

**SEMESTER WISE COURSE STRUCTURE  
& EVALUATION SCHEME**

**For**

**B. TECH. DEGREE PROGRAMME**

**IN**

**CHEMICAL TECHNOLOGY**

**LEATHER TECHNOLOGY**

**(Effective from the session 2023-24)**



**DEPARTMENT OF LEATHER TECHNOLOGY  
SCHOOL OF CHEMICAL TECHNOLOGY  
HARCOURT BUTLER TECHNICAL UNIVERSITY  
KANPUR-208002  
UTTAR PRADESH**

**Harcourt Butler Technical University  
DEPARTMENT OF CHEMICAL TECHNOLOGY - LEATHER TECHNOLOGY  
SCHOOL OF CHEMICAL TECHNOLOGY**

## **Department of Chemical Technology-Leather Technology**

### **Vision**

The Department of Leather Technology at HBTU aims at being a leader of innovation in the area of Leather to produce quality technologists of world standards to deliver the benefits of the developed technologies to the people.

### **Mission**

The mission of the Department of Chemical Technology- Leather Technology are:

**M1:** To achieve academic excellence and practical knowledge in the fields of Leather, Leather Application, and allied areas.

**M2:** To inculcate technical competence in students for formulation, manufacture and application of advanced Leather with eco -friendly and sustainable approach.

**M3:** To develop state-of-art facilities for testing and consultancy for industry to make the department a center of excellence in the field of Leather at global level.

**M4:** To develop indigenous and adaptable technologies related to Leather for small scale production and to develop entrepreneurial skills, towards betterment of society.

**M5:** To cultivate strong ethical values to be a successful professional and to become life - long learners.

### **PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

**PEO 1:** To produce graduates and post graduates who will be able to meet the requirements and challenges at national & international levels in the field of formulation, manufacture and application of Leather and allied products.

**PEO 2:** To inculcate in students the fundamental concepts related to Leather Production & applications to enable them to develop novel technologies to meet the global standards of eco-friendliness & sustainability.

**PEO 3:** To produce technologists with high moral values and professional ethics, who can work with industry hand-in-hand for mutual benefits and to sensitize them for job creation for the society, specially the rural community.

### **Program Specific Outcomes:**

- PSO1** : To apply practical skills, technical knowledge in major streams such as chemistry, manufacturing, processing, and applications areas of engineering and technology in Leather and allied industries
- PSO2** : To take-up career in research organizations or to pursue higher studies in Leather technology and interdisciplinary programs with high regard for ethical values, environmental and social issues.

**SEMESTER WISE COURSE STRUCTURE & EVALUATION SCHEME**  
**B. TECH. CHEMICAL TECHNOLOGY- DEPARTMENT OF LEATHER TECHNOLOGY**  
**(Applicable from Session 2022-23)**

**Year-I, Semester-I**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab.	Total		
1	BSC	Engineering Physics	NPH-101	4	3	0	2	15	20	15	50	50	100
2	BSC	Engineering Mathematics-I	NMA-101	4	3	1	0	30	20	-	50	50	100
3	ESC	Introduction to Electrical Engineering	NEE-101	4	3	0	2	15	20	15	50	50	100
4	ESC	Introduction to Mechanical Engineering	NME-101	4	3	1	0	15	20	15	50	50	100
5	HSMC	Professional Communication	NHS-103	4	2	1	2	15	20	15	50	50	100
6	ESC	Engineering Graphics	NCE-103	2	0	0	4	30	20	-	50	50	100
<b>Total Credits 22</b>												<b>600</b>	

**Year-I, Semester-II**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Chemistry	NCY-102	4	3	0	2	15	20	15	50	50	100
2	ESC	Introduction to Computer Science Engineering	NCS-102	4	3	1	0	30	20	-	50	50	100
3	ESC	Introduction to Electronics Engineering	NET-102	4	3	1	0	30	20	-	50	50	100
4	ESC	Introduction to Civil Engineering	NCE-102	4	3	1	0	30	20	-	50	50	100
5	ESC	Introduction to Chemical Engineering & Chemical Technology	NCT-102	4	3	1	0	30	20	-	50	50	100
6	ESC	Workshop Practice	NWS-102	2	0	0	4	-	20	30	50	50	100
<b>Total Credits 22</b>												<b>600</b>	

**(Applicable from Session 2023-24)**  
**Year-II, Semester-III**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Mathematics-II	NMA-201	4	3	1	0	30	20	-	50	50	100
2	ESC	Fluid Mechanics and Mechanical operation	NCT-201	4	3	0	2	15	20	15	50	50	100
3	PCC	Leather Microscopy & Skin Proteins	NLT-201	4	3	1	0	30	20	-	50	50	100
4	PCC	Pre-Tanning & Tanning of Hides & Skins	NLT-203	4	3	1	0	30	20	-	50	50	100
5	PCC	Chemical Process Calculations	NCT-203	3	3	0	0	30	20	-	50	50	100
6	HSMC	Industrial Economics & Management	NHS-201	3	3	0	0	30	20	-	50	50	100
7	PCC	Leather Microscopy & Skin Pre-Tannages Lab	NLT-207	2	0	0	4	-	20	30	50	50	100
<b>Total Credits 24</b>												<b>700</b>	

**Year-II, Semester-IV**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Modern Analytical Techniques	NCY-202	4	3	1	0	30	20	-	50	50	100
2	ESC	Computer Oriented Numerical Methods	NMA-204	4	3	0	2	15	20	15	50	50	100
3	PCC	Analysis of Materials of Leather Manufacture	NLT-202	4	3	1	0	30	20	-	50	50	100
4	PCC	Chemical Engineering Thermodynamics	NCT-204	4	3	1	0	30	20	-	50	50	100
5	PCC	Heat Transfer Operations	NCT-202	3	3	0	0	30	20	-	50	50	100
6	PCC	Introduction to Post Tanning Operations	NLT-208	3	3	0	0	30	20	-	50	50	100
7	PCC	Analysis of Materials of Leather Manufacture Lab	NLT-210	2	0	0	4	-	20	30	50	50	100
<b>Total Credits 24</b>												<b>700</b>	

**(Applicable from Session 2024-25)****Year-III, Semester-V**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks	
					L	T	P	MSE	TA	Lab	Total			
1	PCC	Processing of Leather-I	NLT-301	4	3	0	2	15	20	15	50	50	100	
2	PCC	Inorganic Tannages	NLT-303	4	3	1	0	30	20	-	50	50	100	
3	PCC	Organic Tannages	NLT-305	3	3	0	0	30	20	-	50	50	100	
4	PCC	Mass Transfer Operations	NCT-307	3	3	0	0	30	20	-	50	50	100	
5	PCC	Chemical Reaction Engineering	NCT-309	3	3	0	0	30	20	-	50	50	100	
6	PCC	Advance Post Tanning & Finishing Operations	NLT-311	3	3	0	0	30	20	-	50	50	100	
7	HSMC	Entrepreneurship Development	NHS-301	2	2	0	0	30	20	-	50	50	100	
<b>Total Credits</b>											<b>22</b>			<b>700</b>

**Year-III, Semester-VI**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks	
					L	T	P	MSE	TA	Lab.	Total			
1	PCC	Instrumentation & Process Control	NCT-302	4	3	0	2	15	20	15	50	50	100	
2	PCC	Processing of Leather-II	NLT-304	4	3	0	2	15	20	15	50	50	100	
3	PCC	Tannery Effluent Treatment	NLT-306	3	3	0	0	30	20	-	50	50	100	
4	PCC	Leather Analysis and Quality Control	NLT-308	3	2	0	1	15	20	15	50	50	100	
5	PCC	Leather Trade Engineering	NLT-310	3	3	0	0	30	20	-	50	50	100	
6	PEC-I	1. Process Equipment Design 2. Process Modeling & Simulation 3. Process Optimization	NCT-322 NCT-324 NCT-326	3	3	0	0	30	20	-	50	50	100	
7	OEC-I	Leather Manufacture from Skins & Hide	OLT-302	2	2	0	0	30	20	-	50	50	100	
<b>Total Credits</b>											<b>22</b>			<b>700</b>

**(Applicable from Session 2025-26)****Year-IV, Semester-VII**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks	
					L	T	P	MSE	TA	Lab	Total			
1	PEC-II	<b>Programme Elective Course II</b> 1. Leather Auxiliaries Technology 2. Polymer Science 3. Leather Dyes and Dyestuffs chemistry	NLT-421 NLT-423 NLT-425	4	3	1	0	30	20	-	50	50	100	
2	PEC-III	<b>Programme Elective Course III</b> 1. Footwear Technology 2. Footwear Material Components 3. Leather Goods Manufacturing	NLT-441 NLT-443 NLT-445	3	3	0	0	30	20	-	50	50	100	
3	PEC-IV	<b>Programme Elective Course IV</b> 1. Animal and Tannery by Products 2. Professional Areas of Leather Technology 3. Fashion Forecasting for Leather and Leather Products	NLT-461 NLT-463 NLT-465	3	3	0	0	30	20	-	50	50	100	
5	Industrial Training	Industrial Training	NLT-481	2	0	0	4	-	50	-	50	50	100	
5	OEC-II	Entrepreneurship for Leather Sector	OLT-401	2	2	0	0	30	20	-	50	50	100	
6	Minor Project	Minor Project	NLT-491	6	0	0	12	-	50	-	50	50	100	
7	Seminar	Seminar	NLT-471	2	0	0	4	-	50	-	50	50	100	
<b>Total Credits</b>				<b>22</b>										<b>700</b>

**Year-IV, Semester-VIII**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks	
					L	T	P	MSE	TA	Lab	Total			
1	PEC-V	<b>Programme Elective Course V</b> 1. Leather Biotechnology 2. Computer Aided Leather Product Design 3. Total Quality Management	NLT-422 NLT-424 NLT-426	4	3	1	0	30	20	-	50	50	100	
2	OEC-III	Leather Machinery	OLT-402	2	2	0	0	30	20	-	50	50	100	
3		Project	NLT-492	16	0	0	24	-	100	100	200	200	400	
<b>Total Credits</b>				<b>22</b>										<b>600</b>

**OEC**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	OEC-I	Leather Manufacture from Skins & Hide	OLT-302	2	2	0	0	30	20	-	50	50	100
2	OEC-II	Entrepreneurship for Leather Sector	OLT-401	2	2	0	0	30	20	-	50	50	100
3	OEC-III	Leather Machinery	OLT-402	2	2	0	0	30	20	-	50	50	100

**PEC-I**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-I	Process Modeling & Simulation	NLT-322	3	3	0	0	30	20	-	50	50	100
2	PEC-I	Process Equipment & Design	NLT-324	3	3	0	0	30	20	-	50	50	100
3	PEC-I	Process Optimization	NLT-326	3	3	0	0	30	20	-	50	50	100

**PEC-II**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-II	Leather Auxiliaries Technology	NLT-421	4	3	1	0	30	20	-	50	50	100
2	PEC-II	Polymer Science	NLT-423	4	3	1	0	30	20	-	50	50	100
3	PEC-II	Leather Dyes and Dyestuffs chemistry	NLT-425	4	3	1	0	30	20	-	50	50	100

**PEC-III**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-III	Footwear Technology	NLT-441	3	3	0	0	30	20	-	50	50	100
2	PEC-III	Footwear Material Components	NLT-443	3	3	0	0	30	20	-	50	50	100
3	PEC-III	Leather Goods Manufacturing	NLT-445	3	3	0	0	30	20	-	50	50	100

**PEC-IV**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
	PEC-IV	Animal and Tannery by Products	NLT-461	3	3	0	0	30	20	-	50	50	100
1	PEC-IV	Fashion Forecasting for Leather and Leather Products	NLT-463	3	3	0	0	30	20	-	50	50	100
2	PEC-IV	Professional Areas of Leather Technology	NLT-465	3	3	0	0	30	20	-	50	50	100

**PEC-V**

Sl. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-V	Leather Biotechnology	NLT-422	4	3	1	0	30	20	-	50	50	100
2	PEC-V	Computer Aided Leather Product Design	NLT-424	4	3	1	0	30	20	-	50	50	100
3	PEC-V	Total Quality Management	NLT-426	4	3	1	0	30	20	-	50	50	100



**SEMESTER – I**  
**NPH-101: ENGINEERING PHYSICS**

**L T P C**  
**3 0 2 4**

**OBJECTIVE:**

The objective of the course is to understand the basic concepts of nature around us and to synthesize the knowledge from different areas of physics for analysing and solving various critical problems.

**Course Outcome (CO):**

On successful completion of the course, the students will be able to:

CO1	Understand and apply the principle of conservation of momentum, the theory of relativity.	K2, K1
CO2	Understand the basics of quantum mechanics and apply its principles to learn the phenomenon that occurs at subatomic dimensions.	K3, K1
CO3	Understand Maxwell's equations of electromagnetic theory with the aim to apply them in a communication system.	K5, K1
CO4	Apply the fundamentals of material science, especially to dielectric materials, semiconducting materials, nanomaterials, and Superconducting Materials.	K2, K1
CO5	Understand the statistical behavior of the constituent particles and apply the principles of statistical mechanics in the formation of materials and basics of LASERS	K4, K1

K1-Remember, K2- Understand, K3-Apply, K4-Analyse, K5-Evaluate, K6-Create

**Course Articulation Matrix (CO-PO Matrix)**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	1	2	-	-	-	-	-	3
CO2	3	3	1	2	1	2	-	-	-	-	-	3
CO3	3	3	1	2	1	2	-	-	-	-	-	3
CO4	3	3	3	2	1	3	3	-	-	-	-	3
CO5	3	3	2	3	3	3	-	-	-	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put "-".

**SYLLABUS**

**UNIT- 1**

**Relativistic Mechanics:**

Inertial and Non- Inertial Frames of references, Galilean transformation equations, Michelson Morley Experiment, Lorentz Transformation equations, Length contraction, Time dilation and its experimental evidence, Relativistic velocity addition formula, Relativistic variation of mass with velocity, Evidence of variation of mass with velocity, Einstein's Mass-Energy equivalence, examples from nuclear physics, Relativistic energy momentum relation.

**UNIT- 2**

**Quantum Mechanics:**

Dual nature of matter & radiation, Heisenberg's uncertainty Principle and their applications, wave packet concept, Davisson-Germer experiment, Postulates of quantum mechanics, Significance of wave function, Derivation of Schrodinger equation for time independent and time dependent cases. Applications of Schrodinger wave equation for a free particle, Particle in a box (one dimensional and three dimensional cases), Simple harmonic oscillator (one dimensional case).

**UNIT- 3**

**Electromagnetic Theory:**

Ampere's law and Faraday's law of electromagnetic induction, Derivation of Maxwell's equations and their physical significance, Correction of Ampere's law by Maxwell, Concept of displacement current, Poynting

theorem, Maxwell's equations in free space & velocity of electromagnetic waves, Transverse character of the wave and orthogonality of  $\mathbf{E}$ ,  $\mathbf{H}$  and  $\mathbf{k}$  vectors, Maxwell's equation in dielectric medium and velocity of e.m. wave, Comparison with free space, Maxwell's equations in conducting media & solution of differential equation in this case, penetration depth & its significance.

#### UNIT- 4

##### **Statistical Mechanics & Lasers:**

Macrostates and Microstates, Phase space, probability of distribution, most probable distribution, Maxwell-Boltzmann Statistics, Applications of Maxwell-Boltzmann Statistics, derivation of average velocity, RMS velocity and most probable velocity in the above cases, Bose-Einstein Statistics & its application in case of black body radiation, distribution law of energy, Planck's radiation formula, derivation of Wien's law, Rayleigh-Jeans law and Stefan's law from Planck's radiation formula. Fermi – Dirac statistics, application in case of free electrons in metals, energy distribution, Fermi energy.

**Lasers:** Spontaneous and stimulated emission of radiations, Einstein's theory of matter-radiation interaction, Einstein's coefficients and relation between them, Population inversion, components of a laser, different kinds of lasers, Ruby laser, He-Ne laser, solid state lasers, properties of laser beams, mono- chromaticity, coherence, directionality and brightness, applications of lasers in various technological applications.

#### UNIT- 5

##### **Materials of Technological Importance:**

**Dielectric Materials:** Electric field in presence of dielectric medium, concept of electric polarization, different types of polarizations, behaviour of dielectric in a.c. field, concept of dielectric loss and loss energy and their importance.

**Semiconducting Materials:** Concept of energy bands in solids, carrier concentration and conductivity in intrinsic semiconductors and their temperature dependence, carrier concentration and conductivity in extrinsic semiconductors and their temperature dependence, Hall effect in semiconductors, compound semiconductors, amorphous semiconductors.

**Nano Materials:** Basic principles of nanoscience and technology, preparation, structure and properties of fullerene and carbon nanotubes, applications of nanotechnology.

**Superconducting Materials:** Resistivity and susceptibility of Superconductors, Type – I and Type – II superconductors, Meissner effect, Low temperature Superconductors, Organic Superconductors, Oxide Superconductors, High temperature Superconductors, BCS theory (Qualitative).

##### **Text Books:**

1. Engineering Physics, R. K. Shukla, Pearson Education, Vol.-II, 2014
2. Electrical Engineering Materials, R.K. Shukla, McGraw Hill, 1<sup>st</sup> Edition, 2012
3. Principles of Engineering Physics, R.K. Shukla, Ira Books, 1<sup>st</sup> Edition, 2011
4. Engineering Physics –I & II, S.K. Gupta, Krishna Prakashan Media (P) Ltd., 2014

##### **References Books:**

1. Fundamental university physics, Vol. - I: Mechanics, Marcelo Alonso, J. Finn Edwards, Addison-Wesley, 1<sup>st</sup> Edition, 1967
2. Concepts of Modern Physics, Arthur Beiser, McGraw Hill, 6<sup>th</sup> Edition, 2003
3. Introduction to Electrodynamics, David Griffiths, Cambridge University Press, 4<sup>th</sup> Edition, 2017
4. Introduction to Solid State Physics, Charles Kittel, Willey, 8<sup>th</sup> Edition, 2005
5. Introduction to Nanotechnology, Charles P. Poole Jr., Frank J. Owens, Wiley-Interscience, 1<sup>st</sup> Edition, 2003

##### **Web Links:**

1. <https://nptel.ac.in/courses/122101002> [IIT Bombay, Prof. D.K. Ghosh]
2. <https://nptel.ac.in/courses/122103011> [IIT Guwahati, Prof. Alike Khare , Prof. Pratima Agarwal, Prof. S. Ravi]
3. <https://nptel.ac.in/courses/115105099> [IIT Kharagpur, Prof. Amal Kumar Das]
4. <https://nptel.ac.in/courses/115101005> [IIT Bombay, Prof. D.K. Ghosh]
5. <https://nptel.ac.in/courses/115106066> [IIT Madras, Prof. S. Lakshmi Bala]

## NMA-101 ENGINEERING MATHEMATICS –I

**OBJECTIVE:** The objective of this course is to educate the students about

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

- The convergence of infinite series, improper integrals, and differential calculus.
- Partial differentiation, multiple integrals and Beta, Gamma functions.
- Vector calculus, matrices, linear algebra, and optimization techniques.

**Course Outcome:** On the successful completion of the course, students will be able to

CO1	Find nth derivative, determine the expansion of functions, and find convergence of series and improper integrals.	K1, K2
CO2	Find partial differentiation and evaluate area and volume using multiple integrals.	K2, K5
CO3	Convert line integrals to surface integrals and volume integrals, determine potential functions for irrotational force fields.	K3, K5
CO4	Solve linear system of equations and determine the eigen vectors of the matrix.	K3, K4, K5
CO5	Learn concept of optimization and optimization techniques.	K1, K2

### CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	1	-	1	-	3
CO2	3	3	2	1	2	-	-	1	-	1	-	3
CO3	3	3	2	1	2	-	-	1	-	1	-	3
CO4	3	3	2	1	2	-	-	1	-	1	-	3
CO5	3	3	2	1	2	-	-	1	-	1	-	3
Average	3	3	2	1	2	-	-	1	-	1	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put “-”*

### SYLLABUS

#### **Unit I- Functions of One Real Variable: 6 hours**

Successive differentiation, Leibnitz theorem, Mean value theorems, sequences and series, expansion of functions, improper integrals, and their convergence.

#### **Unit II- Functions of Several Real Variables: 10 hours**

Limit, Continuity, Partial differentiation, Total differential and approximations, Jacobian, Euler’s theorem for expansion of functions, Beta and Gamma Functions, Multiple integrals, change of order, Change of variables, Applications to area, volume, mass, surface area etc. Dirichlet’s Integral & applications.

#### **Unit III- Vector Calculus: 8 hours**

Point functions, differentiation, Differential operators: Gradient, Laplacian, Hessian, Directional derivative; Divergence and Curl of a vector and their physical interpretations, Solenoidal & irrotational fields, Integration: Line, Surface and Volume integrals, Green’s, Stoke’s and Gauss Divergence theorems (without proof) and applications

#### **Unit IV- Matrices and Linear Algebra: 10 hours**

Vector space and subspace, linear dependence, basis and dimensions, Linear transformation and its matrix representation, Elementary transformations, Echelon form, rank & nullity, consistency of linear system of

equations and their solutions, characteristic equation, Cayley Hamilton theorem, real and complex eigenvalues and eigenvectors, diagonalization, SVD, quadratic forms, complex, orthogonal, and unitary matrices, Application to Cryptography, discrete, Compartmental models, and system stability.

**Unit V- Optimization: 6 hours**

Engineering applications of optimization, statement and classification of optimization problems, Optimization techniques, single and multi-variable optimizations with no constraint, with equality and inequality constraints, Linear Programming Problems, Graphical method, and Simplex method.

**Textbooks:**

1. R.K. Jain & S. R. K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House 2002.
2. Erwin Kreyszig: Advanced Engineering Mathematics. John Wiley & Sons 8th Edition.
3. Dennis G. Zill & Michael R Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers, 2nd Edition.
4. S.S. Rao; Optimization: Theory & application Wiley Eastern Limited.

**Reference Books:**

1. T.M. Apostol, calculus, Vol. I, 2nd ed., Wiley 1967.
  2. T.M. Apostol, Calculus, Vol. II, 2nd ed., Wiley 1969.
  3. Gilbert Strang, Linear Algebra & its applications, Nelson Engineering 2007.
- Calculus & Analytic Geometry, Thomas and Finny.

## NEE-101: INTRODUCTION TO ELECTRICAL ENGINEERING

**L T P C**  
**3 0 2 4**

### OBJECTIVES

The goal of the course is to make the students understand the basic principles of electrical engineering.

### Course Outcomes

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

- CO1. Apply Mesh and Nodal Methods of Analysis and Network Theorem in DC Network.
- CO2. Understand and analyze the ac circuit and calculate the various parameters.
- CO3. Understand and analyze the 3-phase connections of source and load, and, measurement of 3-phase power.
- CO4. Understand the magnetic circuit with working & applications and to calculate the various parameters of magnetic circuits and transformer efficiency.
- CO5. understand the basic principles of AC & DC Machines

### Course Articulation Matrix (CO-PO Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2		1					2		2
CO2	3	1			1					2		2
CO3	3			3	1					2		2
CO4	3				1					2		2
CO5	3		2		1					2		2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put “-”.

### SYLLABUS

#### UNIT 1 - DC Circuit Analysis and Network Theorems

Circuit Concepts: Concepts of Network, Active and Passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements. R L and C as linear elements. Source Transformation. Kirchhoff's Law, loop and nodal methods of analysis; star – delta transformation; Network Theorems: Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem. (Simple Numerical Problems)

#### UNIT 2 - Steady State Analysis of Single Phase AC Circuits

Sinusoidal, Square and Triangular waveforms – average and effective values, form and peak factors, concept of phasors, phasor representation of sinusoidally varying voltage and current. Analysis of series, parallel, and series – parallel RLC Circuits: Apparent, Active & Reactive Powers, Power factor, causes and problems of low power factor, power factor improvement. Resonance in Series and Parallel Circuits. (Simple Numerical Problems)

#### UNIT 3 - Three Phase AC Circuits

Three Phase System – its necessity and advantages, meaning of phase sequence and star and delta connections, balanced supply and balanced load, line and phase voltage / current relations, three phase power and its measurement. (Simple Numerical Problems)

#### UNIT 4 - Magnetic Circuits and Transformer

Magnetic Circuit: Magnetic circuit concepts, analogy between Electric & Magnetic circuits, Magnetic circuits with DC and AC excitations, Magnetic leakage. B-H curve, Hysteresis and Eddy Current losses, Magnetic circuit calculations.

