- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:
- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE


Suggested Activities:
- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:
- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.
UNIT IV  ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK


Suggested Activities:
- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:
- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V  OTHER DATA ANALYTICAL FRAMEWORKS

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:
- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:
- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

OUTCOMES:
On completion of the course, the student will be able to:
- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

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OBJECTIVES:
- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I  INTRODUCTION
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II  FUNDAMENTALS OF MAINTENANCE ENGINEERING
Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III  WEAR AND CORROSION AND THEIR PREVENTION

UNIT IV  FAULT TRACING
Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V  PERIODIC AND PREVENTIVE MAINTENANCE
Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

OUTCOMES:
- CO1: Ability to summarize basics of industrial safety
- CO2: Ability to describe fundamentals of maintenance engineering
- CO3: Ability to explain wear and corrosion
- CO4: Ability to illustrate fault tracing
- CO5: Ability to identify preventive and periodic maintenance

TOTAL: 45 PERIODS
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REFERENCES:

OE5093 OPERATIONS RESEARCH

OBJECTIVES:
- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9
Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9
Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9
Transportation problems - Northwest corner rule, least cost method, Voges's approximation method - Assignment problem - Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9
Shortest path problem: Dijkstra’s algorithms, Floyds algorithm, systematic method - CPM/PERT

UNIT V NETWORK ANALYSIS – III 9
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:
CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems
REFERENCES:

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS

OBJECTIVES:
- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS
Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS
OUTCOMES
CO1 – Understand the costing concepts and their role in decision making
CO2 – Understand the project management concepts and their various aspects in selection
CO3 – Interpret costing concepts with project execution
CO4 – Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 – Become familiar with quantitative techniques in cost management

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REFERENCES:
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

OE5095                                      COMPOSITE MATERIALS                        L T P C
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OBJECTIVES:
• Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
• Identify the various reinforcements used in composite materials.
• Compare the manufacturing process of metal matrix composites.
• Understand the manufacturing processes of polymer matrix composites.
• Analyze the strength of composite materials.

UNIT I INTRODUCTION
Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCMENTS
Preparation - layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES
UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES

UNIT V STRENGTH
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:
- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

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REFERENCES:
OBJECTIVES:
- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT-I  INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE  9
Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT-II  BIOMASS PYROLYSIS  9
Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III  BIOMASS GASIFICATION  9

UNIT-IV  BIOMASS COMBUSTION  9
Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V  BIO ENERGY  9
Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:
- CO1 – Understand the various types of wastes from which energy can be generated
- CO2 – Gain knowledge on biomass pyrolysis process and its applications
- CO3 – Develop knowledge on various types of biomass gasifiers and their operations
- CO4 – Gain knowledge on biomass combustors and its applications on generating energy
- CO5 – Understand the principles of bio-energy systems and their features

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REFERENCES:
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AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C 2 0 0 0

OBJECTIVES
- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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AX5092 DISASTER MANAGEMENT L T P C
OBJECTIVES
- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS

UNIT III DISASTER PRONE AREAS IN INDIA
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES
CO1: Ability to summarize basics of disaster
CO2: Ability to explain critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

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AX5093             Sanskrit For Technical Knowledge  L T P C  2 0 0 0

Objectives
- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

Unit I  Alphabets  6
Alphabets in Sanskrit

Unit II  Tenses and Sentences  6
Past/Present/Future Tense - Simple Sentences

Unit III  Order and Roots  6
Order - Introduction of roots

Unit IV  Sanskrit Literature  6
Technical information about Sanskrit Literature

Unit V  Technical Concepts of Engineering  6
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Total: 30 Periods

Outcomes
- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

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1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I
Values and self-development–Social values and individual attitudes.

UNIT II

UNIT III

UNIT IV

OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the over all personality.

Suggested reading
OBJECTIVES
Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

UNIT IV ORGANS OF GOVERNANCE:
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

UNIT VI ELECTION COMMISSION:
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origin of the framework of argument that informed the conceptualization
- of social reform sliding to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading
1. The Constitution of India, 1950 (Bare Act), Government Publication.
OBJECTIVES
Students will be able to:
- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:
Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES
Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers’ attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT
Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS
Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to understand:
- What pedagogical practices are being used by teachers in informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness soft he sepedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
Suggested reading
siteteachereducationresearchproject(MUSTER) country report 1.London:DFID.

AX5097 STRESS MANAGEMENT BY YOGA L T P C
2 0 0 0

OBJECTIVES
- To achieve overall health of body and mind
- To overcome stress

UNIT I
Definitions of Eight parts of yoga.(Ashtanga)

UNIT II
Yam and Niyam - Do’s and Don’t’sin life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III
Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING
1. ‘YogicAsanasforGroupTarining-Part-I”:JanardanSwamiYogabhyasiMandal, Nagpur
2. “Rajayogaorconquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department),Kolkata
OBJECTIVES
- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To a waken wisdom in students

UNIT I
Neetishatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II
Approach to day to day work and duties - Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III
Statements of basic knowledge - Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 -Personality of role model - shrimadbhagwadgeeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Study of Shrimad- Bhagwad- Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Suggested reading
1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari’s Three Satakam, Niti-sringar-vairagya, New Delhi,2010