Single Phase Transformer: Principle of Operation, Construction, e.m.f. equation, Power losses, efficiency. (Simple Numerical Problems)

#### UNIT 5 - Electro Mechanical Energy Conversion

Basic Principles of electro mechanical energy conversion.

DC Machines: Types of DC machines, e.m.f. equation of generator and torque equation of motor, Speed-Torque characteristics of DC Series and Shunt Motors, Applications of dc motors. (Simple Numerical Problems).

Three Phase Induction Motor: Types, Principle of Operation, Slip – torque Characteristics, applications. (Simple Numerical Problems).

Single Phase Induction Motor: Basic Principles of 1-phase Induction Motor and its applications

Three Phase Synchronous Machines: Principle of Operation of alternator and synchronous motor and their applications.

#### **List of Experiments**

1. Verification of Kirchhoff's laws.
2. Verification of Superposition Theorem.
3. Verification of Thevenin's Theorem.
4. Verification of Maximum Power Transfer Theorem.
5. Measurement of power and power factor in a 1 –  $\emptyset$  ac series inductive circuit and study improvement of power factor using capacitor.
6. Study of phenomenon of resonance in RLC series circuit and obtain the resonant frequency.
7. Measurement of power in 3 –  $\emptyset$  circuit by Two Wattmeter method and determination of its power factor.
8. Determination of parameter of ac 1 –  $\emptyset$  series RLC Circuit.
9. Determination of Efficiency by load test of a 1 –  $\emptyset$  Transformer.
10. To study running and speed reversal of a 3 –  $\emptyset$  induction motor and record its speed in both direction.

#### **Note:**

- a. Department may add any three experiments in the above list.
- b. Minimum eight experiments are to be performed out of the above list.

#### **Text books:**

1. V. Del Toro, "Principles of Electrical Engineering" Prentice Hall International
2. I. J. Nagarath, "Basic Electrical Engineering" Tata Mc - Graw Hill
3. D. E. Fitzgerald & A. Grabel Higginbotham, "Basic Electrical Engineering" Mc - Graw Hill
4. B. L. Theraja and A. K. Theraja, "Basic Electrical Engineering: July 1999.

#### **Reference books:**

1. Edward Hughes, "Electrical Technology" Longman
2. T. K. Nagsarkar & M. S. Sukhija, "Basic Electrical Engineering" Oxford University Press
3. H. Cotton, "Advanced Electrical Technology" Wheeler Publishing
4. W. H. Hayt & J. E. Kennely, "Engineering Circuit Analysis" Mc - Graw Hill

## NME-101: INTRODUCTION TO MECHANICAL ENGINEERING

**L T P C**  
**3 1 0 4**

### OBJECTIVES

To explain the basic fundamentals of forces, moments, stresses, strains, fundamental of fluid and fluid flow application, fundamentals of thermodynamics and mode of heat transfers.

#### **Course Outcomes (CO):**

At the end of this course students should be able to:

CO1	Understand the basic laws concepts of mechanical systems.	K2, K1
CO2	Determine resultants and apply conditions of static equilibrium to plane force systems.	K3, K1
CO3	Analyze beam for shear force and bending moment along the span and analyze trusses for axial forces.	K4, K1
CO4	Evaluate the structural properties centroid and moment of inertia	K5, K1
CO5	Stress analysis for one- and two-dimensional stress systems.	K3, K1

K1- Remember, K2- Understand, K3-Apply, K4-Analyse, K5- Evaluate, K6- Create

#### **Course Articulation Matrix (CO-PO Matrix)**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3			1	1	1	1	1		1
CO2	3	3	3									1
CO3	3	3	3									1
CO4		3	2	2								1
CO5		3	2	2								1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put “-”.

### SYLLABUS

#### **UNIT-1: Fundamental Concepts and Definitions:**

**Mechanical Engineering:** Scope and expanse

Concept of machines and mechanisms, classification of machines.

Thermodynamic systems, Laws of thermodynamics. Introduction to modes of heat transfer, applications.

Materials, classification, selection of materials in design of components.

Manufacturing processes, mechanical working of metals.

#### **UNIT-2:**

**Two-Dimensional Force Systems:** Basic concepts, laws of motion, Principle of transmissibility of forces, transfer of a force to parallel position, resultant of a force system, simplest resultant of two dimensional concurrent and non-concurrent force systems, distributed force system, free body diagrams, equilibrium and equations of equilibrium, applications.

**Friction:** Introduction, Laws of Coulomb friction, Equilibrium of bodies involving dry-friction, belt friction, applications.



**UNIT-3:**

**Beam:** Introduction, Shear force and bending moment, differential equations for equilibrium, shear force and bending moment diagrams for statically determinate beams.

**Trusses:** Introduction, simple truss and solution of simple truss, Method of joints and method of sections.

**UNIT-4: Centroid and Moment of Inertia:** Centroid of plane, curve, area, volume and composite bodies, Moment of inertia of plane area, Parallel Axes theorem, Perpendicular axes theorems, Principal moment of inertia, mass moment of inertia of circular ring, disc, cylinder, sphere and cone about their axis of symmetry.

**UNIT-5: Introduction to Strength of Materials:** Introduction, normal and shear stresses, stress- strain diagrams for ductile and brittle material, elastic constants, One Dimensional loading of members of varying cross- sections, strain energy, 2D state of plane stress, Principal stresses and strains.

**Text books:**

1. Engineering Mechanics by Abhijit Chanda and Debabrata Nag, Wiley India Pvt. Ltd, 2018, Kindle - Edition, ISBN: 9788126570935.
2. Engineering Mechanics: Statics by J L Meriam. L G Kraige. Virginia Polytechnic Institute and State University, John Wiley & Sons, 2017. ISBN-978-8126564033.
3. Engineering Mechanics of Solids, Egor P. Popov, PHI Publications, 1990.
4. Theory of Machines and Mechanisms by J.E. Shigley, Oxford University Press, 5<sup>th</sup> Edition, 2017.
5. Engineering Thermodynamics by P K Nag, TMH Publication, 4<sup>th</sup> Edition, 2008.

**Reference Books:**

1. Theory of Machines and Mechanisms by Amitabha Ghosh and Asok Kumar Mallick, Affiliated East-West Press, 3<sup>rd</sup> Edition, ISBN: 9788185938936.
2. Engineering Mechanics by Timoshenko S., McGraw-Hill Education – Europe, 5<sup>th</sup> Edition, 2013.
3. Engineering Mechanics by Nelson A, McGraw Hill Education India, 1<sup>st</sup> Edition, ISBN-978-0070146143, 2017
4. Materials and Manufacturing: An Introduction to How they Work and Why it Matters by Mark A Atwater McGraw-Hill Education, 1<sup>st</sup> Edition, ISBN: 9781260122312, 2018
5. Engineering Thermodynamics: Work and Heat Transfer by Rogers, Pearson Education India, 4<sup>th</sup> Edition, 2002.

**Web Links:**

- 1- <https://nptel.ac.in/courses/112106286> [ IIT Madras, Prof. K. Ramesh]
- 2- <https://nptel.ac.in/courses/112103108> [IIT Guwahati, Prof. US Dixit]
- 3- <https://nptel.ac.in/courses/112103109> [IIT Guwahati, Prof. US Dixit]
- 4- <https://eng.utq.edu.iq/wp-content/uploads/sites/4/2019/09/engineering-mechanics-lectures.pdf>[Thi-Qar University, Prof. Haider]
- 5- [https://www.youtube.com/watch?v=tisNUzd\\_f1M&t=96s](https://www.youtube.com/watch?v=tisNUzd_f1M&t=96s) [Dr. V. P. Singh, HBTU, Kanpur]
- 6- <https://www.youtube.com/watch?v=a6RNss9kBuI&t=11s> [Dr. V. P. Singh, HBTU, Kanpur]
- 7- [https://www.youtube.com/watch?v=LE1Lc6\\_640U](https://www.youtube.com/watch?v=LE1Lc6_640U)[Dr. V. P. Singh, HBTU, Kanpur]

## NHS 103: PROFESSIONAL COMMUNICATION

### OBJECTIVES

**L T P C**  
**3 0 2 4**

- Critically think about communication processes and messages.
- Write effectively for a variety of contexts and audiences.
- Interact skillfully and ethically.
- Develop and deliver professional presentations

### Course Outcomes (CO)

At the end of this course students should be able to:

CO1	Effectively communicate their ideas in the contemporary global competitive environment.	K2, K1
CO2	Convey their messages through constructive writing.	K3, K1
CO3	Draft potent E-Mails, letters, proposals and reports.	K4, K1
CO4	Present their presentations along with using all nuances of delivery with clarity and thoroughness.	K5, K1
CO5	Solve problems based on real time situations and articulate them eventually.	K3, K1

K1- Remember, K2- Understand, K3-Apply, K4-Analyse, K5- Evaluate, K6- Create

### Course Articulation Matrix (CO-PO Matrix of selected Course): NHS 103

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	0	0	0	0	0	0	2	3	0	1
CO2	0	0	0	0	0	0	0	0	2	3	0	1
CO3	0	0	0	0	0	0	0	0	2	3	0	1
CO4	0	0	0	0	0	0	0	0	2	3	0	1
CO5	0	0	0	0	0	0	0	0	2	3	0	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put “-”.

### SYLLABUS

#### UNIT I

##### **Fundamentals of Technical Communication**

Process of communication, language as a tool of communication, levels of communication, flow of communication, barriers to communication, communication across cultures; Technical Communication: meaning, significance, characteristics, difference between technical and general communication.

#### UNIT II

##### **Elements of Written Communication**

Words and phrases, word formation, synonyms and antonyms, homophones, one word substitution, sentence construction, paragraph construction,

#### UNIT III

##### **Forms of Technical Communication**

(A) business letters, job application letter and resume, 7C's of letter writing, business letters: sales & credit letters, letters of enquiry, letters of quotation, order, claim and adjustment letters, official letters: D.O. letters, government letters, letters to authorities, etc. ,

(B) Technical Reports: general format of a report, formal and informal reports, memo report, progress report, status report, survey report, trip report, complaint report, , Joining Report ,laboratory report, research papers, dissertations and theses. E-mail writing

Technical Proposals: purpose, characteristics, types, structure

#### UNIT IV

##### **Presentation Strategies**

Defining the subject, scope and purpose, analysing audience & locale, collecting materials, preparing outlines, organising the contents, Pre-presentation strategies, during presentation strategies, nuances of delivery, verbal and non-verbal communication, Body language, paralinguistic features of voice, visual aids.

## UNIT V

### Value-based Text Reading

(A) Study of the following essays from the text book with emphasis on writing skills:

1. Man and Nature by J. Bronowski
2. The Language of Literature and Science by Aldous Huxley
3. The Aims of Science & The Humanities by Moody E Prior
4. Gods in this Godless Universe by Bertrand Russell
5. Science and Survival by Barry Commoner

(B) Readings of selected short stories:

1. The Renunciation by Rabindranath Tagore
2. The Lament by Anton P. Chekhov
3. The Barber's Trade Union by Mulk Raj Anand
4. The Eyes Are Not Here by Ruskin Bond

### Professional Communication Laboratory

Interactive practical sessions with emphasis on oral presentations / spoken communication:

Practical Sessions on:

1. Group Discussions: selected topical issues to be discussed in groups.
2. Mock interviews
3. Communication skills for seminars/conferences/workshops with emphasis on non-verbal skills.
4. Presentation skills for technical papers/project reports/professional reports.
5. Theme presentation/ key note presentation based on correct argumentation methodologies.
6. Argumentative skills
7. Role play
8. Comprehension skills based on reading and listening practice, asking questions.
9. Introduction to International Phonetics Alphabets
10. Audio Visual demonstration of effective communicative strategies & TED Talks

### Text Books

1. Improve Your Writing Edited By V N Arora and Laxmi Chandra, Oxford University Press, First Edition, New Delhi, 2013.
2. An Anthology of English Short Stories, Edited by R P Singh, First Edition, 2015, Oxford University Press.
3. Technical Communication- Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Third Edition, 2015, Oxford University Press, New Delhi.
4. Sethi and Dhamija, 'A Course in Phonetics and Spoken English', Second Edition, 2004, Prentice Hall of India, New Delhi.
5. Joans Daniel, 'English Pronouncing Dictionary', 18th Edition, 2011, Cambridge University Press.

### Reference Books

1. Effective Technical Communication, by Barun K Mitra, First Edition, 2008, Oxford University Press.
2. Business Correspondence & Report Writing by R.C. Sharma & Krishna Mohan, Fifth Edition, 2017, Tata McGraw Hill, N.D.
3. Developing Communication Skills by Krishna Mohan & Meera Banerjee, Second Edition, 2000, Macmillan India
4. Technical Communication- Principles and Practices by M R S Sharma, Third Edition, 2015, Oxford University Press, New Delhi

5. R. K. Bansal & J.B. Harrison, Spoken English for India, Orient Longman, Fourth Edition, 2013, Orient Blackswan, Hyderabad.
6. Excellence in Business Communication, 13th Edition, 2020 Publisher-Pearson Education.

**Web Links:**

1. <https://nptel.ac.in/courses/109104030> [ Dr. T Ravichandran, IIT Kanpur]

## NCE-103: ENGINEERING GRAPHICS

### Course Outcomes

**L T P C**  
**0 0 4 2**

At the end of this course, students should be able:

CO1	To understand and apply the concepts of lettering, dimensioning, scales and geometric construction
CO2	To visualize the position and location of any point, line, plane, or surface and draw their orthographic projections
CO3	To visualize and draw/develop the true shape, size, and sections of solid objects the true shape, size, and specifications of physical objects
CO4	To apply the visualization skill, to draw a simple isometric and perspective projections
CO5	To understand and draw basic civil Engineering building components using AutoCAD

### Course Articulation Matrix (CO-PO Matrix)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	1	2	-	-
CO2	2	-	-	-	-	-	-	-	1	2	-	-
CO3	2	-	-	-	-	-	-	-	1	2	-	-
CO4	2	-	-	-	-	-	-	-	1	2	-	-
CO5	2	-	-	-	3	-	-	-	1	2	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put “-”.

### SYLLABUS

#### Unit –I

Lettering and Dimensioning: Introduction, lettering practices, Rules of dimensioning – systems of dimensioning.

Geometric Constructions: Freehand sketching, Conic Sections, Special Curves.

Engineering Scales

#### Unit –II

Orthographic Projection

Projection of Points: First and Third Angle Projections; Projection of Points

Projection of Lines: Projection of straight lines (First angle projection only); Projection of lines inclined to one plane and both planes, true length and true inclinations.

Projection of solids: Classification of solids, Projection of solids in simple position, Projection of solids inclined to one plane.

#### Unit –III

Sections of Solids: Right regular solids and auxiliary views for the true shape of the sections.

Development of Surfaces: Development of surfaces for various regular solids.

#### Unit –IV

Isometric Projection: Isometric scales, Isometric projections of simple and combination of solids;

Perspective Projection: Orthographic representation of perspective views – Plane figures and simple solids – Visual Ray Method.

Conversion of pictorial view into orthographic Projection.

#### Unit –V

Introduction to Auto CAD, Drawings of Buildings and their components – front view, top view, and sectional views of a typical residential building using Auto CAD.

Detailed Drawing of RCC Design- Slab, beam, column, footings.

**Textbooks**

1. D.A. Jolhe (2008). '*Engineering Drawing- With an Introduction to AutoCAD.* ', Tata Mcgraw, Delhi.
2. N D Bhatt and V M Panchal (2001). '*Engineering Drawing.* ', 43rd Ed., Charotar Publishing House, Anand, 2001.
3. M B Shah and B C Rana (2009). '*Engineering Drawing.* ', 2nd Ed., Pearson Education, Delhi.

**Reference Books**

1. A Textbook of Engineering Graphics by K.V. Natarajan.
2. T E French, C J Vierck and R J Foster, *Graphic Science and Design*, 4th Ed., McGraw Hill, 1984.
3. W J Luzadder and J M Duff, *Fundamentals of Engineering Drawing*, 11th Ed., PHI, 1995.
4. K Venugopal, *Engineering Drawing and Graphics*, 3rd Ed., New Age International, 1998

**Web Resources**

<https://nptel.ac.in/courses/112103019>

<https://nptel.ac.in/courses/112102304>

<https://nptel.ac.in/courses/112105294>

<https://archive.nptel.ac.in/courses/112/102/112102304/>

## SEMESTER – II

### NCY-102: ENGINEERING CHEMISTRY

**L T P C**  
**3 0 2 4**

#### **OBJECTIVE:**

The objective of this course is to make students learn the laboratory skills needed to design safe conduction of reactions and experiments in Chemistry. The student will acquire a foundation of Chemistry to enable them to understand and critically interpret the primary research in Chemistry.

#### **Course outcome**

On the successful completion of the course, students will be able to

CO1	Interpret UV-Visible and IR-Spectra	K2, K4
CO2	Describe reaction rates for reactions of various orders	K2, K3, K4
CO3	Understand different aspects of corrosion and thermodynamic view of electrochemical processes, reversible, irreversible cells and nanochemistry	K2, K3
CO4	Understand the stereochemistry of molecules and identify organic reactions on the basis of their mechanism	K1, K3, K4
CO5	Distinguish between different polymeric structures, classify polymers, and analyze the polymerization mechanism and use of polymers in different walks of life. Knowledge of conductivity of polymer, biodegradable polymers and fibre reinforced plastics. Acquire knowledge about water and treatment of municipal water and solid waste management	K2, K3, K5, K6
CO6	To develop experimental skills to perform, monitor and manipulate the reactions.	K2, K4, K5

K1-Remember, K2-Understand, K3-Apply, K4-Analyse, K5- Evaluate, K6-Create

#### **Course Articulation Matrix (CO-PO Matrix)**

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
3	3	1	3	2	-	2	-	-	-	-	3
3	3	1	3	2	-	2	-	-	-	-	3
3	3	1	3	2	-	2	-	-	-	-	3
3	3	1	3	2	-	2	-	-	-	-	3
3	3	1	3	2	-	2	-	-	-	-	3
3	3	3	3	2	2	2	2	1	2	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put “-”.

#### **SYLLABUS**

##### **UNIT- 1**

**Bonding** VSEPR Theory, Valence Bond Theory, Crystal-field theory, Electronic Spectra and Ligands (strong and weak field), Phosphorescence and Fluorescence, Jablonski diagram, hydrogen bonding and their effect on physical properties, Metallic bonds, Classification and Applications of Liquid crystals, Band Theory of Solids and superconductors.

**Spectroscopy** Basic Principles, Instrumentation and Applications of UV-Vis and IR Spectroscopy.

##### **UNIT- 2**

**Chemical Kinetics** Second order reactions. Determination of order, Fast and slow reaction, steady state approximation, Temperature effect, Concept of Activated Complex / Transition State: Energy of activation,

Potential energy surface, Theories of reaction rate: Collision and Transition State theories in terms of enzyme catalysis.

**Surface Chemistry** Introduction, Types of adsorption, Adsorption isotherms, BET, Applications of adsorption.

### UNIT- 3

**Electrochemistry** Dry and fuel cells, electrochemical cell, Solar cells, Disensitized cell, Photovoltaic cell.

**Nanochemistry** Introduction, general methods of synthesis, classification and applications of nano materials.

**Environmental Chemistry** Air and Water Pollution, analysis of gaseous effluents oxides of Nitrogen, oxides of Sulphur and  $H_2S$ , chemical analysis of effluents liquid streams, BOD, COD, control of pollution, Depletion of ozone layer.

### UNIT- 4

**Stereochemistry** Stereoisomerism of organic compounds containing one & two chiral centers. Enantiomers & Diastereomers, E-Z nomenclature, R-S configuration, Atropisomerism, and Optical isomerism in Allenes, biphenyl and Spiranes, Circular Dichroism.

**Reaction Mechanism** Inductive, Electromeric and Mesomeric effects. Study of reaction intermediates (Carbanion, carbocation, carbene, nitrene and benzyne). Mechanism of nucleophilic and electrophilic substitution reactions. Mechanism and application of following reactions:

- a) Suzuki-Miyaura Cross coupling reaction
- b) Fries and Photo-Fries Rearrangement
- c) Wagner-Meerwein Rearrangement
- d) Umpolung Reactions
- e) Favorskii Rearrangement

### UNIT- 5

**Polymers:** Introduction, types of polymers, Molecular mass-number and mass average molecular weight, determination of molecular mass by Osmometry, viscosity, light scattering and size exclusion chromatography, Rheological properties and uses of some common polymers. Synthetic Polymers (carbon framework, silicon framework, fluorinated polymer), Conducting and Biodegradable polymers.

**Water Analysis:** Introduction; Hardness of Water- cause, types, units, Disadvantages of using hard water for domestic and industrial purposes, Softening of hard water, Chemical analysis of Water- estimation of free chlorine, total alkalinity, hardness, Numerical based on determination of hardness.

**Solid Waste Management:** Classification, waste treatment & Disposal methods (Composting, sanitary landfilling, thermal processes, recycling and reuse).

#### List of Experiments:

1. Determination of alkalinity in given water sample.
  - i. Sodium Carbonate & Sodium Bicarbonate
  - ii. Sodium Carbonate & Sodium Hydroxide
2. Determination of temporary and permanent hardness in water sample using EDTA as standard solution.
3. Determination of Chloride content of water by Mohr's Method.
4. Determination of Chlorine content in Bleaching powder.
5. Determination of strength of supplied Ferrous Ammonium Sulphate (FAS) solution in using external, internal indicators.
6. Determination of viscosity of a given liquid by Ostwald's viscometer.
7. Determination of surface tension of a given liquid by Stalagmometer.
8. pH metric titration.
9. Determination of Dissociation constant of weak acids by conductometric Titration.

10. To prepare aspirin (acetyl salicylic acid) from salicylic acid.
11. Synthesis of polyurethanes
12. Find the concentration of the given samples using UV-visible spectroscopy.

**Textbooks**

1. A Text Book of Engineering Chemistry by Shashi Chawla, Dhanpat Rai & Co., Fifth Edition, 2017.

**Reference Books:**

1. Organic Chemistry by I. L. Finer, Vol-1, Ninth Edition, 2015, Pearson Publisher.
2. Physical Chemistry by Puri, Sharma & Pathania, Vishal Publishing Co., 48th Edition, 2021, ISBN: 978-93-87015-81-4
3. Polymer Science by V. R. Gowariker, N. V. Vishwanathan and J. Shridhar, Wiley Eastern Ltd., New Delhi, 1987, ISBN: 978-0470203224.
4. Elementary Organic Spectroscopy by Y.R. Sharma, S. Chand, Fifth Edition, 2013, ISBN: 9788121928847.

**Web links**

1. <https://nptel.ac.in/courses/104101121> [Prof. Debabrata Maiti, IIT Bombay]
2. <https://nptel.ac.in/courses/104106119> [Prof. Harinath Chakrapani & Prof. Neeraja Dashaputre, IIT Madras]
3. <https://nptel.ac.in/courses/104105084> [Prof. Debashis Ray, IIT Kharagpur]
4. <https://nptel.ac.in/courses/104106129> [Prof. M. V. Sangaranarayanan, IIT Madras]

## NCS-102: INTRODUCTION TO COMPUTER SCIENCE AND ENGINEERING

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

### Course Outcomes (COs):

To explain the fundamentals of the computer system in terms of hardware components and basics of an operating system, understanding of programming, database management systems, and working with Internet and web applications.

At the end of this course students should be able to:

CO1	Understand hardware components of computer systems such as memory system organization, and input/output devices, and be aware of software components of computer system	Understand	K1
CO2	Understand Operating systems and be able to develop basic shell scripts.	Understand, Apply	K1, K2
CO3	Develop a basic understanding of programming and get a concept of algorithmic thinking.	Apply, Analyze	K2, K3
CO4	Understand Databases, Use SQL to write queries.	Understand, Evaluate	K1, K4
CO5	Explain how the Internet works and be able to make basic static Web applications.	Understand, Create	K1, K5

K1-Understand, K2-Apply, K3-Analyse, K4-Evaluate, K5-Create

### Course Articulation Matrix (CO-PO Matrix)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	1	1	-	-	-	-	-	-	-	-	-
CO3	3	3	2	3	1	-	-	1	1	1	1	1
CO4	3	2	2	3	1	-	-	-	1	-	2	1
CO5	3	2	3	1	2	1	1	2	2	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put “-”.

## SYLLABUS

### Unit - 1

**Fundamentals of Computers:** Introduction to Computers - Computer Definition, Characteristics of Computers, Evolution, and History of Computers, Types of Computers, Basic Organization of a Digital Computer; Classification of Digital Computer Systems: Microcomputers, Minicomputers, Mainframes, Supercomputers. Number Systems, Computer Codes – BCD, Gray Code, ASCII, and Unicode; Boolean Algebra – Boolean Operators with Truth Tables; Types of Software – System Software and Utility Software; Computer Languages - Machine Level, Assembly Level & High-Level Languages, Translator Programs – Assembler, Interpreter and Compiler; Planning a Computer Program – Data Structures, Algorithm, Flowchart and Pseudo code with Examples.

### Unit-2

**Operating System Fundamentals:** Operating Systems: Introduction, Functions of an Operating System, Classification of Operating Systems, System programs, Application programs, Utilities, The Unix Operating System, Basic Unix commands, Microkernel Based Operating System, Booting.

### **Unit-3**

**Fundamentals of C Programming Language:** Introduction to C Programming Languages, Structure of C programs, compilation and execution of C programs, Debugging Techniques, Data Types and Sizes, Declaration of variables, Modifiers, Identifiers and keywords, Symbolic constants, Storage classes (automatic, external, register and static), Enumerations, command line parameters, Macros, The C Preprocessor.

Operators: Unary operators, Arithmetic & logical operators, Bitwise operators, Assignment operators and expressions, Conditional expressions, Precedence, and order of evaluation.

Control statements: if-else, switch, break, and continue the comma operator, goto statement. Loops: for, while, do-while. Functions: built-in and user-defined, function declaration, definition and function call, and parameter passing: call by value, call by reference, recursive functions. Arrays: linear arrays, multidimensional arrays, passing arrays to functions, Arrays, and strings.

### **Unit-4**

**Introduction to Database Management Systems:** Database, DBMS, Why Database -File system vs DBMS, Database applications, Database users, Introduction to SQL, Data types, Classification of SQL-DDL with constraints, DML, DCL, TCL

### **Unit-5**

**Internet Basics:** Introduction, Features of the Internet, Internet application, Services of the Internet, Logical and physical addresses, Internet Service Providers, Domain Name System.

**Web Basics:** Introduction to web, web browsers, http/https, URL, HTML5, CSS

### **Text Books:**

1. Kernighan B.W., Ritchie D.M., "The C Programming Language", 2<sup>nd</sup> Edition, Prentice Hall Software, 2015
2. V. Rajaraman, "Fundamentals of Computers", 6<sup>th</sup> Edition, PHI Learning Pvt. Ltd., 2015
3. Peter Norton's, "Introduction to Computers", 7<sup>th</sup> Edition, Tata McGraw Hill, 2017
4. David Riley and Kenny Hunt, "Computational Thinking for Modern Solver", Chapman & Hall/CRC, 1<sup>st</sup> Edition, 2014

### **Reference:**

1. J. Glenn Brook shear," Computer Science: An Overview", Addison-Wesley, Twelfth Edition, 2017
2. R.G. Dromey, "How to Solve it by Computer", PHI, 1982
3. Balagurusamy E., "Fundamentals of Computers", Second ed. 2009, McGraw Hill
4. Thareja R., "Fundamentals of Computers", 2014, Oxford University Press.

### **Web link:**

1. [https://onlinecourses.swayam2.ac.in/cec19\\_cs06/preview](https://onlinecourses.swayam2.ac.in/cec19_cs06/preview)

## NET-102: INTRODUCTION TO ELECTRONICS ENGINEERING

L T P C  
3 1 0 4

### Course Objective

To understand the fundamentals of analog & digital electronic devices like diode, transistor, logic gates, flip-flop and to understand the working principles of common Instruments used in electronic measurement.

### Course Outcomes (CO):

At the end of this course students should be able to:

CO1	To understand the basic concept of diodes, and use the diode as a circuit element for different applications.	K2,K3
CO2	To understand the working of BJT, FET and OP-amp and their application.	K2, K3, K6
CO3	To design the simple digital circuits using different logic gates.	K4, K6
CO4	To identify the errors while making electronic measurements and to understand the working of different types of transducers.	K1, K4, K5
CO5	To understand the working principle of electronic instruments and displaying it on electronic devices.	K1, K2, K4

K1- Remember, K2- Understand, K3-Apply, K4-Analyse, K5- Evaluate, K6- Create

### Course Articulation Matrix (CO-PO Matrix)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	1	-	-	-	-	-	-	-
CO2	2	3	3	3	2	2	-	-	-	-	-	-
CO3	3	2	1	3	2	1	-	-	-	-	-	-
CO4	3	2	1	1	1	-	-	-	-	-	-	-
CO5	3	1	3	2	1	-	-	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put “-”.

### Course Content

#### Unit-I:

P-N Junction Diode, Depletion layer, Barrier potential, forward and reverse bias, Knee voltage, V-I Characteristics and its Equivalent Models, Avalanche and Zener Break Down, Diode Applications as Half Wave, Full Wave & Bridge Rectifier and their comparative analysis, Clippers, Clampers, Voltage Multiplier Circuit, Zener Diode and its Applications as a voltage regulator, Varactor diode.

#### Unit-II:

Basic theory and operation of PNP and NPN transistors, Characteristics of Common Base, Common Emitter and Common Collector configuration, DC Biasing : Fixed Bias, Emitter Bias, voltage divider bias, Field effect transistor: JFET, Drain and Transfer characteristic, MOSFET, Introduction to Operational Amplifier and its Applications as Adder, Subtractor, Integrator, Differentiator, log antilog.

#### Unit-III:

Number System, Base Conversion, BCD code, Excess-3 code, Gray Code, Review of Logic Gates, Concept of Universal Gates &, Boolean laws and theorems, SOP and POS representation of Boolean functions, Minimization of Boolean functions using K map, Basic Combinational Circuits: Half Adder, Full Adder, Subtractor, Sequential Circuits: Latch, Flip-Flops, Characteristic and Excitation Table of SR, JK, D and T Flip-flop. Concept of Master Slave Flip- Flop, Shift Registers.

**Unit-IV:**

Functional Elements of Instruments, Classification & Characteristics, Types of Errors, Sources of Error, Dynamic Characteristics, Active and Passive Transducers: Resistive Transducers, Thermistor, Strain Gauge, Thermocouple, Differential Output Transducers, LVDT and their Characteristics.

**Unit-V:**

Display Devices: LCD, LED, Seven Segment Display, Alphanumeric Display, Electronic Ammeter and Voltmeter, Digital Multi-meter, Cathode Ray Oscilloscope (CRO), Digital Storage Oscilloscope (DSO)

**Text Books:**

1. Electronics Principles by Albert Malvino, & David Bates, 2016, Tata McGraw-Hill, Eighth Edition, ISBN- 978-0-07-337388-1
2. Electronic Devices & Circuit Theory by Boylestad, Robert & Nashelsky, 2015, Louis, Prentice Hall of India. Eleventh Edition, ISBN- 10-9332542600
3. Electronic Instrumentation and Measurements by H.S. Kalsi, 2019, Tata McGraw-Hill, Fourth Edition, ISBN-10- 9353162513
4. Digital Principles and Applications by Leach, Malvino, & Saha, 2014, Tata McGraw-Hill, 8th Edition, ISBN-10- 9789339203405

**Reference Books:**

1. Microelectronic Circuits by Adel Sedra, Kenneth C.(KC) Smith, Tony Chan Carusone, Vincent Gaudet, 2020, Oxford University Press, 8th Edition, ISBN-10-0190853468
2. A Course in Electrical and Electronic Measurements and Instrumentation by A K Sawhney 2021, Dhanpat Rai & sons, ISBN-10- 8177001000
3. Fundamentals of Microelectronics by Behzad Razavi, Wiley, Second Edition, ISBN-13:9781118156322

**Web Links:**

1. <https://nptel.ac.in/courses/108101091>
2. <https://nptel.ac.in/courses/122106025>

## NCE-102: INTRODUCTION TO CIVIL ENGINEERING

### Course Outcomes

**L T P C**  
**3 1 0 4**

At the end of this course students should be able to:

CO1	To understand the overview and scope of Civil Engineering and apply the fundamentals of Surveying
CO2	To understand the various types of Civil Engineering materials
CO3	To understand the basic concepts of water and wastewater quality, infrastructure, and also the basics of different pollution
CO4	To understand the basics of Highways, Railways and Airport Engineering
CO5	To understand the basics of various Civil Engineering structures

### Course Articulation Matrix (CO-PO Matrix)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	2	-	-	-	-	-	1
CO1	2	-	-	-	-	2	-	-	-	-	-	1
CO2	2	-	-	-	-	2	3	-	-	-	-	1
CO3	2	-	-	-	-	2	3	-	-	-	-	1
CO4	2	-	-	-	-	2	3	-	-	-	-	1
CO5	2	1	1	-	-	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put “-”.

### SYLLABUS

#### **Unit-1: Introduction**

**Civil Engineering:** Overview and scope of Civil Engineering, Civil Engineering landmarks, Job opportunities in Civil Engineering

**Fundamentals of Surveying:** Introduction, Types of Surveying - Chain, Compass, levelling and contouring, Total Station, Introduction to Remote Sensing/ GIS/ GPS

#### **Unit-2: Civil Engineering materials**

**Building materials :** Bricks, Stones, Cement, Aggregate, Concrete, RCC, Steel, Timber, Tiles, [lime](#), [paint](#).

**Highway materials:** bitumen, concrete, Surkhi, sand, stone dust

**Soil:** Types of soil, classification of soil.

#### **Unit-3: Environmental Engineering**

Water and Wastewater Quality, Drinking Water Standards, Water infrastructure- Intake, Treatment plants, distribution system, and household plumbing.

Waste water infrastructure- household drainage system, sewerage system, Treatment Plant, and, disposal, effluent standards.

Introduction to Air Pollution, Air Quality Index, Air quality standards, Solid Waste Management- collection and segregation, Noise Pollution- standards

#### **Unit-4: Transportation Engineering**

**Highway Engineering:** Introduction, Model, elemental and functional classification of Transportation System, IRC classification of roads, Typical cross-section of pavements, Control system.

**Railway Engineering:** Types of rails, Components of permanent way, stations

Airport- Components of the airport

Introduction to Docks, Harbour, and Inland waterways

## **Unit-5: Civil Engineering Structures**

Introduction to buildings: Elements- slab, beam, column, footing

Introduction to various Civil Engineering Structures- Bridges, Retaining Wall, Tanks and Reservoirs, Hydraulic Structures-Dams, Canals, Weirs, Barrage, Industrial Structures

### **Textbooks**

1. S.S. Bhavikatti (2010). 'Basic Civil Engineering.', 1<sup>st</sup> edition, New Age International Publishers, New Delhi
2. Sateesh Gopi (2009). 'Basic Civil Engineering.', Pearson Publishers, Delhi, India
3. Punmia, B.C., Jain, A.K. and Jain, A.K. (2003). 'Basic Civil Engineering.', Laxmi Publications, New Delhi.

### **Reference Books**

1. An Introduction to Civil Engineering by V. Okumu, CreateSpace Independent Publishing Platform.
2. Penn M. R. and Parker P. J. "Introduction to Infrastructure: An Introduction to Civil and Environmental Engineering" John Wiley & Sons 2011.

### **Web Resources**

<https://nptel.ac.in/courses/105106201>

## NCT 102: INTRODUCTION TO CHEMICAL ENGINEERING AND TECHNOLOGY

L T P C  
3 1 0 4

### **Objective:**

Objective of the course is to impart

- Knowledge of basic concepts of microbiology and Food processing
- General introduction to Oils, fats, oleochemicals, essential oils, their sources, composition and structures. Basic concepts about paints, ingredients, functions, formulation and application of paints
- Knowledge of basic concepts of Polymer and Plastics
- Knowledge of basic concepts of chemical engineering
- Knowledge of basics of leather processing

### **Course Outcome**

On the successful completion of the course, students will be able to:

CO1	Understanding the basic concepts of microbiology and food processing	Understand
CO2	Understand the basic concepts about oils & paints, their ingredients and functions	Understand
CO3	Understand the basics and applications of Polymers and Plastics	Understand
CO4	Understand basics and application of chemical engineering	Understand
CO5	Understanding basics of leather processing	Understand

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1				1	2	1	1	2		2
CO2	3	1				1	2	1	1	2		2
CO3	3	1				1	2	1	1	2		2
CO4	3	1				1	2	1	1	2		2
CO5	3	1				1	2	1	1	2		2
Average	3.0	1.8	1.8	1.4	1.0	1.4	1.0	1.4	1.4	0.0	0.6	1.4

### **Syllabus**

#### **Module 1: Introduction to Biochemical Engineering and Food Technology**

Introduction to biochemical engineering. Microorganisms: Characteristics, classification, morphology, and reproduction in brief, Introduction to Food Technology: Scope of Food Technology, Overview of Food Constituents, Food Quality & Safety, Regulatory framework in India.

#### **Module 2: Introduction to Oil and Paint**

General introduction to Oils; their sources, composition, physiochemical characteristics. Fatty acids; structures nomenclature, classification and principal sources. Production and consumption pattern of various oils.

Basics concepts of paints, general ingredients & their functions. Introduction of drying oils, natural & synthetic resins, extenders & prime pigments, solvents, driers and plasticizers. General formulation of paint and basic machineries used in its manufacture. Testing and application of paint.

#### **Module 3: Introduction to Polymer Science and Technology**

Concept and definition of monomers, polymers, plastics and related chemicals, Basic properties, and types of plastic materials, Utility of plastic materials in variety of fields and their advantages over other material of construction, Global and Indian scenario of Plastic and allied industries.

#### **Module 4: Introduction to Chemical Engineering**

Introduction to Chemical Engineering, Unit Operations and Processes, Thermodynamics and Kinetics, Material and Energy Balances, Reactor Design, Piping and Instrumentation, Automation and Control, Energy Resources and Environmental Engineering, Process Safety, Operations and Troubleshooting, Career Opportunities and Challenges.

#### **Module 5: Introduction to Leather Technology**

History of Leather; Overview of Leather Sector; By-Product of Meat Industry; Biodegradable products; Hides and Skins Protein; Curing of Hide & Skins; Introduction to Leather Processing; Leather Machinery.

#### **Suggested Readings**

##### **Module 1:**

*Text Books:*

1. Biochemical Engineering Fundamentals by J. E. Bailey & D. F. Ollis (1987) 2nd Ed. McGraw Hill International Edition.
2. Pelczar M J, Chan E C S and Krieg N R “Microbiology, 5th Edition, ” Mc Graw Hill, New York (1995)
3. Food Science By Norman N. Potter, 2012

*Reference Books:*

1. Food Microbiology By William C. Frazier, Dennis C. Westhoff · 2004
2. The Food Safety and Standards Act, 2006
3. Food Facts and Principles By N. Shakuntala Manay & M. Shadaksharaswamy

*Web Links:*

1. [www.fssai.gov.in](http://www.fssai.gov.in)
2. <https://egyankosh.ac.in>

##### **Module 2:**

*Text Books*

1. Baileys Industrial oil and fat products by Daniel Swern, Wiley Interscience publication (1979)
2. Chemistry and Technology of Oils and Fats by Prof. M. M. Chakrabarti, Allied publishers (2003)
3. Nontraditional oilseeds and oils by N. V. Bringi, Oxford and IBH Co. Pvt. Ltd. (1989)

*Reference Books:*

1. Fatty Acid by K. S. Markely, Inter Science publishers (1968)
2. Organic Coating Technology, Vol. I & II; by HF Payne.
3. Outlines of Paint Technology; by WMMorgan.
4. Basics of Paint Technology (Part I & II); by Malshe & Sikchi.

*Web Links:*

1. <https://www.youtube.com/watch?v=34IADhdKvKQ>
2. <https://www.youtube.com/watch?v=6j8HnaZLVL8>
3. <https://www.youtube.com/watch?v=KTyQ-T21XgM>

##### **Module 3:**

*Text Books:*

1. F. W. Billmeyer; Text Book of Polymer Science; Wiley; Third edition; January 2007.
2. Vasant R. Gowariker; Polymer Science; New Age International; January 2019

*Reference Books:*

1. Premamoy Ghosh; Polymer Science and Technology; Tata McGraw-Hill Education, New Delhi; 1990.
2. R.J. Young and P.A. Lovel; Introduction to Polymers; CRC Press; London, 2011.

*Web Links:*

1. Introduction to Polymer Science - <https://nptel.ac.in/courses/104/105/104105124/>
2. Science & Technology of Polymers - <https://nptel.ac.in/courses/113/105/113105028/>
3. Polymer Chemistry - <https://nptel.ac.in/courses/104/105/104105039/>

**Module 4:***Text Books:*

1. Salil K Ghosal, Siddhartha Datta, "Introduction to Chemical Engineering" Tata McGraw Hill Education Private Limited, 1993.
2. Warren Lee MacCabe Smith, Peter Harriott, "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill 2005

*Reference Books:*

1. Maloney, James O. Perry Chemical Engineers Handbook. The McGraw-Hill Companies, Inc, 2008

*Web Links:*

1. <https://youtu.be/WgWNQVdhE9A>
2. <https://www.pmu.edu/departement-of-chemical-engineering/pdf/IntroductionChemicalEngineering.pdf>
3. [https://en.wikipedia.org/wiki/Chemical\\_engineering](https://en.wikipedia.org/wiki/Chemical_engineering)

**Module 5:***Text Books:*

1. Dutta. S.S., "An Introduction to the Principles of Leather Manufacture".

*Reference Books:*

1. Covington T., "Tanning Chemistry: The Science of Leather".
2. Sarkar K.T., "Theory & Practice of Leather Manufacture".

*Web Links:*

1. <https://youtu.be/z6QnUCc7ZCg>
2. <https://youtu.be/4PBRW-g01Ag>
3. <https://www.neratanning.com/knowledge/the-leather-making-process-step-by-step/>

## NWS 102: WORKSHOP PRACTICE

**Course Objective:** The objective of this course is to educate and impart basic knowledge of various hand tools and equipment's and their use in different shops, day to day industrial work and domestic life. Students able to understand safety precautions in the workshop. Student acquires skills of application oriented task.

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Course Outcome

At the end of the course the student should be able to :

CO 1	Study and practice on machine tools and their operations	K2
CO 2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry, black - smithy and welding work	K3
CO 3	Identify and apply suitable tools for machining processes including plain turning, step turning, taper turning, facing, thread cutting operations	K4
CO 4	Understand and practice welding and forging operations	K3
CO 5	Select the appropriate tools required for specific operation and the proper safety measure required to be taken while using different tools.	K2 , K3

K1 - Remember, K2 - Understand, K3 - Apply, K4 - Analyze, K5 - Evaluate, K6 – Create

### Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO(	PO10	PO11	PO12
CO1	2	-	-	1	1	1	-	-	-	-	-	1
CO2	2	-	-	1	1	1	-	-	-	-	-	1
CO3	2	-	-	1	1	1	-	-	-	-	-	1
CO4	2	-	-	1	1	1	-	-	-	-	-	1
CO5	2	-	-	1	1	1	-	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put “-”.

#### CO1

1. Working principle of lathe machine
2. Parts and operations on lathe machine
3. Tool geometry of single point cutting tool

#### CO2

1. Study and practice of different tools used in Fitting shop, Carpentry shop and Foundry shop.
2. Study and practice of different tools used in Black-smithy shop, Sheet metal shop and Welding shop.

#### CO3

1. Explanation and demonstration of various processes like plain turning and step turning.
2. Explanation and demonstration of various processes like taper turning and facing.
3. Explanation and demonstration of various processes like thread cutting, knurling and chamfering.

#### CO4

1. Classification of different welding processes with the help of flow chart.
2. Explanation and demonstration forging operations.
3. Safety precautions during actual forging and welding.

#### CO5

1. Selection of proper drilling tool for drilling operation.
2. Selection of proper tap for internal thread cutting operation.

3. Selection of power hacksaw blade, wood cutting cutter, snips, chisels etc.

## **CO6**

1. Proper demonstration of safety precautions to be taken for example leather apron, leather hand gloves, welding shield etc.
2. Description of different safety tools and precautions in workshop.

## **Course Content**

### **1. Carpentry Shop**

Practice ( I ) : To prepare half lap corner joint from given pieces of mango wood.

Practice ( II ) : To prepare mortise and tenon joint from given pieces of mango wood.

Instructions : Description and demonstration of different tools, joints along with advanced carpentry joints, classification and definition of timber, wood seasoning, demonstration of wood working lathe and advanced power tools used in carpentry work, safety precaution during actual working.

### **2. Fitting and Bench working Shop**

Practice ( I ) : To prepare male-female joint from given pieces of mild steel.

Practice ( II ) : To prepare practice work piece involving marking , measuring , sawing, drilling and tapping operations.

Instructions : Classification and description of different tools used in fitting shop e.g. marking and measuring tools , holding and supporting tools, striking tools and cutting tools etc , safety precaution during actual working.

### **3. Black Smithy Shop**

Practice ( I ) : To prepare ' L ' shape job from given piece of mild steel rod by hand forging.

Practice ( II ) : To prepare a ' Ring ' from given piece of mild steel rod by hand forging.

Instructions : Description of various forging processes done in black-smithy work e.g. upsetting, drawing down, punching, bending, fullering etc, classification and description of different tools, equipments used in black smithy shop, safety precaution during actual working.

### **4. Welding Shop**

Practice ( I ) : To prepare simple butt joint and lap joint by electric arc welding from given pieces of mild steel.

Practice ( II ) : To prepare simple lap joint by oxy-acetylene gas welding and gas flame cutting practice.

Instructions : Concept of welding, classification and explanation of various types of welding with the help of flow chart, description of different tools. Equipments required for arc welding and gas welding, demonstration of various types of flames in Oxy-acetylene gas welding, setting of current and selection of electrodes along with different welding joints, safety precaution during actual working.

### **5. Sheet Metal Shop**

Practice ( I ) : To prepare a funnel complete with soldering from given G.I. sheet.

Practice ( II ) : To fabricate tray / tool box or electric panel box from given G.I. sheet.

Instructions : Classification and description of different types of tools, equipments used in sheet metal work, different types of metals used in sheet metal shop e.g. Galvanized iron, lack iron, copper, aluminum etc, concept of development of surfaces along

with different types of joints in sheet metal work, safety precaution during actual working.

## 6. Machine Shop

- Practice ( I ) : To prepare a job by plain turning, facing, step turning and chamfering operation from given mild steel rod.
- Practice ( II ) : To prepare a job by taper turning, threading, knurling operations from given mild steel rod.
- Instructions : Classification of lathe machines, different parts of lathe machine, tools and equipments used, explanation and demonstration of various operations on lathe machine, tool geometry of single point cutting tool, cutting speed, feed and depth of cut in turning, safety precaution during actual working.

## 7. Foundry Shop

- Practice ( I ) : To prepare a mould of given pattern in Green Sand
- Practice ( II ) : To prepare a mould with two step pulley with runner and riser
- Instructions : Description and use of various foundry tools, shovel, flat rammer, hand rammer, strike off bars, vent wire, trowels, hand riddle etc. Types of various moulding sands, types of patterns, pattern materials, pattern allowances, safety precautions during actual working.

### Text Books

1. Elements Of Workshop Technology Vol-1, by Choudhury H S K, MPP Pvt. Ltd., 2008
2. A Course in Workshop Technology Vol I by Raghuwanshi, Dhanpat Rai & sons, 2011.
3. Workshop Practice Manual by V Kapoor, Dhanpat Rai & sons, 1998
4. Workshop Technology: Manufacturing Processes by Khurmi & Gupta, S. Chand Publications, 2008

### Reference books

- 1-Mechanical Workshop Practice, 2/E 2nd edition, Kindle Edition, K.C.John, PHI, 2010.
- 2-Workshop Practice , Singh Swarn, Katson Books, 2003.
- 3- Workshop Practice, R.K.Rajput, 2016.
- 4- Workshop Practice, B.L.Juneja, Cengage Learning Publishers, 2015.

### Link:

- 1- <https://sjce.ac.in/wp-content/uploads/2018/04/Workshop-Laboratory-Manual.pdf>
- 2- <https://nptel.ac.in/courses/112107219>

## SEMESTER – III

### NMA-201 ENGINEERING MATHEMATICS–II

**L T P C**  
**3 1 0 4**

**OBJECTIVE:** The objective of this course is to educate the students about

- Ordinary differential equations and their applications as mathematical models.
- Series solutions of ordinary differential equations and special functions.
- Laplace transform, Fourier series, differential equations, and boundary value problems.

**Course Outcome:** On the successful completion of the course, students will be able to

CO1	Solve first and higher order ordinary differential equations.	K3, K5
CO2	Find series solutions of ordinary differential equations and learn Bessel's and Legendre's function and its applications.	K1, K3
CO3	Solve IVPS and BVPS using Laplace Transform.	K3, K5
CO4	Find Fourier series expansion of given function and solve partial differential equations.	K3, K5
CO5	Solve boundary value problems using variable separable method etc.	K2, K3

#### CO-PO Mapping:

CO	PO1	PO 2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	2	-	-	1	-	1	-	3
CO2	3	3	2	1	2	-	-	1	-	1	-	3
CO3	3	3	2	1	2	-	-	1	-	1	-	3
CO4	3	3	2	1	2	-	-	1	-	1	-	3
CO5	3	3	2	1	2	-	-	1	-	1	-	3
Avg.	3	3	2	1	2	-	-	1	-	1	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put “-”*

#### SYLLABUS

##### **Unit- I: Ordinary Differential Equations: 10 hours**

First order ordinary differential equations, Existence and uniqueness of solutions of initial value problems, Solution of higher order linear differential equation with constant coefficients, Solution of second order differential equations by changing dependent and independent variables, Cauchy- Euler equations, Methods of diagonalization, undetermined coefficients and variation of parameters: Nonlinear equations, Linear and nonlinear models, Initial value and boundary value problems, Systems of equations. Application of differential equations as mathematical models, Models from population dynamics, Newton's Law of cooling, electric circuit, Oscillation of spring.

##### **Unit-II: Series Solutions of Ordinary Differential Equations & Special Functions: 8 hours**

Ordinary and singular points of a differential equation, Power series solutions, Frobenius method, Bessel's and Legendre's equations and their series solutions, Properties of Legendre's polynomials and Bessel's functions, Generating functions, Fourier- Bessel series and Fourier- Legendre series expansions, Sturm-Liouville Problem and related theorems.

**Unit-III: Laplace Transform: 8 hours**

Laplace transform, Existence conditions and ROC, Inverse Laplace transform, Operational properties, Convolution, Unit step function, Dirac-Delta function, Periodic functions, Applications to solve IVPs and BVPs: Linear ordinary differential equations, Transfer function and control system analysis.

**Unit-IV: Fourier Series and Partial Differential Equations: 8 hours**

Orthogonal functions, Fourier series, existence conditions, Fourier series of even and odd functions, convergence of Fourier series, Fourier half range series, Harmonic analysis, Complex Fourier series and frequency spectrum. Development of partial differential equations and solutions, Solution of first order partial differential equations, Solutions of linear higher order partial differential equations with constant coefficients.

**Unit-V: Boundary-Value Problems: 6 hours**

Classification of second order partial differential equations, Derivation of heat and wave equations, solutions in rectangular coordinates by separation of variable method, solution of Laplace equation, D'Alembert's solution of wave equation, non-homogeneous equations and boundary conditions, Orthogonal series expansions, Fourier series in two dimensions, Boundary value problems in polar, cylindrical, and spherical coordinate systems and their solutions.

**Books Recommended:**

1. E.A. Coddington, An Introduction to Ordinary Differential Equations, Practice Hall, 1995.
2. I.N. Sneddon, Elements of Partial Differential equations, McGraw-Hill 1957.
3. Dennis G, Zill & Michael R. Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers. 2<sup>nd</sup> Edition.
4. B. S. Grewal, " Higher Engineering Mathematics", Khanna publishers, 42nd edition, 2013.

**Reference Books:**

- 1.R.K. Jain & S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House, 2002.
2. Erwin Kreyszig; Advanced Engineering Mathematics, John Wiley & Sons 8th Edition.
3. H. K Das and Er. Rajnish Verma, "Higher Engineering Mathematics", S. Chand publishing, 1<sup>st</sup> edition, 2011.
4. B.V. Ramana "Higher Engineering Mathematics" Tata Mc Graw-Hill, 200

## NCT-201: FLUID MECHANICS & MECHANICAL OPERATIONS

**L T P C**  
**3 0 2 4**

**Course Objectives: The objective of this course is to impart**

- Knowledge of various fluid properties and their measurement devices.
- Knowledge of different types flow and flow behavior during flow of fluid through pipes.
- Knowledge of mass, energy and momentum balance in the system for interdisciplinary applications
- Knowledge of mechanical operations used in understanding fluid mechanics.

<b>CO1</b>	and the concept of viscosity and other fluid properties and their measurement.	Understand
<b>CO2</b>	the fluid flow systems by applying integral balances.	Design, Apply
<b>CO3</b>	Differential balance on fluid flow to formulate and solve the problems related to fluid flow.	Analyze, Apply, Evaluate
<b>CO4</b>	Apply the concept of agitation and mixing of liquids to solve problems related to particulate flow	Apply, Evaluate
<b>CO5</b>	Understand the principle involved in various mechanical operations.	Understand, Apply
<b>CO6</b>	do various experiments to apply the concepts of fluid mechanics and mechanical operations.	Analyze, Understand, Apply, Evaluate

### CO-PO Mapping

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
<b>CO1</b>	3	2	-	-	1	-	-	-	-	-	-	2		
<b>CO2</b>	3	2	3	2	1	-	-	-	-	-	-	2		
<b>CO3</b>	3	3	3	2	1	-	-	-	-	-	-	2		
<b>CO4</b>	3	3	3	1	1	-	-	-	-	-	-	2		
<b>CO5</b>	3	3	3	1	1	-	-	-	-	-	-	2		
<b>CO6</b>	3	3	2	2	1	-	-	1	3	3	3	3		
<b>Average</b>	3	2.7	2.8	1.6	1	0	0	1	3	3	3	2.2		

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put “-”*

### Syllabus

#### Module I (6 hours)

Definition of a fluid; Continuum hypothesis; Newtonian and non-Newtonian fluids, Fluid statics: pressure variation in a static fluid, hydrostatic forces on submerged surfaces, buoyancy, Manometers. Dimensional analysis and similitude: Buckingham Pi theorem and applications

#### Module II (6 hours)

Macroscopic Balances: derivation of integral balances for mass, energy and momentum; Derivation of engineering Bernoulli equation with losses, Application of macroscopic balances. Flow measurement: Orifice meter, venturimeter, Pitot tube, and Rota meter, Hydrodynamics in environmental systems.

#### Module III (6 hours)

Differential balances of fluid flow: derivation of continuity and momentum (Navier-Stokes) equations for a Newtonian fluid, Boundary layer theory, Pipe flows and fittings: laminar and turbulent flows; friction factor charts, losses in fittings, Fluid transportation: Valves and Pumps.

#### **Module IV (6 hours)**

Flow through packed and fluidized beds: Flow through beds of solids, motion of particles through the fluid, Particle settling, Fluidization, minimum fluidization velocity, Mixing and Agitation-power consumption, mixing times, scale up. Application of fluidized systems for environmental remediation.

#### **Module V (6 hours)**

Properties and handling of Particulate solids. Classification of size reduction equipment: Crushers, Grinders, Ultra-fine grinders, Cutting machines and related Problems. Size reduction – Rittingers Law, Kicks law, Bonds crushing law, Work index, Problems. Different types of screening equipment in industries, Screen efficiency. Filtration: Governing equations, constant pressure operation, constant flow operation, cycle time, types of filters. Centrifuges and Cyclones: Gravity settling, centrifugal separation, cyclone separations, separation efficiency, pressure loss. Basic idea of transportation equipment's.

#### **List of experiments**

1. To determine coefficient of discharge of an venturimeter
2. To determine coefficient of discharge of an orifice meter.
3. To determine the minor losses in pipe fittings
4. To verify the Bernoulli's Theorem
5. To find critical Reynolds number for a Pipe flow,
6. To calculate reduction ratio in Jaw crusher
7. To calculate reduction ratio in crushing roll
8. To calculate critical speed of Ball mill
9. To perform differential and cumulative screen analysis

Text book:

1. Dr. R. K. Bansal, Fluid mechanics and hydraulic machines, Lakshmi Publication, Tenth edition, 2019
2. McCabe, Smith and Harriott, Unit Operations of Chemical Engineering: McGraw Hill, 7<sup>th</sup> Edition 2017
3. K. Swain, H. Patra, G. K. Roy, Mechanical operations, Mc Graw Hill, 2017

Reference:

1. Chhabra, R. P., and V. Shankar, eds. Coulson and Richardson's Chemical Engineering: Volume 1A: Fluid Flow: Fundamentals and Applications. Butterworth-Heinemann, 2017.
2. Gupta, Vijay and S. K. Gupta, "Fluid Mechanics and its Applications", Wiley Eastern, New Delhi, 2015

Web Links:

<https://nptel.ac.in/courses/103102211>

<https://archive.nptel.ac.in/courses/103/104/103104043/>

## NLT – 201: LEATHER MICROSCOPY AND SKIN PROTIEN

**L T P C**  
**3 1 0 4**

**OBJECTIVE: The objective of this course is to enable the students understand**

- The composition of Hide & Skin and their classifications.
- To study Mechanical and optical part of compound microscope.
- To study the fiber structure.
- To study the Bacterial Cell and its Internal Structure.
- To study defects of hide & skin.

### Course Outcome:

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the composition Hide & Skin and their classifications	Understand
<b>CO2</b>	Understand the Working of compound microscopy.	Understand
<b>CO3</b>	Understand Orientation of fiber.	Understand
<b>CO4</b>	Understand the fiber structure change in curing soaking, liming and bating	Understand
<b>CO5</b>	Understand the Chemistry of DNA & RNA	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO2</b>	3	2	–	–	–	–	–	–	–	–	–	–
<b>CO3</b>	3	2	–	–	–	–	–	–	–	–	–	–
<b>CO4</b>	3	2	3	–	–	1	–	–	–	–	–	–
<b>CO5</b>	3	2	2	–	–	1	–	1	–	–	–	–
<b>Average</b>	3	2	2.6	2	–	1.3	1	1	2	–	–	1

1: Slight (Low)  
correlation, put “-”

2: Moderate (Medium)

3: Substantial (High)

*If there is no*

### Course Level Assessment Questions

#### Course Outcome 1(CO1)

1. Histology of hides and skins-cells,
2. Fibrous and Non-Fibrous
3. Composition of Hide and Skins of different animals

#### Course Outcome 2 (CO2)

1. Classification of Microscope.
2. Mechanical and optical part of compound microscope.
3. Image formation.

#### **Course Outcome 3(CO3)**

1. General and physical chemistry of proteins
2. Identification and classification of fungi associate with leather processing,
3. Morphology and physiology of fungi

#### **Course Outcome 4(CO4)**

1. Chemical Constituents of hides and skins:
2. Other skin proteins.
3. Non proteinous skin components

#### **Course Outcome 5(CO5)**

1. Structure of Collage
2. Reactive groups in collagen,
3. Defect of hides and skins.

### **SYLLABUS**

#### **Module I:**

**History:** Histology of hides and skins-cells, tissues, fibers, muscles, glands, epidermis, dermis etc., histological characteristics of buffalo and cow hides, goat and sheep skins, reptile's skins.

#### **Module II:**

**Compound Microscope:** Mechanical and optical part of compound microscope, image formed, defects in eye pieces and their rectification etc. different types of microscopes.

**Microscopical slides:** Preparation of microscopical slides, finishing and hardening, embedding, sectioning, staining and counting the photomicrography.

#### **Module-III:**

**General and physical chemistry of proteins:** with special reference to hide proteins, chemical constituents of hides and skins, reaction of proteins with acids, base and salts.

**Mycology:** Isolation, identification and classification of fungi associate with leather processing, Morphology and physiology of fungi, Mycological problems of leather industry and their prevention.

#### **Module-IV:**

**Chemical Constituents of hides and skins:** Variation fibrous and non-fibrous proteins, non-proteinous skin components.

**Other skin proteins:** Keratin, Reticulin, elastin- their chemical composition, structure and functions, non-fibrous skin proteins.

**Non proteinous skin components:** Lipids, carbohydrates vitamins, mineral constituents, Mechanism of Denaturation process, Renaturation of gelatin solution.

#### **Module-V:**

**Structure of collagen:** primary structure of collagen, amino acid composition, X-ray diffraction pattern, the triple helix structure, electron microscopy of the collagen fiber, precipitated form of collagen, Kinetics of fibril formation.

**Reactive groups in collagen:** Modification of reactive groups of collagen modified proteins, Flaying, curing, defect of hides and skins.

#### **References and suggested readings:**

1. Pelczar, Reid, "Microbiology"
2. Staineer, "Microbiology"
3. Seelay, "Demark, Microbes in Action"
4. Reed, R, "Science for Students of Leather Technology"
5. CLRI Publication "Histology of Hides and Skins-A Monograph,".
6. Dutta. S.S., "An Introduction to the Principles of Leather Manufacture".
7. Sarkar K.T., "Theory & Practice of Leather Manufacture".
8. Heidemann, "Fundamentals of Leather Manufacture".
9. Flaherty, Roddy, Lollar, "The Chemistry and Technology of Leather" Vol. I

#### **Course contents and lecture schedule**

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>History:</b>	
1.1	Histology of hides and skins-cells.	01
1.2	Study of tissues, fibers, muscles.	01
1.3	Study of glands, epidermis, dermis etc.	02
1.4	Histological characteristics of buffalo & cow hides.	01
1.5	Histological characteristics of goat and sheep skins,	01
1.6	Histological characteristics of reptile's skins.	01
<b>2.</b>	<b>Compound Microscope:</b>	
2.1	Mechanical and optical part of compound microscope.	01
2.2	Image formed, defects in eye pieces and their rectification etc.	02
2.3	Different types of microscopes.	02
2.4	Preparation of microscopical slides.	01

2.5	Finishing and hardening.	01
2.6	Embedding, sectioning, staining etc.	02
2.7	Counting the photomicrography.	02
<b>3.</b>	<b>General and physical chemistry of proteins:</b>	
3.1	with special reference to hide proteins, chemical constituents of hides and skins	02
3.2	reaction of proteins with acids, base and salts	01
<b>3.3</b>	<b>Mycology:</b>	
3.3.1	Isolation, identification and classification of fungi associate with leather processing	02
3.3.2	Morphology and physiology of fungi, Mycological problems of leather industry and their prevention	02
<b>4.</b>	<b>Chemical Constituents of hides and skins:</b>	
4.1	Variation fibrous and non-fibrous proteins,	01
4.2	non-proteinous skin components	01
<b>4.3</b>	<b>Other skin proteins:</b>	02
4.3.1	Keratin, Reticulin, elastin- their chemical composition	01
4.3.2	structure and functions, non-fibrous skin proteins	02
<b>4.4</b>	<b>Non proteinous skin components:</b>	
4.4.1	Lipids, carbohydrates vitamins, mineral constituents	01
4.4.2	Mechanism of Denaturation process, Renaturation of gelatin solution	01
<b>5</b>	<b>Structure of collagen:</b>	
5.1	primary structure of collagen, amino acid composition, X-ray diffraction pattern	02
5.2	the triple helix structure, electron microscopy of the collagen fiber	02
5.3	Precipitated form of collagen, Kinetics of fibril formation	02
<b>5.4</b>	<b>Reactive groups in collagen:</b>	
5.4.1	Modification of reactive groups of collagen modified proteins	01
5.4.2	Flaying, curing, defect of hides and skins	01
<b>Total hours</b>		<b>40</b>

## NLT – 203: PRETANNING & TANNING OF HIDES & SKINS

**L T P C**  
**3 1 0 4**

<p><b>OBJECTIVE:</b> The objective of this course is to enable the students understand</p> <ul style="list-style-type: none"> <li>To study raw hides &amp; skins, their availability and defects.</li> <li>Pre-tanning or beam house Operations.</li> <li>Concept of Chrome and Vegetable Tanning.</li> <li>Various machines employed in the tannery.</li> <li>Principle of various tanning methods</li> </ul>
--

**Course Outcome:** On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the availability of hides and skins and their defects.	Understand
<b>CO2</b>	Understand the application of pretanning or beam house operation	Understand
<b>CO3</b>	Understand the concept of chrome and vegetable tanning	Understand
<b>CO4</b>	Understand various machines employed in the tannery	Understand
<b>CO5</b>	Understand the principle of various tanning methods	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO2</b>	3	2	–	–	–	–	–	–	–	–	–	–
<b>CO3</b>	3	2	–	–	–	–	–	–	–	–	–	–
<b>CO4</b>	3	2	3	–	–	1	–	–	–	–	–	–
<b>CO5</b>	3	2	2	–	–	1	–	1	–	–	–	–
<b>Average</b>	3	2	2.6	2	–	1.3	1	1	2	–	–	1

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no correlation, put “-”*

### Course Level Assessment Questions

#### Course Outcome 1(CO1)

1. Raw hides and skins availability, sizes.
2. Identification of their defects.
3. Raw hides and skins grading and selection

#### Course Outcome 2 (CO2)

1. Beam house operation.
2. Curing of raw hides and skins.
3. Soaking, liming, deliming, bating and pickling.

**Course Outcome 3(CO3)**

1. Definition of tanning.
2. Concept of chrome tanning.
3. Concept of vegetable tanning

**Course Outcome 4(CO4)**

1. Machine employed in tannery.
2. Preparation of chrome liquor.
3. Preparation of vegetable liquor.

**Course Outcome 5(CO5)**

1. Principle of various tanning.
2. Aluminum tanning process control,
3. Zirconium tanning process control.

**SYLLABUS**

**Module I:**

Raw hides & skins, their availability, sizes, identification of defects, grading & selection.

**Module II:**

Beam House operations, curing, soaking, liming, deliming, bating & pickling.

**Module III:**

Definition of tanning, introduction to chrome & vegetable tanning.

**Module IV:**

Various machines employed in the tannery, preparation of chrome liquors and Vegetable liquors.

**Module V:**

Chrome tanning principles, vegetable tanning principles, aluminum and zirconium process control.

**References and suggested readings**

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

3. Tony Covington, "Tanning Chemistry-The Science of Leather"
4. Reed, R, "Science for Students of Leather Technology"

### Course contents and lecture schedule

Module No.	Topic	No. of Lectures
<b>1.</b>	<b>Raw hides &amp; skins</b>	
1.1	Raw hides & skins, their availability	01
1.2	Raw hides & skins their sizes	01
1.3	Identification of defects in raw hides and skins	02
1.4	Grading & selection of raw hides and skins	01
<b>2.</b>	<b>Compound Microscope:</b>	
2.1	Mechanical and optical part of compound microscope.	01
2.2	Image formed, defects in eye pieces and their rectification etc.	02
2.3	Different types of microscopes.	02
2.4	Preparation of microscopical slides.	01
2.5	Finishing and hardening.	01
2.6	Embedding, sectioning, staining etc.	02
2.7	Counting the photomicrography.	02
<b>3.</b>	<b>General and physical chemistry of proteins:</b>	
3.1	with special reference to hide proteins, chemical constituents of hides and skins	02
3.2	reaction of proteins with acids, base and salts	01
<b>3.3</b>	<b>Mycology:</b>	
3.3.1	Isolation, identification and classification of fungi associate with leather processing	02
3.3.2	Morphology and physiology of fungi, Mycological problems of leather industry and their prevention	02
<b>4.</b>	<b>Chemical Constituents of hides and skins:</b>	
4.1	Variation fibrous and non-fibrous proteins,	01
4.2	non-proteinous skin components	01
<b>4.3</b>	<b>Other skin proteins:</b>	02
4.3.1	Keratin, Reticulin, elastin- their chemical composition	01
4.3.2	structure and functions, non-fibrous skin proteins	02
<b>4.4</b>	<b>Non proteinous skin components:</b>	
4.4.1	Lipids, carbohydrates vitamins, mineral constituents	01
4.4.2	Mechanism of Denaturation process, Renaturation of gelatin solution	01
<b>5</b>	<b>Structure of collagen:</b>	
5.1	primary structure of collagen, amino acid composition, X-ray diffraction pattern	02
5.2	the triple helix structure, electron microscopy of the collagen fiber	02
5.3	Precipitated form of collagen, Kinetics of fibril formation	02
<b>5.4</b>	<b>Reactive groups in collagen:</b>	
5.4.1	Modification of reactive groups of collagen modified proteins	01

5.4.2	Flaying, curing, defect of hides and skins	01
<b>Total hours</b>		<b>40</b>

**NCT-203 : CHEMICAL PROCESS CALCULATION**

**L T P C**  
**3 0 0 3**

**Course Objective:**

To understand and apply the basics of calculations related to material and energy flow in the processes.

CO1	Demonstrate comprehensive understanding of material and energy balance equations for open and closed systems.	Remember, Understand, Apply
CO2	Select appropriate basis and conduct degree of freedom analysis for solving material and energy balance problems.	Apply, Evaluate
CO3	Make elementary flow-sheets and perform material and energy balance calculations without and with chemical reactions, and involving concepts like recycle, bypass and purge.	Analyze, Evaluate
CO4	Perform process calculations utilizing psychometric charts and steam tables.	Understand, Apply, Evaluate
CO5	Design of steady state continuous flow systems and unsteady state systems by applying simultaneous material and energy balance calculations	Design, Apply, Evaluate

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs	
CO1	3	3	2	1	-	-	-	-	-	-	-	2		
CO2	3	3	3	2	-	-	-	-	-	-	-	2		
CO3	3	3	3	3	2	2	-	-	-	-	-	2		
CO4	3	3	2	2	1	-	-	-	-	-	-	2		
CO5	3	3	2	1	-	-	-	-	-	-	-	2		
Avg	3	3	2.4	1.8	1.5	2	0	0	0	0	0	2		

**Syllabus**

**Module 1 (6 hours):**

Dimensions, system of units and their conversions, Mass and volume relations, Basic stoichiometric principles, limiting and excess reactants, Degree of completion, Conversion, Ideal gas law, Dalton's Law,

**Module 2 (6 hours)**

Vapor pressure of liquids and solids, Vapor pressure plot (Cox chart), Vapor pressures of miscible and immiscible liquids and solutions, Raoult's Law, and Henry's Law. Humidity and saturation use of humidity charts for engineering calculations.

**Module 3 (6 hours)**

Material balance without chemical reactions and its application to unit operations like distillation, absorption etc.

**Module 4 (6 hours)**

Material balance with chemical reaction Recycle, bypass and purging. Yield and selectivity.

**Module 5 (6 hours)**

Heat capacity of gases, liquids and solutions Heat of fusion and vaporization. Steady state energy balance for systems with and without chemical reactions. Calculations and application of heat of reaction combustion, formation.

**Text books**

1. Hougen, O.A., Watson, K.M and Ragatz, R.A., "Chemical Process Principles Part-I", John Wiley and Asia Publishing, 2nd edition 2005.
2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", Prentice Hall Inc., seventh edition, 2003
3. Felder, R.M. & Rousseau, R.W. "Elementary Principles of Chemical Processes ", JohnWiley, 4th edition, 2016.

**Reference Books**

1. Venkataramani, V., Anantharaman, N., Begum, K. M. MeeraSheriffa, "Process Calculations", Prentice Hall of India, Second Edition, 2011.
2. Sikdar, D. C., "Chemical Process Calculations", Prentice Hall of India, 2013.

Web Links:

<https://archive.nptel.ac.in/courses/102/106/102106069/>

## NHS 201: INDUSTRIAL ECONOMICS AND MANAGEMENT

L T P C  
3 0 0 3

### Course Outcome (COs)

1. Understand essential economic principles for solving economic problems with suitable policy alternatives.
2. Apply the knowledge of production, cost and market functions
3. Understand and apply basic functions of management
4. Develop and apply the understanding of people and marketing
5. Develop and apply the understanding of finance and operations

### CO-PO Mapping

Co/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	0	0	0	0	2	1	0	0	0	2
CO2	0	0	0	0	0	0	2	1	0	0	0	2
CO3	0	0	0	0	0	0	2	1	2	2	1	2
CO4	0	0	0	0	0	0	2	1	2	2	2	2
CO5	0	0	0	0	0	0	2	1	2	2	3	2

### UNIT I: Introduction to Economics:

Overview: production possibility curve, choices-what, how and for whom, micro- and macroeconomics, inflation, unemployment, GDP and business cycle; demand and supply, elasticity of demand, consumer surplus and its applications,

### UNIT II: Production, Cost and Market:

Production function, Cost Function, Types of Market: Perfect Competition, Monopoly, Oligopoly

### UNIT III: Fundamentals of Management:

Development of Management Thoughts, Objectives, Functions of Management

### UNIT IV: Functional Areas of Management-I

Human Resource Management: HRP, Recruitment and Selection, Performance Appraisal;  
Marketing Management: Functions, Strategies

### UNIT V: Functional Areas of Management-II

Finance Management: Objectives, Functions; Operations Management: Concepts, Functions,  
Inventory Management

### Text Books:

1. **Koutsoyiannis, A.**, 'Modern Microeconomics', English Language Book Society, Macmillan.
2. **Joseph, L Massod**, "Essential of Management", Prentice Hall, India.
3. **S. P. Robbins**, "Management", Prentice Hall, India

### Additional Reference Books:

1. **Armstrong, Michel**, "A Handbook of Management Techniques", Kogan Page Limited

2. **Samuelson, Paul A** , ‘Economics’, 5<sup>th</sup> edition, McGraw Hill New York.
3. **Henderson, J M and Quadnt, R E** , ‘Microeconomic Theory: A Mathematical Approach.’, Tata MacGraw Hill, New Delhi,2003

**NLT – 207: LEATHER MICROSCOPY AND SKIN PRETANNAGES LAB**

**L T P C**  
**0 0 4 2**

**Course Outcome:**  
On the

<p><b>OBJECTIVE:</b> The objective of this course is to enable the students applications of:</p> <ul style="list-style-type: none"> <li>• Microscopy</li> <li>• Bacteriology</li> <li>• Raw hides and Skins</li> <li>• Beam house Operations</li> <li>• Preparation of chrome liquors and tannig</li> </ul>
---

successful completion of the course, students will be able to

<b>CO1</b>	Apply the Working of compound microscopy.	Apply
<b>CO2</b>	Preparation of different culture media	Apply
<b>CO3</b>	Identification of raw hides and skins and defects	Apply
<b>CO4</b>	Application of beam house Operations	Apply
<b>CO5</b>	Preparation of chrome liquors and application of tanning	Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	-	-	-		-	-	-	-			-
<b>CO2</b>	3	2	-	-		-	-	-	-			-
<b>CO3</b>	3	2	3	-		-	-	-	-			-
<b>CO4</b>	3	2		-		1	-	-	-			-
<b>CO5</b>	3	2	2	-		1	-	1	-			-
<b>Average</b>	3	2	2.6	2		1.3	1	1	2			1

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no correlation, put “-”*

**Course Level Assessment Questions**

**Course Outcome 1(CO1)**

1. Applications of a compound microscope.
2. Identification of hides and skins of different.
3. Preparation of microscopical slide

**Course Outcome 2(CO2)**

- 1 Preparation of different culture media.
2. Staining of bacteria.
3. Identification defects

**Course Outcome 3(CO3)**

1. Identification defects
2. Grading and selection.

**Course Outcome 4(CO4)**

1. Application of curing and Soaking
2. Application of Liming and Deliming
3. Application of Bating etc.

**Course Outcome 5(CO5)**

1. Practical training in various machines
2. Application of tanning.

**SYLLABUS**

**Module-I:**

**Microscopy**

1. Study of optical part of a compound microscope. Setting up of compound microscope.
2. Identification of hides and skins of different species from their anatomical structure.
3. Identification of hides and skins of different species from their grain pattern.
4. Assessment of sole leather, Leather board etc.
5. Preparation of microscopical slides by paraffin wax and freezing method of different hides and skins.

**Module-II:**

**Bacteriology**

1. Preparation of different culture media.
2. Staining of bacteria.
3. Identification defects caused on hides, skins and leather
4. Assessment of finished leather, heavy leather and light leather

**Module-III: Raw hides and Skins**

1. Study of raw hides and skins
2. Identification defects
3. Grading and selection.

**Module-IV Beam house Operations**

Training in the various unit operations such as-

1. Curing and Soaking
2. Liming and Deliming
3. Bating etc.

**Module-V**

1. Practical training in various machines employed in the tannery.
2. Preparation of chrome liquors by different procedures and tanning.

**References and suggested readings:**

1. Pelczar, Reid, "Microbiology"
2. Staineer, "Microbiology"
3. Seelay, Demark, "Microbes in Action"
4. Reed, R, "Science for Students of Leather Technology"
5. Dutta. S.S., "An Introduction to the Principles of Leather Manufacture".

### Laboratory Experiments schedule

	<b>Laboratory Experiments</b>	
1	Study of optical part of a compound microscope. Setting up of compound microscope	04
2	Identification of hides and skins of different species from their anatomical structure and grain pattern, Assessment of sole leather, Leather board etc.	04
3	Preparation of microscopical slides by paraffin wax and freezing method of different hides and skins.	04
4	Identification defects caused on hides, skins and leather, Assessment of finished leather, heavy leather and light leather	04
5	Study of raw hides and skins, Identification defects, Grading and selection	04
6	curing and Soaking	04
7	Liming and Deliming	04
8	Bating etc	04
	Practical training in various machines employed in the tannery	04
10	Preparation of chrome liquors by different procedures and tanning.	04

## SEMESTER –IV

### NCY-202: MODERN ANALYTICAL TECHNIQUES

**L T P C**  
**3 0 3 4**

**OBJECTIVE:**

The objective of this course is to make the students aware of the modern instrumental techniques, the principles underlying them and their applications in the characterization of materials.

**Course outcome**

On the successful completion of the course, students will be able to

CO1	Interpret Raman and IR–Spectra for characterization of materials.	Understand,Apply,Analyze
CO2	Interpret NMR, Mass and ESR–Spectra for characterization of materials.	Understand,Apply,Analyze
CO3	To analyze the conductivity to determine the concentration of Solution and i-E characteristics of the samples.	Understand,Apply
CO4	Analytical separation carried out by Chromatography in A multi-component system.	Remember,Apply,Analyze
CO5	Elucidation of the Thermal Stability of different molecules and their Characterization on the basis of their thermal stability and Glass Transition Temperature of Polymers. Determine the specific heat, heat of reaction, Melting point & boiling point. Check the purity of drugs, crystallization and fusion of polymeric Materials.	Understand,Apply,Evaluate,Create
CO6	To develop experimental skills to perform, monitor and manipulate the reactions.	Understand,Evaluate,Analyze

<b>Chemistry</b>												
<b>BCY252</b>	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	O12
CO1	3	3	2	3	2	-	1	-	-	-	-	3
CO2	3	3	2	3	2	-	1	-	-	-	-	3
CO3	3	3	2	3	2	-	1	-	-	-	-	3
CO4	3	3	2	3	2	-	1	-	-	-	-	3
CO5	3	3	2	3	2	-	1	-	-	-	-	3
CO6	3	3	3	3	2	2	2	2	1	2	-	3
Average	3	3	2.17	3	2	0.33	1.17	0.33	0.17	0.33	-	3

1:Slight(Low) 2:Moderate(Medium) 3:Substantial(High) If there is no correlation put“-”.

## SYLLABUS

### Module I

- (i) **Infrared Spectroscopy:** Principle, mechanics of measurements, Selection rules, fundamental vibration modes, Factors influencing the band position and intensities, some characteristic frequencies and co-relation of IR spectra with molecular structures (applications), effect of Hydrogen Bonding on vibrational frequencies. (Lectures: 5-6)
- (ii) **Raman Spectroscopy:** Introduction theory of Raman Spectroscopy, Mechanism of Raman and Rayleigh scattering, Rule of Mutual Exclusion, correlation with the molecular structure, difference between Raman and IR spectra, Resonance Raman effect, Application of Raman Spectroscopy. (Lecture 2-3)
- (iii) **Inductively coupled plasma-** Introduction, Principle and applications of ICP-AES or OES. (Lectures:2-3)

### Module II

- (i) **Nuclear Magnetic Resonance Spectroscopy:** Introduction, basic principles, mechanics of measurements, chemical shift, band multiplets, spin-spin splitting, shielding and deshielding effect, spin-spin coupling and coupling constant(J), some characteristics of NMR positions, Application in elucidation of molecular structure, Elementary idea of NOE, DEPTNMR, C<sup>13</sup>NMR, P<sup>31</sup>NMR, F<sup>19</sup>NMR. (Lectures:4-5)
- (ii) **Mass Spectroscopy:** Introduction, basic principles, instrumentation, fragmentation patterns, nitrogen rule, McLafferty Rearrangement, interpretation of mass spectra and applications. (Lectures:3-4)
- (iii) **ESR(Electron Spin Resonance)-**Basic Principles, Instrumentation and Applications. (Lectures:2-3)

### Module III

- (i) **Potentiometry and Conductometry:** General principles, reference and indicator electrodes, potentiometric and conductometric titrations. (Lectures: 3-4)
- 4) **Polarography:** Basic principle, dropping mercury electrode (DME), half wave potential, polarographic currents and applications. (Lectures:3-4)

### Module IV

- (i) **Chromatographic methods:** Introduction to chromatographic methods: Paper, TLC, Column and Gas chromatography, Principles, Instrumentation, GC column, Detectors and stationary phases and applications Hyphenated techniques(GC-MS). (Lectures: 4-5)
- Liquid Chromatography LC/HPLC, Column efficiency in LC, Detectors, Instrumentation, Partition/Adsorption/Ion Exchange Chromatography and applications. (Lectures: 4-5)

### Module V

- (i) **Thermal Methods of Analysis:** Thermo gravimetric analysis, differential thermal analysis and

differential scanning calorimetry and applications.(Lectures:4-5)

(ii) **Electron Microscopy:** Introduction and Applications of Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM). (Lectures: 2-3)

(iii) **X-ray methods:** Introduction and applications of XRD.(Lectures: 2-3)

### **CHEMISTRYLAB**

#### **List of Experiments:**

1. Estimation of vitamin C in commercial soft drink/GluconD.
2. Determine the strength of oxalic acid conductometrically using sodiumhydroxide solution.
3. Separation of amino acids by thin layer chromatography.
4. Determination of  $R_f$  value of Methyl Orange and Phenolphthalein using paper/thin layer chromatography.
5. Separation of metal ions by paper chromatography.
6. Determine the adsorption isotherm of oxalic acid/acetic acid on activated charcoal and verify the Freundlich adsorption isotherm.
7. Determine the rate constant(K)of hydrolysis of ethyl acetate catalyzed by HCl.
8. Synthesis of p-nitro acetanilide from acetanilide and find its percentage yield.
9. Determine the viscosity and percentage composition of the given liquid using Ostwald's viscometer.
10. Determine the strength of given glucose solution by titration against Fehling's solution.
11. Determination of dissociation constant k for a weak acid using conductometry.
12. Separation of mixtures using column chromatography.
13. Estimation of Phosphoricacid from cocacola.
14. Preparation of picric acid (2,4,6-trinitrophenol) from phenol.

#### **ReferenceBooks:**

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler & Stanley R. Crouch, Publisher: Thomson Brooks/Cole.
2. Instrumental Methods Analysis, by B. K. Sharma, Publisher: Krishna Prakashan Media.
3. Textbook of Quantitative Inorganic Analysis, A. I. Vogel, Publisher: Longman
4. Elementary Organic SpectroscopybyY.R. Sharma, Publisher: S. Chand .
5. Engineering Chemistry by Shashi Chawla, Publisher: Dhanpat Rai& Co.

## NMA-204 COMPUTER ORIENTED NUMERICAL METHODS

**L T P C**  
**3 0 2 4**

**OBJECTIVE: The objective of this course is to provide conceptual understanding of:**

- various numerical methods for solving linear and nonlinear equations.
- various numerical techniques of interpolation, integration, and differentiation with their applications.
- various numerical methods to solve IVPs and BVPs.

**Course Outcome:** On the successful completion of the course, students will be able to

CO1	find roots of nonlinear equations and solve systems of algebraic equations.	K1, K5
CO2	use interpolation techniques and to find numerical differentiation/integration of data, function.	K3, K5
CO3	use numerical methods for finding solutions of ordinary differential equations, simultaneous and higher order equations.	K3, K5
CO4	learn numerical methods for finding solution of initial and boundary value problems, partial differential equations.	K1, K2
CO5	learn basic concepts of some Finite element methods.	K1, K2

**CO-PO Mapping:**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	1	1	-	-	-	-	3
CO2	3	2	3	3	1	1	1	-	-	-	-	3
CO3	3	2	3	3	1	1	1	-	-	-	-	2
CO4	3	2	3	3	1	1	1	-	-	-	-	3
CO5	3	2	3	3	1	1	1	-	-	-	-	3
Avg.	3	2	3	3	1	1	1	-	-	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put “-”*

**SYLLABUS:**

**UNIT I: Nonlinear Equations and Simultaneous Linear Equations: 12 hours**

**Roots of nonlinear equation:** Methods of solution, Order of convergence of iterative methods, Simple roots: Bisection, False position, Secant, Newton-Raphson, Chebyshev, Iteration and multi point iteration methods, Multiple roots: Newton-Raphson and Chebyshev, Complex roots: Newton-

Raphson and Muller's method, System of nonlinear equations: Newton-Raphson and Iteration methods, Polynomial equations: Bairstow's method, convergence analysis of above methods.

**Linear systems:** Introduction, Direct methods, Operation count, Pivoting, Ill conditioned linear systems & condition number, Iteration methods: Jacobi, Gauss-Seidel, SOR methods, convergence conditions. Special system of equations: Thomas algorithm, Eigen value problems: Given's and Power methods.

### **UNIT II: Interpolation, Differentiation and Integration: 10 hours**

Curve fitting: Polynomial interpolation, error, existence and uniqueness, truncation error bounds, difference operators, Newton forward and backward difference interpolations, Lagrange, Newton divided difference and iterated interpolations, Stirling and Bessel's interpolations, Spline interpolation, Least squares and Chebyshev approximations, Numerical differentiation: Methods based on interpolation, error analysis, Numerical integration: methods based on interpolations (Trapezoidal, Simpson's 1/3, Simpson's 3/8 rule), Gauss quadrature methods, Romberg integration, error bounds and estimates.

### **UNIT III: Numerical Solution of Ordinary Differential Equations: 6 hours**

Initial-value problems, Single step methods: Taylor's, Picard's, Euler's, Modified Euler's method and Runge-Kutta method (fourth order), error estimates, multi-step methods: Adam's- Bashforth and Milne's methods, convergence and stability analysis, Simultaneous and Higher order equations: RK Fourth order method.

### **UNIT IV: Initial & Boundary Value Problems and Iterative Solvers: 6 hours**

BVP: Shooting method and finite difference methods for ordinary differential equations, Solution of partial differential equations: Laplace, Poisson equations: standard 5- point and diagonal 5- point formulae, Jacobi method, Gauss Seidel method (Liebmann's iterative method), Relaxation method. Solution of heat equation: Crank – Nicolson method, Solution of wave equation.

### **UNIT V: Finite Element Method: 6 hours**

Basic concepts, variational formulation and functional, base functions, approximations weighted residual methods: Ritz method, Galerkin method, least squares method, collocation method, Finite element and solution of simple problems and time dependent problems.

### **NT Lab:**

Develop Programs of the following techniques in C/C++ Language:

1. To implement iterative methods to solve a nonlinear equation.
2. To implement iterative methods to solve a system of linear equations.
3. To implement Forward, Backward and Central difference interpolation formulae.
4. To implement Newton's divided difference and Lagrange's interpolation formulae.
5. To implement Numerical differentiation.
6. To implement Numerical integration using Trapezoidal, Simpson 1/3 and Simpson3/8 rules.
7. To implement single step methods to solve initial value problems.
8. To implement multi step methods to solve initial value problems.
9. Solution of Heat equations (Parabolic equations) by finite difference method.
10. Solution of Laplace equations (elliptic equations) by finite difference method.
11. Solution of wave equations (Hyperbolic equations) by finite difference method.

### **Books Recommended:**

1. M.K. Jain, S.R.K. Iyengar & R.K. Jain, Numerical methods for Scientific and Engineering Computation, N age International Publication.
2. S.S Sastry, Introductory Methods of Numerical Analysis, Eastern Economy Edition.
3. S. Rajsekaran, Numerical Method in Science and Engineering, Wheeler Publishing House.
4. B.S. Grewal, Numerical Method in Engineering & Science, Khanna Publisher.

**Reference Books:**

1. Chapra, S.C. and Canale, R.P., “Numerical Methods for Engineers”, Tata McGraw –Hill.
2. Balagurusamy, E., “Numerical Methods”, Tata McGraw –Hill.
3. Bradie, Brian (2006). A Friendly Introduction to Numerical Analysis. Pearson Education India. Dorling Kindersley (India) Pvt. Ltd. Third Impression, 2011.
4. K. W. Morton and D. F. Mayers, Numerical Solution of Partial Differential Equations, Cambridge University Press.

## NLT-202 ANALYSIS OF MATERIALS OF LEATHER MANUFACTURE

**L T P C**  
**3 1 0 4**

<p><b>OBJECTIVE: The objective of this course is to</b> enable the students</p> <ul style="list-style-type: none"> <li>• To understand principle of analytical method employed in analysis of water.</li> <li>• To understand Analysis of Various Chemicals and Auxiliaries used in Leather Processing:</li> <li>• To understand theory of oils, fats, binders &amp; waxes etc.</li> <li>• To understand Analysis of Tanning Agent.</li> </ul>
--

**Course Outcome:** On the successful completion of the course, students will be able to

<b>CO1</b>	Understand principle of analytical method employed in analysis of water.	Understand
<b>CO2</b>	Understand Analysis of Various Chemicals and Auxiliaries used in Leather Processing:	Understand
<b>CO3</b>	Understand basic principles of titration and standards theory of oils, fats, binders & waxes etc.	Understand
<b>CO4</b>	Understand analysis of Liquors of beam House Processes	Understand
<b>CO5</b>	Understand analysis of Tanning Agent.	Understand
<b>CO6</b>	Understand analysis of materials of leather manufacture.	Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	03	02	–	01	02	–	–	–	–	–	–	–
<b>CO2</b>	03	02	–	01	02	–	–	–	–	–	–	–
<b>CO3</b>	03	–	–	–	–	–	–	–	–	–	–	–
<b>CO4</b>	03	02	–	01	02	–	–	–	–	–	–	01
<b>CO5</b>	03	02	–	–	–	–	–	–	–	–	–	–
<b>CO6</b>	03	02	–	–	02	–	–	–	–	–	–	01
<b>Average</b>	3	2	–	1	2	–	–	–	–	–	–	–

1: Slight (Low)      2: Moderate (Medium)      3: Substantial (High)      *If there is no correlation, put “-”*

### Course Level Assessment Questions:

#### Course Outcome 1(CO1)

1. Analytical method employed in analysis of water
2. Effect of hardness of water on various processes in leather manufacture
3. Softening of water.

**Course Outcome 2(CO2)**

1. Analysis of salt, lime.
2. Analysis of delimiting agents.
3. Neutralizing agents.

**Course Outcome 3(CO3)**

1. Oils and Fats
2. Sulfated oils, soap, fat liquors
3. Auxiliaries like resin binders, wax emulsions etc.

**Course Outcome 4(CO4)**

1. Analysis of Soak liquor,
2. Analysis of lime liquor.
3. Analysis of pickle liquor.

**Course Outcome 5(CO5)**

1. Vegetable tanning materials and extracts.
2. Chrome extracts and liquors.
3. Zirconium and Aluminum Tanning agent.

**SYLLABUS****Module -I:**

Analysis of water: Type of water – principle of analytical method employed in analysis of water effect of hardness of water on various processes in leather manufacture softening of water.

**Module -II:**

Analysis of Various Chemicals and Auxiliaries used in Leather Processing: Salt, Lime, Sodium sulphate, Aluminum salt, Delimiting agents, Bates, Neutralizing agents.

**Module -III:**

Oils and Fats, sulfated oils, soap, fat liquors and other auxiliaries like resin binders, wax emulsions etc.

**Module-IV:**

Analysis of Liquors of beam House Processes: Soak liquor, lime liquor and pickle liquor.

**Module -V:**

Analysis of Tanning Agent: Vegetable tanning materials and extracts, chrome extracts and liquors, zirconium and Aluminum Tanning agent, formaldehyde.

**Module -VI:**

Water Analysis: Temporary hardness, Permanent hardness, Total hardness, Chloride content, Sulphate content, Iron content, Analysis of common salt, Analysis of lime-available lime, Total bases. Analysis of sodium sulphide, Analysis of used lime liquors-lime, sodium sulphide, salt content. Analysis of deliming agents-analysis of ammonium salts, analysis of organic acids, Analysis of pickle liquor, Analysis of bate, Analysis of oils, moisture, acid value, saponification value, iodine value, unsaponifiables, Analysis of sulphate oils-moisture, pH, acid value, total alkalinity organically combined SO<sub>3</sub>, Na groups.

**References and suggested readings:**

1. Sarkar, P. K., “*Analysis of Materials of Leather Manufactures*”
2. Mahadevan, T. S. K., “*A Practical Guide for Chemical Analysis and Physical Testing of Leather*”
3. Sarkar K.T. “*Theory and practices of Leather Manufacture*”.
4. “*I.S. Standards for Chemical Testing*”.

**Course contents and lecture schedule**

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>Analysis of water:</b>	
1.1	Type of water	02
1.2	principle of analytical method employed in analysis of water	02
1.3	effect of hardness of water on various processes in leather manufacture	02
1.4	softening of water.	02
<b>2.</b>	<b>Analysis of Various Chemicals and Auxiliaries used in Leather Processing:</b>	
2.1	Salt & Lime.	02
2.2	Sodium sulphate & Aluminum salt.	02
2.3	Deliming agents & Bates,	02
2.4	Neutralizing agents.	02
<b>3.</b>	<b>Oils, Fats and Soaps</b>	
3.1	Oils and Fats.	02
3.2	Sulfated oils & soap.	02
3.3	Fat liquors and other auxiliaries like resin binders,	02
3.4	Wax emulsions etc.	02
<b>4.</b>	<b>Analysis of Liquors of beam House Processes</b>	
4.1	Soak liquor.	02
4.2	Lime liquor.	02
4.3	Pickle liquor.	02
<b>5.</b>	<b>Analysis of Tanning Agent:</b>	
5.1	Vegetable tanning materials and extracts	03
5.2	Chrome extracts and liquors.	03
5.3	Zirconium and Aluminum Tanning agent.	03
5.4	Formaldehyde	01
<b>Total hours</b>		<b>40</b>

<b>6.</b>	<b>Laboratory experiments</b>	
6.1	Water Analysis: Temporary hardness, Permanent hardness, Total hardness, Chloride content, Sulphate content, Iron content.	06
6.2	Analysis of common salt.	06
6.3	Analysis of lime-available lime, Total bases.	06
6.4	Analysis of sodium sulphide.	06
6.5	Analysis of used lime liquors-lime, sodium sulphide, salt content.	06
6.6	Analysis of deliming agents-analysis of ammonium salts, analysis of organic acids.	06
6.7	Analysis of pickle liquor.	06
6.8	Analysis of bate.	06
6.9	Analysis of oils, moisture, acid value, saponification value, iodine value, unsaponifiables.	06
6.10	Analysis of sulphate oils-moisture, pH, acid value, total alkalinity organically combined SO <sub>3</sub> , Na groups.	06
<b>Total hours</b>		<b>60</b>
<b>Grand total hours</b>		<b>100</b>

**NCT- 204 : CHEMICAL ENGINEERING THERMODYNAMICS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**Course Objective:**

To understand the theory and applications of classical thermodynamics, thermodynamic properties, equations of state, methods used to describe and predict phase equilibria.

**Course outcomes:**

CO1	Understand the basic laws of thermodynamics and the terminology associated with engineering thermodynamics.	Understand, Analysis
CO2	Apply the laws of thermodynamics to evaluate the work and energy required/produced in different thermodynamic processes	Apply, Evaluate
CO3	Apply the knowledge of phase equilibria in two-component and multi-component systems.	Apply, Evaluate
CO4	Analyze the thermodynamic properties of substances in gas or liquid state of ideal and real mixture	Understand, Analysis
CO5	Understand intermolecular potential and excess property behaviour of multi-component systems	Understand, Analysis

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	1	-	-	1	-	1
CO2	3	1	1	1	-	-	3	-	-	1	-	1
CO3	3	3	2	2	-	-	-	-	-	1	-	1
CO4	3	3	3	2	-	-	1	-	-	1	-	1
CO5	3	2	2	3	-	-	1	-	-	1	-	1
Avg.	3	2.2	1.8	1.8	-	-	1.5	0	0	1	0	1

**Syllabus****Module 1 (8 hours)**

Basic Concepts: Scope of thermodynamics, System & Surroundings, Properties, phase, zeroth law of thermodynamics, Temperature, Equilibrium, Reversible & Irreversible process, Work, Heat, Energy;

First Law of Thermodynamics: Joule's Experiment, Internal energy, Enthalpy, Heat capacities, Application of first law to closed & open systems; Volumetric properties of pure fluids: PVT behaviour of pure substances, Phase rule; Virial equation of state and its application: ideal gas and cubic equation of state.

#### **Module 2 (6 hours)**

Second Law of Thermodynamics: Limitations of First law of thermodynamics, second law of Thermodynamics, Kelvin–Planck statement & Clausius Statement, Heat engine and thermal efficiency, Heat pump, Refrigerator, COP, Carnot's cycle, Carnot theorems; Entropy: Clausius theorem & Clausius inequality, Principle of entropy, Entropy changes of an ideal gases, Entropy generation, Entropy balance for open systems, ideal work, and lost work, Sustainability in chemical process industry.

#### **Module 3 (6 hours)**

Thermodynamic Properties of Fluids: Residual properties, Two phase systems: Clapeyron equation, Estimation of thermodynamic properties by using graphs and tables;

Vapor-Liquid Equilibria: Nature of equilibrium, phase rule, VLE qualitative behaviour, Simple Models for VLE, VLE by Modified Raoult's law

#### **Module 4 (6 hours)**

Solution thermodynamics Theory: Fundamental property relation, Chemical potential and phase equilibria, Partial properties, Ideal gas mixture model, Fugacity, and fugacity coefficient for pure species and in solution, Ideal solution model and excess properties.

#### **Module 5 (4 hours)**

Solution thermodynamics Application: Liquid phase properties from VLE data, Models for the excess Gibbs energy, Property changes of mixing.

#### **Text Books**

1. J.M. Smith and H.C. Van Ness, Introduction to Chemical Engineering Thermodynamics, McGraw Hill International Ltd, 7<sup>th</sup> Edition, 2009.
2. Y.V.C. Rao, Chemical Engineering Thermodynamics, Universities Press (India) Ltd. Hyderabad.
3. K.V. Narayanan, Chemical Engineering Thermodynamics, Prentice Hall. 2007

#### **Reference Books**

B.G. Kyle, Chemical and Process Thermodynamics, Prentice Hall. 1999 Çengel, Y.A., Boles, M.A., Kanoğlu, M., Thermodynamics: An Engineering Approach, McGraw-Hill Education, New York.

#### **Web Links:**

<https://archive.nptel.ac.in/courses/103/106/103106070/>  
<https://archive.nptel.ac.in/courses/103/101/103101004/>

**NCT-202 : HEAT TRANSFER OPERATIONS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Objective:** To understand the fundamentals of heat transfer mechanisms in solids and fluids through different modes and their applications in various heat transfer equipment such as heat exchangers and evaporators etc in process industries.

**Course outcomes:**

CO 1.	Understand different modes of heat transfer and solving steady and unsteady heat conduction problems	Understand Analyze, Evaluate
CO 2.	Apply calculation of heat transfer by free and force convection	Apply, Analyze, Evaluate
CO 3.	Apply mechanism of radiation of heat transfer in systems used in different processing operations including solar radiation	Apply, Evaluate
CO 4.	Understand phase-change phenomena of boiling and condensation	Understand, Analyze, Evaluate
CO 5.	Design of heat exchangers and its various types and applications	Design

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs	
CO1	3	3	2	1	-	-	-	-	-	-	-	2		
CO2	3	3	3	2	-	-	-	-	-	-	-	2		
CO3	3	3	3	3	2			-	-	-	-	2		
CO4	3	3	2	2	1	-	-	-	-	-	-	2		
CO5	3	3	2	2	-	-	-	-	-	-	-	2		
Avg	3	3	2.4	2	1.5	0	0	0	0	0	0	2		

**Syllabus:****MODULE 1 (6 hours)**

Introduction to heat transfer and general concepts of heat transfer by conduction, convection and radiation, Types of Insulating materials ,Conduction: Basic concepts of conduction in solids, liquids, gases, steady state temperature fields and one dimensional conduction without heat generation e. g. through plain walls, cylindrical and spherical surfaces, composite layers, insulation thickness, Extended surfaces, fins and their applications. Introduction to unsteady state heat transfer.

**MODULE 2 (6 hours)**

Convection: Fundamentals of convection, Basic concepts and definitions, natural and forced convection, hydrodynamic and thermal boundary layers, laminar and turbulent heat transfer inside tubes, Dimensional analysis, determination of individual and overall heat transfer coefficients.

**MODULE 3 (6 hours)**

Radiation: Basic laws of heat transfer by radiation, black body and gray body concepts, view factors, Kirchoff's law, solar radiations, combined heat transfer coefficients by convection and radiation.

**MODULE 4 (6 hours)**

Heat Transfer by phase change: Condensation of pure vapors, film wise and drop wise condensation, heat transfer in boiling liquids, boiling heat transfer coefficients, Evaporation: Elementary principles, types of evaporators, Single and multiple effect evaporators.

**MODULE 5 (6 hours)**

Heat exchangers: Types of heat exchangers, Principal components of a concentric tube & shell-and-tube heat exchangers, baffles, heat exchanger with multiple shell and tube passes, log-mean temperature difference, overall heat transfer coefficient, fouling factors, design of double pipe and shell and tube heat exchangers.

**Text Books:**

1. B. K. Dutta, Heat transfer: principles and applications. PHI Learning Pvt. Ltd., 2000.
2. C.P. Gupta, R. Prakash, Engineering Heat Transfer, Nem Chand & Bros., 2012.
3. D. Q. Kern. Process heat transfer, New York: McGraw-Hill, 1950

**Reference books**

1. J.P. Holman, Heat transfer. McGraw Hill Higher Education; 2010.
2. Y. A., Cengel and A. J. Ghajar, Heat and Mass Transfer Fundamentals and Applications, McGraw Hill, 5th edition, 2016.

**Web Links**

<https://archive.nptel.ac.in/courses/103/105/103105140/>

<https://archive.nptel.ac.in/courses/103/101/103101137/>

## NLT- 208 INTRODUCTION TO POST TANNING OPERATIONS

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE:** The objective of this course is to enable the students understand:

- Chemistry of Bleaching and Mordanting agent
- Theory of Oil, Fat and Fat liquoring.
- Principle of Water Proofing.
- Properties and chemistry aqueous pigment pastes, binders, polymer dispersions.
- Properties and chemistry of the following finishing materials

**Course Outcome:** On the successful completion of the course, students will be able to understand:

<b>CO1</b>	Understand Chemistry of Bleaching and Mordanting agent & dyeing	Understand
<b>CO2</b>	Understand Theory & mechanism of Oil, Fat and Fat liquoring.	Understand
<b>CO3</b>	Understand Principle of Water Proofing & film formation.	Understand
<b>CO4</b>	Understand Properties and chemistry aqueous pigment pastes, binders, dispersions	Understand
<b>CO5</b>	Understand Properties, Chemistry of the following finishing materials	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO2</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO3</b>	3	2	–	–	–	–	–	–	–	–	–	–
<b>CO4</b>	2	2	–	1	–	–	2	–	–	–	–	–
<b>CO5</b>	1	–	2	–	–	–	2	–	2	–	–	1
<b>Average</b>	2.4	2	2	1	–	–	2	–	2	–	–	1

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no correlation, put “-”*

### Course Level Assessment Question

#### Course Outcome 1(CO1)

1. Classification of leather dyes
2. Theory and mechanism of dyeing
3. Dyeing methods

#### Course Outcome 2(CO2)

1. Types and properties of oils and fats applied in Leather.
2. Principal and methods of sulphation, sulphonation and sulphitation of oils.
3. Chemistry and Preparation of Synthetic fatliquors.

**Course Outcome 3(CO3)**

1. Classification and types of leather finishes
2. Theory of film formation
3. Methods of application finishes

**Course Outcome 4(CO4)**

1. Aqueous pigment pastes
2. Synthetic polymer dispersions
3. Binders.

**Course Outcome 5(CO5)**

1. Nitrocellulose lacquers
2. Wax emulsions,
3. Silicone emulsions.

**SYLLABUS****Module I:**

Chemistry of bleaching and mordenting agents, principles of color chemistry, classification of leather dyes, principle of color matching, theory and mechanism of dyeing, dyeing methods.

**Module II:**

Oil fat and fat liquoring, theory of emulsions, types & properties of oils & fats applied to leather, types of fatliquor, principles and methods of sulphation, sulphonation & sulphitation of oils, chemistry & preparation of synthetic fatliquors, fatliquoring methods, mechanism of fatliquoring.

**Module III:**

Water proofing, classification & types of leather finishes, theory of film formation, methods of application of finishes, mechanical operation involved in finishing.

**Module IV:**

Aqueous pigment pastes, binders, polymer dispersions.

**Module V:**

Nitrocellulose lacquers and lacquer emulsions, wax emulsions, silicone emulsions, finishing of leathers.

**References and suggested readings**

1. S.S. Dutta, "An Introduction to the Principles of Leather Manufacture".
2. K.T. Sarkar, "Theory & Practice of Leather Manufacture".
3. Flaherty, Roddy, Lollar, "The Chemistry and Technology of Leather" Vol. III
4. Sharp house, J.H., "Leather Technician's Handbook".

5. Reed. R., "Science for student of leather technology"

**Course contents and lecture schedule**

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>Bleaching and Dyeing of leather :</b>	
1.1	Chemistry of bleaching	01
1.2	Chemistry of mordenting agents	01
1.3	Principles of color chemistry	01
1.4	Principle of color matching	01
1.5	Classification of leather dyes	01
1.6	Theory and mechanism of dyeing	02
1.7	Different types of dyeing methods	02
<b>2.</b>	<b>Oil fat and fat liquoring :</b>	
2.1	Oil fat and fat liquoring	01
2.2	Different theories of emulsions	01
2.3	Types & properties of oils & fats applied to leather	01
2.4	Different types of fatliquor	01
2.5	Chemistry & preparation of synthetic fatliquors	01
2.6	Principles and methods of sulphation, sulphonation & sulphitation of oils	02
2.7	Preparation of fatliquors and mechanism of fatliquoring	02
<b>3.</b>	<b>Leather finishing :</b>	
3.1	Water proofing	02
3.2	Classification & types of leather finishes	02
3.3	Theory of film formation	01
3.4	Different methods of application of finishes	02
3.5	Mechanical operation involved in finishing	02
<b>4.</b>	<b>Leather finishing materials :</b>	
4.1	Aqueous pigment pastes	02
4.2	Binders	02
4.3	Polymer dispersions	02
<b>5</b>	<b>Lacquers and Emulsions:</b>	
5.1	Nitrocellulose lacquers	01
5.2	Lacquer emulsions	01
5.3	Wax emulsions	02
5.4	Silicone emulsions	01
5.5	Finishing of leathers	02
	<b>Total hours</b>	<b>40</b>

## NLT-210 ANALYSIS OF MATERIALS OF LEATHER MANUFACTURE LAB

**L T P C**  
**0 0 4 2**

<p><b>OBJECTIVE:</b> The objective of this course is to enable the students applications of:</p> <ul style="list-style-type: none"> <li>• Water Analysis</li> <li>• Analysis of lime-available lime</li> <li>• Analysis of used lime liquors-lime</li> <li>• Analysis of deliming agents</li> <li>• Analysis of pickle liquor and bate</li> </ul>
---

**Course Outcome:** On the successful completion of the course, students will be able to

<b>CO1</b>	Water Analysis: Temporary hardness, Permanent hardness	Apply
<b>CO2</b>	Analysis of lime-available lime and total bases.	Apply
<b>CO3</b>	Analysis of used lime liquors-lime, sodium sulphide, salt content.	Apply
<b>CO4</b>	Analysis of deliming agents-analysis of ammonium salts	Apply
<b>CO5</b>	Analysis of pickle liquor and bate	Apply

CO	PO 1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	–	–									
CO2	3	2	–									
CO3	3	2	3									
CO4	3	2				1	–	–	–	–	–	–
CO5	3	2	2	–	–	1	–	1	–	–	–	–
<b>Average</b>	3	2	2.6	2	–	1.3	1	1	2	–	–	1

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no correlation, put “-”*

### Course Level Assessment Questions

#### Course Outcome 1(CO1)

1. Analysis Temporary hardness, Permanent hardness.
2. Analysis total hardness, Chloride content.
3. Analysis Sulphate content, Iron content

#### Course Outcome 2(CO2)

- 1 Analysis lime-available lime, Total bases.
2. Analysis of sodium sulphide.

**Course Outcome 3(CO3)**

1. Analysis of used lime liquors-lime
2. Total bases.

**Course Outcome 4(CO4)**

1. Analysis of deliming agents
2. Analysis of ammonium salts
3. Analysis of organic acids.

**Course Outcome 5(CO5)**

1. Analysis of pickle liquor.
2. Analysis of bate.

**SYLLABUS****Module-I:****Water Analysis**

1. Analysis Temporary hardness, Permanent hardness.
2. Analysis total hardness, Chloride content.
3. Analysis Sulphate content, Iron content.

**Module-II:****Lime Liquor**

1. Analysis lime-available lime, Total bases.
2. Analysis of sodium sulphide.

**Module-III:****Used Lime Liquor**

1. Analysis of used lime liquors-lime
2. Total bases.
3. Sodium sulphide, salt content.

**Module-IV:****Deliming agents**

1. Analysis of deliming agents
2. Analysis of ammonium salts

**Module-V:****Pickling and bating**

1. Analysis of pickle liquor.
2. Analysis of bate.

**References and suggested readings:**

1. Sarkar, P. K., "*Analysis of Materials of Leather Manufactures*"
2. Mahadevan, T. S. K., "*A Practical Guide for Chemical Analysis and Physical Testing of Leather*"
3. Sarkar K.T. "*Theory and practices of Leather Manufacture*".
4. "I.S. Standards for Chemical Testing"

	<b>Laboratory experiments</b>	
1	Water Analysis: Temporary hardness, Permanent hardness, Total hardness, Chloride content, Sulphate content, Iron content.	04
2	Analysis of common salt.	04
3	Analysis of lime-available lime, Total bases.	04
4	Analysis of sodium sulphide.	04
5	Analysis of used lime liquors-lime, sodium sulphide, salt content.	04
6	Analysis of deliming agents-analysis of ammonium salts, analysis of organic acids.	04
7	Analysis of pickle liquor.	04
8	Analysis of bate.	04

## SEMESTER- V

### NLT-301 PROCESSING OF LEATHER-I

**L T P C**  
**3 0 2 4**

- OBJECTIVE:** The objective of this course is to enable the students
- To understand the manufacturing of various finished & heavy leather.
  - To understand the processing of industrial & sports leather.
  - To understand the manufacturing of various light leather.
  - To understand the manufacturing of water proof leather.
  - To understand the uses of splits.

#### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	general practices in vegetable and chrome tanning	Understand
<b>CO2</b>	Understand the processing of industrial & sports leather	Understand
<b>CO3</b>	Understand the manufacturing of various light leather.	Understand
<b>CO4</b>	Understand the manufacturing of water proof leather.	Understand
<b>CO5</b>	Understand the uses & of splits by manufacturing different leathers.	Understand
<b>CO6</b>	Processing of chrome leather from different raw materials and tannages.	Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2	–	–	1	–	–	–	–	–	–	–
<b>CO2</b>	3	2	–	–	2	–	–	–	–	–	–	–
<b>CO3</b>	3	2	–	–	2	–	–	–	–	–	–	–
<b>CO4</b>	2	2	–	–	2	–	–	–	–	–	–	–
<b>CO5</b>	3	2	2	2	2	–	3	–	2	–	–	1
<b>CO6</b>	3	2	1	–	–	–	–	–	–	–	–	1
<b>Average</b>	2.8	2	1.5	2	1.8	–	3	–	2	–	–	1

1: Slight (Low)      2: Moderate (Medium)      3: Substantial (High)      *If there is no correlation, put “-”*

#### Course Level Assessment Questions

##### Course Outcome 1(CO1)

1. Finished leathers and composition of finishes
2. Vegetable tanned sole leathers, Bag tanning.
3. Belting leathers

##### Course Outcome 2(CO2)

1. Leather for liquification plants for air, Oil seal, Gas.
2. Sports Goods leather.
3. Hockey ball, Cricket Ball leather.

##### Course Outcome 3(CO3)

1. Softies & nappa leather.
2. Printed Leathers.

3. Upholstery leathers.

**Course Outcome 4(CO4)**

1. Water proof and water repellent upper leather.
2. Lining leather.
3. Bag leather.

**Course Outcome 5(CO5)**

1. Different types of leathers using chrome splits
2. Formulation and different dyestuffs.
3. Retaining agents.

**Course Outcome 6(CO6)**

1. Wet blue hides and skins and their assortment
2. Lining Leathers from different raw materials and tannages.
3. Chrome and Chrome retain upper leathers.

**Syllabus**

**Module-I:**

Finished leathers and composition of finishes, tanned leathers semi-finished leathers wet blue-wet white properties, general practices in vegetable and chrome tanning.

Heavy Leathers: Vegetable tanned sole leathers, Bag tanning, different types of finished leathers, Belting leathers, Harness and saddlery leathers, Chrome and waxed soles, picking band leathers. Picker and apron leathers, Hydraulic and pneumatic leather such as hand pump leathers.

**Module-II:**

Leather for liquification plants for air, Oil seal, Gas, etc. Sports Goods leathers like Football. Rugby ball, Volley ball, Hockey ball, Cricket Ball etc. Gloves leathers for wicket keepers, Batting, Boxing etc.

**Module-III:**

Light Leather: Full chrome retan, hunting suedes, softies, nappa, and burnishable Upper leathers, Printed, Shrunken grain and upholstery leathers, aircraft automotive leather, crazy horse

**Module-IV:**

Water proof and water repellent upper leather, Nubuk and white leather. E.I. tanning, dressing of E.I. tanned leathers in to upper, lining, Bag leather, leather for leather goods kattas, bunwar etc. Wet white pickle free leather.

**Module-V:**

Different types of leathers using chrome splits, Formulation and different dyestuffs, fat liquors, retaining agents.

**Module-VI:**

1. Manufacture of E.I. skins and rips manufacture of vegetable tanned sole leather by rapid tanning method.
2. Manufacture of Chrome and waxed sole leathers manufacture of waterproof sole leathers.
3. Processing of harness and saddlery leather.
4. Wet blue hides and skins and their assortment.
5. Full chrome and Chrome retain upper leathers.
6. Lining Leathers from different raw materials and tannages.
7. Shrunken grain leathers from different raw materials and tannages.
8. Book Binding leather from different raw materials and tannages.
9. Manufacture of aircraft automotive leather.

**References and suggested readings:**

1. Tuck, D.H., *"The Manufacture of Upper Leathers"*.
2. Sarkar, K.T., *"Theory and Practice of Leather Manufacture"*.

**Course contents and lecture schedule**

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>Heavy Leathers:</b>	
1.1	Finished leathers and composition of finishes,	01
1.2	tanned leathers semi-finished leathers wet blue-wet white properties	01
1.3	General practices in vegetable and chrome tanning.	01
1.4	Vegetable tanned sole leathers, Bag tanning,	01
1.5	Different types of finished leathers, Belting leathers, Harness and saddlery leathers	01
1.6	Chrome and waxed soles, picking band leathers	01
1.7	Picker and apron leathers,	01
1.8	Hydraulic and pneumatic leather such as hand pump leathers.	01
<b>2.</b>		
2.1	Leather for liquefaction plants for air, Oil seal, Gas, etc.	02
2.2	Sports Goods leathers like Football. Rugby ball, Volley ball, Hockey ball, Cricket Ball etc.	03
2.3	Gloves leathers for wicket keepers, Batting, Boxing etc.	02
<b>3.</b>	<b>Light Leather:</b>	
3.1	Full chrome retan leathers	01
3.2	Hunting suedes leathers	01
3.3	Softies & nappa leathers	02
3.4	Burnishable Upper leathers	01
3.5	Printed & Shrunken grain leathers	02
3.6	Upholstery leathers, aircraft automotive leather, crazy horse	02
<b>4.</b>		
4.1	Water proof and water repellent upper leather,	01
4.2	Nubuk and white leather. E.I. tanning, dressing of E.I. tanned leathers in to upper	02
4.3	Lining leather.	02
4.4	Bag leather.	02

4.5	Leather for leather goods kattas, bunwar, Wet white pickle free leather.etc.	02
<b>5.</b>		
5.1	Different types of leathers using chrome splits,	02
5.2	Formulation and different dyestuffs.	02
5.3	Fat liquors.	02
5.4	Retainning agents.	01
	<b>Total hours</b>	<b>40</b>

<b>6</b>	<b>Laboratory experiments</b>	
6.1	Manufacture of E.I. skins and rips manufacture of vegetable tanned sole leather by rapid tanning method.	06
6.2	Processing of harness and saddlery leather.	06
6.3	Manufacture of Chrome and waxed sole leathers manufacture of waterproof sole leathers.	06
6.4	Wet blue hides and skins and their assortment.	06
6.5	Full chrome and Chrome retain upper leathers.	06
6.6	Lining Leathers from different raw materials and tannages.	06
6.7	Shrunken grain leathers from different raw materials and tannages.	06
6.8	Book Binding leather from different raw materials and tannages.	06
	<b>Total hours</b>	<b>48</b>

## NLT 303: INORGANIC TANNAGES

**L T P C**  
**3 1 0 4**

<p><b>OBJECTIVE:</b> The objective of this course is to enable the students understand:</p> <ul style="list-style-type: none"> <li>• Behaviour of group elements, chromium, Aluminium, Zirconium, Iron, Titanium, Difference between salts of these elements</li> <li>• Mechanism of different tanning processes.</li> <li>• Theory of neutralization processes &amp; Principle and mechanism of Combination Tannage</li> <li>• Tanning behaviour of group elements</li> <li>• Basic concepts of Basicity, Masking, Olation, Polymerization &amp; Oxolation.</li> <li>• Principles of chemistry applied to transition elements</li> </ul>
---

### Course Outcome:

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand behaviour of group elements	Understand
<b>CO2</b>	Understand Chromium complexes and their structures & mechanism of chrome tanning	Understand
<b>CO3</b>	Understand mechanism of tanning of Aluminium, Zirconium.	Understand
<b>CO4</b>	Understand mechanism of tanning of, Iron, Titanium.	Understand
<b>CO5</b>	Understand Principle and mechanism of semi-chrome, chrome retanned and other combination tannages.	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO2</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO3</b>	3	2	–	–	–	–	–	–	–	–	–	–
<b>CO4</b>	2	2	–	1	–	–	2	–	–	–	–	–
<b>CO5</b>	1	–	2	–	–	–	2	–	2	–	–	1
<b>Average</b>	2.4	2	2	1	–	–	2	–	2	–	–	1

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)    If there is no correlation, put “-”

### Course Level Assessment Questions:

#### Course Outcome 1(CO1)

1. Werners co-ordination theory,
2. Behaviour of group elements,
3. Difference between salts.

#### Course Outcome 2(CO2)

1. Chromium complexes and their structures
2. Olation, oxolation, polymerisation of chrome complexes
3. Variable parameters of chrome tanning.

#### **Course Outcome 3(CO3)**

1. Aluminium Tanning
2. Zirconium Tanning
3. Masking principle of masking

#### **Course Outcome 4(CO4)**

1. Tanning behaviour of salts of Iron and Titanium
2. Theory of neutralization processes.
3. Affect of neutralization.

#### **Course Outcome 5(CO5)**

1. Principle and mechanism of semi-chrome
2. Chrome retanning.
3. Other combination tannages.
- 4.

## **SYLLABUS**

### **Module- I:**

#### **Theory & behaviour of group elements:**

Werners co-ordination theory, behaviour of group elements, chromium, Aluminium, Zirconium, Iron, Titanium, Difference between salts of these elements.

### **Module-II:**

#### **Chrome Tanning:**

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

### **Module-III:**

#### **Aluminium Tanning:**

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

#### **Zirconium Tanning:**

Tanning behaviour of salts of Zirconium, factors affecting Zirconium Tannage, mechanism of zirconium tannage,

### **Module-IV:**

Tanning behaviour of salts of Iron and Titanium, Tannages involving the use of Sodium silicate and poly phosphates. Metal free tanning, alternative tannage (Aldehyde, polyaldehyde tannage)

**Neutralization:** Theory of neutralization processes, affect of neutralization.

## Module-V:

### Combination Tannage:

Principle and mechanism of semi-chrome, chrome retanned and other combination tannages.

### References and other readings:

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

### Course contents and lecture schedule

Module No.	Topic	No. of Lectures
<b>1.</b>	<b>Theory &amp; behaviour of group elements.</b>	
1.1	Werners co-ordination theory	02
1.2	Behaviour of group elements, chromium, Aluminium, Zirconium, Iron, Titanium	04
1.3	Difference between salts of these elements.	03
<b>2.</b>	<b>Chrome Tanning:</b>	
2.1	Chromium complexes and their structures	02
2.2	Study on the phenomena of hydrolysis, olation, oxolation, polymerisation of chrome complexes	02
2.3	Masking principle of masking, affect of masking on chrome tannage	01
2.4	Method of chrome tannage,	02
2.5	Preparation of chrome liquors and powders	02
2.6	Influence of reducing agent on nature of chrome complexes	01
2.7	Mechanism of chrome tanning	02
2.8	Variable parameters of chrome tanning.	02
<b>3.</b>	<b>Aluminium Tanning &amp; Zirconium Tanning:</b>	
3.1	Tanning behaviour of salts of aluminium	01
3.2	Study on phenomena of olation, oxolation and masking in aluminium salts,	01
3.3	Tanning behaviour of salts of Zirconium	01
3.4	Factors affecting Zirconium Tannage	01
3.5	Mechanism of zirconium tannage,	01
<b>4.</b>	<b>Other Tanning &amp; Neutralization:</b>	
4.1	Tanning behaviour of salts of Iron and Titanium	02
4.2	Tannages involving the use of Sodium silicate and poly phosphates. Metal free tanning, alternative tannage (Aldehyde, polyaldehyde tannage)	02
4.3	Theory of neutralization processes	02
4.4	Affect of neutralization	02
<b>5.</b>	<b>Combination Tannage:</b>	
5.1	Principle and mechanism of semi-chrome	02
5.2	Chrome retanned	02
5.3	Other combination tannages.	02

<b>Total hours</b>	<b>40</b>
--------------------	-----------

**NLT-305: ORGANIC TANNAGES**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:** The objective of this course is to enable the students understand

- Concept of tanning.
- Hydrolysable & Condensed tannins.
- Synthetic tannins.
- Resin and Polymeric Tannages.
- Aldehyde tannage.
- The principles and process of vegetable tannage & synthetic tanning in leather processing.

**Course Outcome:**

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the classification & properties of tannins.	Understand
<b>CO2</b>	Understand the concept of Hydrolysable & Condensed tannins.	Understand
<b>CO3</b>	Understand the mechanism of tanning with syntans.	Understand
<b>CO4</b>	Understand the vegetable tanning & synthetic tannins.	Understand
<b>CO5</b>	Understand the Different aldehydes used for tanning	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	1	3	1	1		1					
<b>CO2</b>	3	1	3	1	1		1					
<b>CO3</b>	3	1	3	2	2		2					
<b>CO4</b>	3	1	3	1	1		3					
<b>CO5</b>	3	1	3	2	2		2	1				
<b>Average</b>	3	1	3	1.4	1.4		1.8	1				

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put “-”

**Course Level Assessment Questions**

**Course Outcome 1(CO1)**

1. Process of vegetable tanning
2. Properties and use of different types of syntans in leather manufacture

3. General chemistry of syntans.

**Course Outcome 2(CO2)**

1. Hydrolysable tannins.

2. Condensed tannins.

3. Biosynthesis of plant polyphenols.

**Course Outcome 3(CO3)**

1. Mechanism of vegetable tanning.

2. General chemistry of syntans.

3. Properties and use of different types of syntans.

**Course Outcome 4(CO4)**

1. Study different methylol compounds of nitrogen basis.

2. Properties of oil tanned leather.

3. Synthetic oil tanng.

**Course Outcome 5(CO5)**

1. Different aldehydes used for tanning.

2. Mechanism of tanning with formaldehyde glutaraldehyde.

3. Properties of leather tanned with different aldehydes.

**SYLLABUS**

**Module-I:**

**Collagen Tanning:** Concept of tanning, leather properties of dependent on tanning.

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

**Module-II:**

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

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

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

**Module-III:**

**Vegetable tanning:** Mechanism of vegetable tanning, factors affecting vegetable tannage, process of vegetable tanning.

**Synthetic tannins:** General chemistry of syntans; their classification, general methods of manufacture properties and use of different types of syntans in leather manufacture, mechanism of tanning with syntans.

**Module-IV:**

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

**Module-V:**

**Aldehyde tannage:** Different aldehydes used for tanning, mechanism of tanning with formaldehyde glutaraldehyde and starch dialdehydes, factors involved in tannages, properties of leather tanned with different aldehydes.

**Reference Book**

1. Sarkar, K.T., "*Theory and Practice of Leather Manufacture*".
2. Dutta. S.S., "*An Introduction to the Principles of Leather Manufacture*"
3. Wilson, J. A., "*The chemistry of Leather Manufactures*" Vol. II
4. Gustavson, K. H., "*The Chemistry of Tanning Process*"
5. Flaherty, Roddy, Lollar, "*The Chemistry and Technology of Leather*" Vol. II

**Course content and lecture Schedule**

Module No.	Topic	No. of Lectures
<b>1</b>	<b>Collagen Tanning &amp; Vegetable Tannins:</b>	
1.1	Concept of tanning, leather properties of dependent on tanning.	01
1.2	classification of vegetable tannins	01
1.3	classification of vegetable tannins	01
1.4	tanning materials and their properties	01
1.5	Leaching of vegetable tanning and general methods of tannin extract preparation.	01
<b>2</b>	<b>Hydrolysable tannins , Condensed tannins &amp; Biosynthesis of plant polyphenols:</b>	
2.1	chemistry of poly phenolic tannins present in major hydrolysable tanning material methods of separation of poly phenolic substance from tanning extracts	03
2.2	Structure of galotannins an ellagitannins.	01
2.3	Chemistry of flavonoid tannins present in major condensed tanning materials, methods of separation of monomeric flavonoid compounds from tanning extracts	02
2.4	Structure of galotannins an ellagitannins.	01
2.5	path ways for biosynthesis of gallotannins and ellagitannins in plant biosynthesis of flavonoids and condensed tannins	02
<b>3</b>	<b>Vegetable tanning &amp; Synthetic tannins:</b>	
3.1	Mechanism of vegetable tanning, factors affecting vegetable tannage, process of vegetable tanning.	02
3.2	General chemistry of syntans; their classification, general methods of manufacture properties and use of different types of syntans in leather manufacture, mechanism of tanning with syntans.	03

<b>4</b>	<b>Resin and Polymeric Tannages &amp; Oil Tanning:</b>	
4.1	study different methylol compounds of nitrogen basis and polymeric compounds used in leather manufacture	02
4.2	Methods of oil tannage, properties of oil tanned leather, mechanism of oil tannage, factor involved in oil tannage, synthetic oil tanng	02
<b>5</b>	<b>Aldehyde tannage:</b>	
5.1	Different aldehydes used for tanning	02
5.2	Mechanism of tanning with formaldehyde glutaraldehyde and starch dialdehydes	02
5.3	Factors involved in tannages	02
5.4	Properties of leather tanned with different aldehydes.	01
	<b>Total hours</b>	<b>30</b>

## NCT-307 MASS TRANSFER OPERATIONS

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Objectives:** The Mass Transfer Operations course aims to provide students with an understanding of the principles, processes, and equipment involved in mass transfer operations. Upon completion of the course, students should be able to:

1. Understand the fundamental principles of mass transfer, including diffusion, convection, and mass transfer coefficients.
2. Analyze mass transfer processes in various unit operations such as distillation, absorption, extraction, and drying.
3. Design and optimize mass transfer equipment such as packed and trayed columns, liquid-liquid extraction units, and drying equipment.
4. Apply mathematical models and simulations to predict and optimize mass transfer processes, including heat and mass transfer coefficients, mass transfer rates, and system performance.

*Course outcomes:*

CO 1	Understand the basic principles and laws of mass transfer, Calculation of rate of mass transfer	Understand & Evaluate
CO 2	Analyze the mass transfer concepts and apply them for Absorption and Distillation processes to evaluate different process parameters	Analyze, Apply & Evaluate
CO 3	Analyze the mass transfer concepts and apply them for LLE and SLE processes to evaluate different process parameters	Analyze, Apply & Evaluate
CO 4	Analyze the mass transfer concepts and apply them for Humidification and Drying processes to evaluate different process parameters	Analyze, Apply & Evaluate
CO 5	Analyze the mass transfer concepts and apply them for Adsorption, Membrane separation and Crystallization processes to evaluate different process parameters	Analyze, Apply & Evaluate

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs	
CO1	3	2	2	1	-	-	-	-	-	1		1		
CO2	3	2	1	1	-	-	-	-	-	1		1		
CO3	3	2	3	2	3	-	-	-	-	1		1		
CO4	3	3	2	2	3	-	-	-	-	1		1		
CO5	3	3	3	3	2	-	-	-	-	1		1		
Avg	3	2.4	2.2	1.8	2.7	0	0	0	0	1	0	1		

## **Syllabus**

### **Module I (6 hours)**

Concept of Mass Transfer, Diffusion: Steady-state molecular diffusion: Fick's law of diffusion; Equimolar counter diffusion; Stagnant film diffusion, Diffusion coefficients: Film theory; Penetration theory; surface-renewal theory; film-penetration theory, Two-film theory. Concept of interphase /mass transfer, Analogies in mass transfer.

### **Module II (6 hours)**

Absorption and Stripping: Gas-liquid equilibrium, Henry's law, Selection of solvent, calculation of number of stages and Equipments used in Absorption and Stripping

Distillation: Equilibrium diagrams for ideal and non-ideal solutions; Relative volatility, Flash Distillation-Differential distillation, McCabe Thiele method, for determining number of stages & Equipments for Distillation

### **Module III (6 hours)**

Liquid-Liquid Extraction (LLE): Applications; Ternary liquid-liquid equilibria; Triangular graphical representation; solution of single and multistage operation. Solid-Liquid Extraction: Applications; Solid-liquid equilibrium; Equipments used for single stage and multistage continuous operations in LLE & Leaching

### **Module IV (6 hours)**

Humidification and Dehumidification: Vapor pressure temperature curve and Fundamental concepts  
Drying: Solid-gas equilibrium, Definitions of moisture contents, Different modes of drying operations, Rate and mechanism of batch drying, Time of drying, Classification of Cooling Towers and Dryers

### **Module V (6 hours)**

Adsorption: Concept and application of adsorption, Nature of adsorbents; Adsorption isotherms and adsorption hysteresis; Number of Stages and Equipment used in adsorption. Introduction to membrane separation processes, Introduction to Carbon Capture Technology, Crystallization: Concept and laws; Supersaturation, Nucleation & Crystal growth; Types of crystallization; Equipments used for crystallization.

### **Text Books**

1. R.E. Treybal, "Mass Transfer Operations", 3rd ed. New York: McGraw-Hill, 2017.
2. B. K. Dutta, "Principles of Mass Transfer and Separation Processes", 8th Printing, PHI Learning Private Limited, 2015
3. W. L. McCabe, J. C. Smith, P. Harriott, "Unit Operations of Chemical Engineering", McGraw-Hill, VII International edition, 2005.

### **Reference Books**

1. T. K., Sherwood, R. L. Pigford, and C.R. Wilke, "Mass Transfer" McGraw Hill, 1975.
2. C.J. Geankoplis, "Transport Processes and Separation Process Principles", 4th ed., PHI Learning Private Limited, New Delhi, 2012.
3. J.D. Seader, and E.J., Henley, "Separation Process Principles", 2nd ed., Wiley India Pvt. Ltd., New Delhi, 2013.
4. S. Foust, "Principles of Unit Operations", 2nd Ed., Wiley, 1980.
5. P.C., Wankat "Separation Process Engineering", Prentice Hall, III edition, 2011.

### **Web-Links**

<https://archive.nptel.ac.in/courses/103/103/103103145/>

<https://archive.nptel.ac.in/courses/103/103/103103154/>

## NCT-309 CHEMICAL REACTION ENGINEERING

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Objective:** To apply knowledge from calculus, differential equations, thermodynamics, general chemistry, and material and energy balances to solve reactor design problems, To examine reaction rate data to determine rate laws, and to use them to design chemical reactors, To simulate several types of reactors in order to choose the most appropriate reactor for a given need, To design chemical reactors with associated cooling/heating equipment.

**Course Outcomes:**

CO 1	To develop an understanding of the basic concepts involved in using reaction rate equations and kinetic constants	Understand, Apply
CO 2	To Perform derivations of rate equations for non-elementary reactions both in homogenous and in heterogeneous reacting systems	Apply
CO 3	To understand the role of temperature and concentration in the rate equation	Understand
CO 4	To Perform constant volume batch reactor calculations	Apply
CO 5	To Develop calculations using the integral method and applying differential method of analysis using reactions with different orders	Understand, Apply

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs	
CO1	3	2	3	-	-	-	-	-	-	1	-	1		
CO2	3	3	3	1	-	-	-	-	-	1	-	1		
CO3	3	3	3	2	-	-	-	-	-	1	-	2		
CO4	3	3	1	-	2	-	-	-	-	1	-	2		
CO5	3	3	2	2	2	-	-	-	-	1	-	2		
Avg.	3	2.8	2.4	1.7	2	0	0	0	0	1	0	1.6		

## **Syllabus**

### **Module I (6 hours)**

Rate of Reaction, Elementary and non-elementary homogeneous reactions, Molecularity and order of reaction, Introduction of Arrhenius, collision, and transition theories. Integral and differential methods for analyzing kinetic data, interpretation of constant volume reactor, zero, first, and second, half-life period, irreversible reaction in series, auto catalytic reaction, reversible reactions.

### **Module II (6 hours)**

Interpretation of variable volume batch reactions for zero, first and second order reactions, Space-time and state-velocity, design equation for ideal batch, steady-state continuous stirred tank, steady-state plug flow reactors for isothermal reaction.

### **Module III (6 hours)**

Design for single reactions, Size comparison of single reactors, Multiple reactor systems, plug flow/mixed flow reactors in series and parallel, reactors of different types in series, recycle reactor, autocatalytic reactions.

### **Module IV (6 hours)**

Introduction to multiple reactions, yield, selectivity, qualitative discussion about product distribution, optimum temperature progression. Introduction of heterogeneous catalyst preparation and kinetics. kinetics of enzyme reactions (Michaelis-Menten and Monod models).

### **Module V (6 hours)**

Residence time distribution of fluids in vessels, State of aggregation of the flowing systems, Earliness of mixing, Role of RTD, State of Aggregation and earliness of mixing in determining reactor behavior, E, F and C curves, Conversion in Non-ideal flow reactors.

### **Text Book:**

1. Levenspiel, O., "Chemical Reaction Engineering", 3rd edition, John Wiley 2006.

### **Reference Books**

1. H. Scott Folger, "Elements of Chemical Reaction Engineering" 6<sup>th</sup> Edition, Prentice Hall, 2021.
2. J. M. Smith, "Chemical Engineering Kinetics", 3<sup>rd</sup> Edition, McGraw-Hill chemical engineering series, 1981.

### **Web Links**

<https://archive.nptel.ac.in/courses/103/103/103103153/>  
<https://archive.nptel.ac.in/courses/103/101/103101141/>

## NLT- 311 ADVANCE POST TANNING & FINISHING OPERATIONS

L T P C  
3 0 0 3

<p><b>OBJECTIVE:</b> The objective of this course is to enable the students understand:</p> <ul style="list-style-type: none"> <li>• Chemistry of Polymers</li> <li>• Theory of Drying Oil, Fatty acids, structure of glycerides etc.</li> <li>• Theory and chemistry of Natural resins.</li> <li>• Theory and chemistry of Synthetic resins .</li> <li>• Methods of preparation of the following finishing materials</li> </ul>
--

**Course Outcome:**

On the successful completion of the course, students will be able to understand:

<b>CO1</b>	Understand Chemistry of polymers	Understand
<b>CO2</b>	Understand Theory & mechanism of Drying Oil, Fatty acids, structure of glycerides etc.	Understand
<b>CO3</b>	Understand Theory and chemistry of Natural resins.	Understand
<b>CO4</b>	Understand Theory and chemistry of Natural resins.	Understand
<b>CO5</b>	Understand the methods of preparation of the following finishing materials	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO2</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO3</b>	3	2	–	–	–	–	–	–	–	–	–	–
<b>CO4</b>	2	2	–	1	–	–	2	–	–	–	–	–
<b>CO5</b>	1	–	2	–	–	–	2	–	2	–	–	1
<b>Average</b>	2.4	2	2	1	–	–	2	–	2	–	–	1

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)    If there is no correlation, put “-”

### Course Level Assessment Question

**Course Outcome 1(CO1)**

1. Structure and properties of polymers
2. Fundamentals of polymer formations
3. Addition & condensation of polymers

**Course Outcome 2(CO2)**

1. Theory of drying oils
2. Structure of glycerides, linseed oils
3. Film formation by oxidation

**Course Outcome 3(CO3)**

1. Theory of natural resins
2. Resin & Resin derivatives
3. Copals, shellac, other natural resins.

### Course Outcome 4(CO4)

1. Theory of Synthetic resins
2. Polyesters, alkyds, maleic resins, unsaturated polyester resins
3. Binders, silicone, polyethylene, poly vinyl chlorides

### Course Outcome 5(CO5)

1. Nitrocellulose lacquers
2. Solvents, plasticizers, pigments, inorganic, organic
3. toxicity, fire hazards

## SYLLABUS

### Module I

Structure & properties of polymers, molecular weight of polymers, fundamentals of polymer formations, addition & condensation of polymers.

### Module II

Drying oils: - fatty acids, structure of glycerides, linseed oils, stand oils, bloom oils, sulfurized oil, tung oil, castor oil, vegetable oils, tall oils, fish oil, film formation by oxidation.

### Module III

Natural resins: - Resin & Resin derivatives, production of Resin, properties of Resin, copals, shellac, other natural resins.

### Module IV

Synthetic resins: - Polyesters, alkyds, maleic resins, unsaturated polyester resins, phenolic resins, amino resins, urea resins, melamine resins, epoxide resins, urethane binders, silicone, polyethylene, poly vinyl chlorides, polyacrylates, styrene butadiene.

### Module V

Nitrocellulose, solvents, plasticizers, pigments, inorganic, organic, toxicity, fire hazards.

### References and suggested readings

1. S.S. Dutta, "An Introduction to the Principles of Leather Manufacture".
2. K.T. Sarkar, "Theory & Practice of Leather Manufacture".
3. Paul nylen and Edward sunderland, "Modern Surface Coatings".

### Course contents and lecture schedule

Module No.	Topic	No. of Lectures
<b>1.</b>	<b>Polymers :</b>	
1.1	rs	01
1.2	Structure & properties of polymers	02
1.3	Molecular weight of polymers	01
1.4	Fundamentals of polymer formations	02
1.5	Addition of polymers	01
1.6	Condensation of polymers	01
<b>2.</b>	<b>Drying oils :</b>	
2.1	Fatty acids	01
2.2	Structure of glycerides	01
2.3	Linseed oils and stand oils	01
2.4	Bloom oils and sulfurized oil	01

2.5	Tung oil and castor oil,	01
2.6	Vegetable oils	01
2.7	Tall oils and fish oil	01
2.8	Film formation by oxidation	02
<b>3.</b>	<b>Natural Resins :</b>	
3.1	Natural resins	01
3.2	Rosin & Rosin derivatives	02
3.3	Production and properties of Rosin	02
3.4	Copals	01
3.5	Shellacs	01
3.6	Other natural resins	01
<b>4.</b>	<b>Synthetic Resins :</b>	
4.1	Acrylic resins	01
4.2	Epoxy resins, alkyds, maleic resins, unsaturated polyester resins	02
4.3	Urea resins, amino resins, urea resins, melamine resins	02
4.4	Phenolic resins, urethane binders, silicone	02
4.5	Styrene, poly vinyl chlorides, polyacrylates, styrene butadiene	02
<b>5</b>	<b>Toxicity &amp; fire hazard:</b>	
5.1	Nitrocellulose, solvents	01
5.2	Paints, pigments	01
5.3	Inorganic, organic	01
5.4	Toxicity & fire hazards	01
<b>Total hours</b>		<b>40</b>

## NHS 301: ENTREPRENEURSHIP

### Course Outcomes (COs)

**L T P C**  
**2 0 0 2**

1. Develop understanding of basics of entrepreneurship.
2. Apply the beginner's concept, ownership and various forms
3. Identify opportunities using identification; project conceptualisation, formulation & evaluation.
4. Learn , apply and evaluate the project financing and working capital management
5. Evaluate the role of Institution support and policy framework of Government for entrepreneurship development in India.

### CO-PO Mapping

Co/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	0	0	0	0	1	1	0	0	1	2
CO2	0	0	0	0	0	0	1	1	0	0	2	2
CO3	0	0	0	0	0	0	1	1	0	0	3	2
CO4	0	0	0	0	0	0	1	1	0	0	3	2
CO5	0	0	0	0	0	0	1	1	0	0	3	2

#### **UNIT I Entrepreneurship:**

Entrepreneur and manager, Growth of entrepreneurship in India, Government's policy actions towards entrepreneurial motivation, entrepreneurship development programmes.

#### **UNIT II Business Enterprises and Ownership Structure:**

Small scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, companies and co-operatives firms: their formation,

#### **UNIT III Project Management:**

Identification and selection of projects; project report: contents and formulation, project evaluation, method

#### **UNIT IV Project Financing and Working Capital Management:**

Cost of Project, Capital Structure Planning, Sources of long term financing, Working Capital Management

#### **UNIT V Institutional Support and Policies:**

Institutional support towards the development of entrepreneurship in India: technical consultancy organizations (TCOs), government policies for small scale enterprises.

#### **Text Books:**

1. **Khanka, S S.** 'Entrepreneurial Development', S Chand & Company Ltd. New Delhi
2. **Desai, Vasant,** 'Project Management and Entrepreneurship', Himalayan Publishing House, Mumbai, 2002.

#### **Additional Reference Books**

1. **Gupta and Srinivasan,** 'Entrepreneurial Development', S Chand & Sons, New Delhi.
2. **Ram Chandran,** 'Entrepreneurial Development', Tata McGraw Hill, New Delhi
3. **Saini, J. S.** 'Entrepreneurial Development Programmes and Practices', Deep & Deep Publications (P), Ltd
4. **Holt, Davis,** 'Entrepreneurship : New Venture Creations, PHI

## SEMESTER- VI

### NCT-302 INSTRUMENTATION & PROCESS CONTROL

**L T P C**  
**3 0 2 4**

**Course Objective:** Objective is to introduce the fundamentals of process control, controllers, stability and frequency response along with different process instruments used in chemical industries. The course will teach the students, how to obtain dynamic response of closed loop systems, stability analysis in transient and frequency domains. The course will also introduce about the instruments used for measurement of temperature, pressure, flow, level, viscosity.

CO1	Introduction to process control and controllers along with open and closed loop systems	Understand, Apply
CO2	Transient response of simple control systems	Apply, Evaluate, analyze
CO3	Concept of stability and frequency response, control system design by frequency response	Analyze, Evaluate, Design
CO4	Understand the principles involved in measurements. knowledge on different measurement methods employed in industrial process units	Understand, Apply, Evaluate, analyze
CO5	Application of different measurement devices in Chemical allied industries	Apply, evaluate, analyze
CO6	Conduct various experiments to apply the concepts of fluid mechanics and unit operations.	Apply, Evaluate, analyze

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs	
CO1	3	3	2	2	1	-	-	-	-	1	-	2		
CO2	3	3	3	2	1	-	-	-	-	1	-	2		
CO3	3	3	3	3	1	-	-	-	-	-	-	2		
CO4	3	1	1	-	1	-	-	-	-	1	-	2		
CO5	3	2	1	1	1	-	-	-	-	1	-	2		
Avg	3	2.4	2	2	1	0	0	0	0	1	0	2		

### Syllabus

#### Module 1 (6 hours)

Introduction to Process control systems, Use of Laplace & Inverse Laplace Transformation in study of Process Dynamics & Control. Dynamic Modeling of a Process, Dynamic behavior of

First order system. First order systems in series, Second and higher order systems for various kind of inputs, Linearization of nonlinear systems, Transportation & Transfer Lag.

**Module 2 (6 hours)**

Classification of control systems, Regulator & Servo control, Feed Forward & Feed backward control, Negative & Positive Feedback Control, Controllers & Final control Elements, Reduction of Block & Signal Flow Diagrams, P, PI, PD and PID controller, Response of control system with these controllers

**Module 3 (6 hours)**

Concept of stability, Stability Criterion, Routh test for stability, Introduction to frequency response, Introduction to control system design by frequency response (Bode Plot, Zeigler Nichols controller settings), Introduction to Controller Tuning.

**Module 4 (6 hours)**

Principles of measurements and classification of process control instruments, Functional elements of an instrument, Static & Dynamic Characteristics of instruments, Transducers, Error analysis, Measurement of temperature: expansion thermometers, Resistance Thermometers, thermocouples, Thermistors, Pyrometers.

**Module 5 (6 hours)**

Flow measurement instruments, Concentration Measuring Instruments, Level measurement; float types- hydrostatic types, thermal effect types, electrical methods and solid level measurement. Pressure Measurement: Manometers, measurement of vacuum.

**List of Experiment**

1. To calibrate and study the response of bimetallic thermometer.
2. To study the response of a liquid level tank system.
3. To calibrate the P/I converter.
4. To calibrate the given manometer for level measurement.
5. To study and calibrate diaphragm control valve.
7. To study the response of first order system in series using two tank liquid level system (Non-interacting system) to step input.
8. To study the response of first order system in series using two tank liquid level system (interacting system).
9. To calibrate a thermocouple using a glass bulb thermometer.
10. To assess the accuracy of a pressure gauge with a dead weight gauge tester.

**Text Books**

1. Coughnour and Koppel, "Process Systems Analysis and Control", McGraw-Hill, New York, 3<sup>rd</sup> Edition, 2017.
2. George Stephanopolous, "Chemical Process Control ", Prentice-Hall of India Pvt-Ltd., New Delhi, 2015.
- 3 Eckman, D.P., "Industrial Instrumentation", Wiley Eastern Ltd., New York, 1990

**Reference Books:**

1. Singh, S. K. , "Industrial Instrumentation and Control" , Prentice Hall of India, 2016

Web Links:

<https://archive.nptel.ac.in/courses/103/105/103105064/>

<https://archive.nptel.ac.in/courses/103/105/103105130/>

## NLT-304: PROCESSING OF LEATHER-II

**L T P C**  
**3 0 2 4**

<p><b>OBJECTIVE:</b> The objective of this course is to enable the students understand</p> <ul style="list-style-type: none"> <li>• Manufacturing of Different types of goat upper leather.</li> <li>• Manufacturing of Different types of goat dressing leather.</li> <li>• Manufacturing of Different types of sheep leather.</li> <li>• Manufacturing of Different types of fur leather.</li> <li>• Up gradation of leather.</li> <li>• Processing of light leather &amp; fashionable leather</li> </ul>
---

**Course Outcome:**

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the Manufacturing of Different types of goat upper leather.	Understand
<b>CO2</b>	Understand the Manufacturing of Different types of goat dressing leather	Understand
<b>CO3</b>	Understand Manufacturing of Different types of sheep leather	Understand
<b>CO4</b>	Understand the processing of hair on tanning.	Understand
<b>CO5</b>	Up gradation of leather by different finishing technique.	Understand
<b>CO6</b>	Apply knowledge of processing of leather.	Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3											
<b>CO2</b>	3	2	2									
<b>CO3</b>	3	2	2									
<b>CO4</b>	3	2										
<b>CO5</b>	3	2	2			1		1				
<b>CO6</b>	3	2	3	2		2	1		2			1
<b>Average</b>	3	2	2.2	2		1.5	1	1	2			1

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)    If there is no correlation, put “-”

**Course Level Assessment Questions**

**Course Outcome 1(CO1)**

1. Glazed kid.
2. Glazed uppers, shoe suede.
3. Garment suede, lining leathers

**Course Outcome 2(CO2)**

1. Chamois leathers
2. Printed leathers
3. Dressing into different types of leathers

**Course Outcome 3(CO3)**

1. Vegetable tanning and chrome tanning of sheep skins
2. Conversion into different types of finished leathers-sheep nappa garment.
3. Lining leathers, glove leathers.

**Course Outcome 4(CO4)**

1. Reptile leathers
2. hair on tanning
3. Dressing of fur skins

**Course Outcome 5(CO5)**

1. Special finishing effects for up gradation of leather.
2. Embossing, screen printing block printing.
3. Roller coating and other modern equipment's.

**Course Outcome 6(CO6)**

1. Preparation of Different types of leathers using wet Blue Cow and Buffalo hides, calf skins.
2. Preparation of Different types of leathers using wet Blue of Goat and Sheep skins.
3. Application of Different types of leathers.

**SYLLABUS****Module-I: Goat skins**

Glazed kid, resin uppers, glazed uppers, shoe suede, garment suede, lining leathers.

**Module-II:**

Chamois leathers, printed leathers, morocco and book binding leathers, E.I. Goat skins and their dressing into different types of leathers.

**Module-III: Sheep Skins**

Vegetable tanning and chrome tanning of sheep skins, conversion into different types of finished leathers-sheep nappa, garment, suede, uppers. Lining leathers, glove leathers, diaphragm leathers.

**Module-IV: Exotics and others**

Reptile leathers, hair on tanning and dressing of fur skins.

### Module-V: Upgrading of leathers

Retanning special finishing effects for up gradation of lower ends like Embossing, screen printing block printing, transfer film finishing, seal and Sink finish, popcorn effect, punching etc. Roller coating and other modern equipment's, Burnishable and oil pull up leathers. Laminated leather and synthetic leather.

### Module-VI : Laboratory experiments

Different types of leathers using Raw / wet Blue/ E.I. of Cow and Buffalo hides, calf skins. Different types of leathers using Raw / wet Blue of Goat and Sheep skins. Vegetable tanned sole leather, Chrome tanned sole leather, Belting leather, Cycle saddle leathers, Picking band leathers, Picker, Apron leather, Football leather, Cricket ball leathers, Volley ball leathers, Upholstery leathers, E.I. Kips , Upper leathers from different raw materials and tannages.

### References and suggested readings:

1. Dey, J.M. "*Practical Aspects of the manufacture of upper leathers*".
2. Tuck, D.H. "*The Manufacture of upper leathers*".
3. Dutta. S.S., "*An Introduction to the Principles of Leather Manufacture*".
4. Sarkar K.T., "*Theory & Practice of Leather Manufacture*".

### Course Content and lecture Schedule

Module No.	Topic	No. of Lectures
<b>1</b>	<b>Goat skins:</b>	
1.1	Process for manufacturing of Glazed kid leather.	01
1.2	Process for manufacturing of resin uppers leather.	01
1.3	Process for manufacturing of glazed uppers leather.	01
1.4	Process for manufacturing of shoe suede leather.	01
1.5	Process for manufacturing of garment suede leather.	01
1.6	Process for manufacturing of Lining leathers.	01
<b>2</b>		
2.1	Process for manufacturing of Chamois leathers.	02
2.2	Process for manufacturing of printed leathers.	01
2.3	Process for manufacturing of Morocco and book binding leathers	01
2.4	Process for manufacturing of E.I. Goat skins and their dressing into different types of leathers.	01
<b>3</b>	<b>Sheep Skins:</b>	
3.1	Vegetable tanning and chrome tanning of sheep skins conversion into	02

	different types of finished leathers.	
3.2	Process for manufacturing of sheep nappa, garment.	02
3.3	Process for manufacturing of suede uppers.	01
3.4	Process for manufacturing of Lining leathers.	01
3.5	Process for manufacturing of glove leathers.	01
3.6	Process for manufacturing of diaphragm leathers.	01
3.7	Process for manufacturing of garment suede.	01
<b>4</b>	<b>Exotics and others:</b>	
4.1	Reptile leathers	02
4.2	hair on tanning	02
4.3	dressing of fur skins.	02
<b>5</b>	<b>Upgrading of leathers:</b>	
5.1	Retanning special finishing effects for up gradation of lower ends like Embossing.	01
5.2	Special finishing effects for up gradation of lower ends like screen printing	01
5.3	Special finishing effects for up gradation of lower ends like block printing,	01
5.4	Special finishing effects for up gradation of lower ends like transfer film finishing,	01
5.5	Special finishing effects for up gradation of lower ends like seal and Sink finish.	01
5.6	Special finishing effects for up gradation of lower ends like popcorn effect, punching etc.	01
5.7	Roller coating and other modern equipment's.	02
5.8	Burnishable and oil pull up leathers, laminated leather and synthetic leather.	02
	<b>Total hours</b>	<b>30</b>
<b>6</b>	<b>Laboratory experiments</b>	
6.1	Preparation of Different types of leathers using Raw / wet Blue/ E.I. of Cow and Buffalo hides, calf skins.	9
6.2	Preparation of Different types of leathers using Raw / wet Blue of Goat and Sheep skins.	9
6.3	vegetable tanned sole leather	3
6.4	Chrome tanned sole leather	3
6.5	Belting leather	3
6.6	Cycle saddle leathers	3
6.7	Picking band leathers & Picker	3
6.8	Apron leather	3
6.9	Foot ball leather, Cricket ball leathers & Volley ball leathers	3
6.10	Upholstery leathers	3
6.11	E.I. Kips , Upper leathers from different raw materials and tannages.	3
	<b>Total hours</b>	<b>45</b>
	<b>Grand hours</b>	<b>75</b>

## NLT-306: TANNERY EFFLUENT TREATMENT

**L T P C**  
**3 0 0 3**

<p><b>OBJECTIVE:</b> The objective of this course is to enable the students</p> <ul style="list-style-type: none"> <li>To understand types of water pollution.</li> <li>To know Types of tannery effluents, characteristics of effluents.</li> <li>To know primary &amp; secondary treatments.</li> <li>To know effluent disposal and specification for industrial effluent discharge.</li> <li>To understand solid waste management.</li> </ul>
--

### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand types of water pollution.	Understand
<b>CO2</b>	Understand Types of tannery effluents, characteristics of effluents.	Understand
<b>CO3</b>	Understand primary & secondary treatment systems.	Understand
<b>CO4</b>	Understand effluent disposal and specification for industrial effluent discharge	Understand
<b>CO5</b>	Understand recovery and reuse of water in tanning Industry.	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO 1</b>	3						1					
<b>CO 2</b>	3						2					
<b>CO 3</b>	3	1				1	1					
<b>CO 4</b>	3	1	2	2		2	2					
<b>CO 5</b>	3	2	2	3	3	2	2	2	1			3
<b>Ave rage</b>	3	1.3	2	2.5	3	1.6	1.6	2	1			3

1: Slight (Low)  
*correlation, put “-”*

2: Moderate (Medium)

3: Substantial (High)

*If there is no*

### **Course Level Assessment Questions**

#### **Course Outcome 1 (CO1)**

1. Types of water pollution
2. Physical, chemical, physiological and biological pollutants,
3. Pollution effects

#### **Course Outcome 2(CO2)**

1. Characteristics of effluents from Beam House Process,
2. Characteristics of effluents from tan yard process and finishing yard process.
3. Estimation of OD. BOD, COD

#### **Course Outcome 3 (CO3)**

1. Waste water drainage and collection system in tanneries
2. Primary treatment unit.
3. Trickling filter, design criteria.

#### **Course Outcome 4 (CO4)**

1. Types of effluent disposal.
2. Indian Standards.
3. Specification for industrial effluent discharge.

#### **Course Outcome 5(CO5)**

1. Recovery and reuse of water in tanning Industr
2. Utilization of treated effluents
3. Solid wastes from tanneries origin and disposal.

### **SYLLABUS**

#### **Module-I:**

**Pollution:** Types of water pollution, physical, chemical, physiological and biological pollutants, pollution effects of land ground after, surface water, aquatic life and sea.

#### **Module-II:**

**Tannery Effluents:** Types of tannery effluents, characteristics of effluents from Beam House Process, tan yard process and finishing yard process- Estimation of OD. BOD, COD, heavy metals (Ca, Cr, Pb and Hg) and total dissolved solids in waste water.

#### **Module-III:**

**Primary treatments:** Waste water drainage and collection system in tanneries, screens, equalization of waste water, primary treatment unit.

**Secondary Treatment Systems:** Lagoon treatment, aeration systems, trickling filter, design criteria, Biotechnology in effluent and disposals.  
ZLD, Electro coagulation, UV etc.

**Module-IV:**

**Effluent Disposal:** Types of effluent disposal, standards and specification Indian Standards, specification for industrial effluent discharge.

**Module-V:**

**Water for Tanning:** Water for tanning process, recovery and reuse of water in tanning Industry, utilization of treated effluents.

**Solid Waste Management:** Solid wastes from tanneries origin and disposal, utilization sludge disposal from treatment system.

**Reference Books and Suggested Readings :**

1. Metcalf and Eddy, "Wastewater Engineering (treatment Disposal Reuse)".
2. Steel, E.W. & Meghee J.T., "Water Supply and Sewerage".
3. Hardenbergh, W.A. & Rodie, E.R., "Water Supply and Waste Disposal".
4. Chambolle, "Environment & Tannery".
5. Dutta. S.S., "An Introduction to the Principles of Leather Manufacture".

**Course contents and lecture schedule**

Module No.	Topic	No. of lectures
<b>1.</b>	<b>Pollution:</b>	
1.1	Types of water pollution	01
1.2	Physical & chemical pollutants	02
1.3	Physiological and biological pollutants	02
1.4	Pollution effects of land ground after, surface water, aquatic life and sea.	02
<b>2.</b>	<b>Tannery Effluents:</b>	
2.1	Types of tannery effluents	02
2.2	Characteristics of effluents from Beam House Process,	03
2.3	Characteristics of effluents from tan yard process.	02
2.4	Characteristics of effluents from finishing yard process.	02
2.5	Estimation of OD. BOD, COD, heavy metals(Ca, Cr, Pb and Hg) and total dissolved solids in waste water	03
<b>3.</b>	<b>Primary &amp; secondary treatment systems:</b>	
3.1	Waste water drainage and collection system in tanneries, screens.	02
3.2	Equalization of waste water, primary treatment unit.	02
3.3	Lagoon treatment, aeration systems,	02
3.4	Trickling filter, design criteria,	01
3.5	Biotechnology in effluent and disposals	01
3.6	ZLD, Electro coagulation, UV etc.	02
<b>4.</b>	<b>Effluent Disposal:</b>	
4.1	Types of effluent disposal	03

4.2	standards and specification Indian Standards	02
4.3	specification for industrial effluent discharge	02
<b>5.</b>	<b>Water for Tanning &amp; Solid Waste Management:</b>	
5.1	Water for tanning process, recovery and reuse of water in tanning Industry.	02
5.2	Utilization of treated effluents.	02
5.3	Solid wastes from tanneries origin and disposal.	02
5.4	Utilization sludge disposal from treatment system.	02
<b>Total hours</b>		<b>40</b>

## NLT-308: LEATHER ANALYSIS AND QUALITY CONTROL

**L T P C**  
**2 0 1 3**

- OBJECTIVE:** The objective of this course is to enable the students understand
- Principles and methods of analysis of limed and pickled pelt
  - chemical testing of vegetable tanned/chrome tanned
  - Physical Testing of Leather
  - Quality control in leather processing
  - Instrument Analysis.

### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the Chemical analysis of pelts and Leathers	Understand
<b>CO2</b>	Understand the Physical Testing of Leather	Understand
<b>CO3</b>	Principle involved in Static and Dynamic methods of non destructive testing of leathers	Understand
<b>CO4</b>	Understand the Standards and quality Control	Understand
<b>CO5</b>	Understand the Instrument Analysis	Understand
<b>CO6</b>	Analysis of chrome tanning agents & Physical testing of heavy and light leather.	Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO2</b>	3	2	2	–	–	–	–	–	–	–	–	–
<b>CO3</b>	3	2	2	–	–	–	–	–	–	–	–	–
<b>CO4</b>	3	2	–	–	–	–	–	–	–	–	–	–
<b>CO5</b>	3	2	2	–	–	1	–	1	–	–	–	–
<b>CO6</b>	3	2	3	2	–	2	1	–	2	–	–	1
<b>Average</b>	3	2	2.2	2	–	1.5	1	1	2	–	–	–

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put “–”*

### Course Level Assessment Questions

### **Course Outcome 1(CO1)**

1. Principles and methods of analysis of limed and pickled pelt,
2. Chemical testing of vegetable tanned, chrome tanned etc.
3. Chemical testing of combination tanned leathers.

### **Course Outcome 2(CO2)**

1. Sampling position.
2. Physical testing of leather.
3. Different methods employ for physical testing of leather

### **Course Outcome 3(CO3)**

1. Principle involved in Static methods of nondestructive testing of leathers.
2. Principle involved in Dynamic methods of nondestructive testing of leathers.
- 3 Different methods in testing of color fastness of leathers.

### **Course Outcome 4(CO4)**

1. Quality control in leather processing
2. Rectification of defects in hides, Skin and Leathers
3. Physical and chemical characteristics of various types of leathers.

### **Course Outcome 5(CO5)**

1. Potentiometry.
2. Non-aqueous titrations.
3. Spectrophotometry and colorimetry.

### **Course Outcome 6(CO6)**

1. Testing of chrome tanning agents.
- 2 Chemical analysis of vegetable tanned/chrome tanned
3. Physical testing of heavy and light leather

## **SYLLABUS**

### **Module-I:**

Chemical analysis of pelts and Leathers: Principles and methods of analysis of limed and pickled pelt, chemical testing of vegetable tanned/chrome tanned/aluminum tanned/zirconium tanned/formaldehyde tanned, combination tanned leathers.

### **Module-II:**

**Physical Testing of Leather:** Sampling position for physical testing of leather. Different methods employ for physical testing of leather.

### Module-III:

Principle involved in Static and Dynamic methods of nondestructive testing of leathers. Different methods in testing of color fastness of leathers. Standards for metal free leather (ISO), Fire retardancy, Reach standards for leather, top coat soil resistance.

### Module-IV:

**Standards and quality Control:** Quality control in leather processing, Rectification of defects in hides, Skin and Leathers, control of yield, color and finish of leather etc. Physical and chemical characteristics (standard specifications) of various types of leathers.

### Module-V:

**Instrument Analysis:** Potentiometry, non-aqueous titrations, conductometry chromatography, spectrophotometry and colorimetry, ion-exchange resins, electrophoresis. Principles and their application analysis.

### Module-VI:

#### Laboratory Experiments

Analysis of chrome tanning agents- Moisture, Cr<sub>2</sub>O<sub>3</sub> content, basicity, Degree of olation. Analysis of Alum tanning agents. Analysis of formaldehyde. Chemical analysis of vegetable tanned/chrome tanned/comboination tanned leathers. Physical testing of heavy and light leather, Spectrophotometry, chromatography and electrophoresis.

#### References and suggested readings:

1. Mahadevan, T. S. K., "*A Practical Guide for Chemical Analysis and Physical Testing of Leather*".
2. Sarkar, P. K., "*Analysis of Materials of Leather Manufactures*"
3. "*I.S. Standards for Chemical Testing*."

#### Course contents and lecture schedule

Module No.	Topic	No. of lectures
<b>1.</b>	<b>The role of leather auxiliaries in up gradation of leather</b>	
1.1	The roll of leather auxiliaries in up gradation of leather	02
1.2	an overview of Indian leather auxiliaries industry development,	01
1.3	Important aspects of auxiliary's production such as plant and equipment design.	01
1.4	Unit operations and unit process & Instrumentation.	02
1.5	quality control	01
<b>2.</b>	<b>Fatliquaring agents &amp; Dyes:</b>	

2.1	Fatliquaring agents	01
2.2	Vegetable tanning agents and systems manufacturers unit processes involved, evaluation and quality control. Fatliquoring Chemicals	02
2.3	Oils, and Fats-extration, fatliquor preparations.	02
2.4	Sulphation, Sulphonation, Sulphitation synthetic fatliquors-quality control.	02
2.5	Chemistry and technology of Dyes.	01
2.6	acid, basic, direct, premetalsed dyes etc.	02
2.7	Reactive and solvent dyes.	02
<b>3.</b>	<b>Pigments:</b>	
3.1	Chemistry and technology of organic and inorganic pigments,	02
3.2	Products mixture and machinery requirements for pigment dispersions with or without binders for leather finishing,	02
3.3	Factors controlling brilliancy, transparency, opacity, solvent, thermal and light resistances	02
3.5	Evaluation and quality control.	01
3.6	Standards for metal free leather (ISO), Fire retardancy, Reach standards for leather, top coat soil resistance.	02
<b>4.</b>	<b>Binders:</b>	
4.1	Protein and resin binders	02
4.2	preparation and properties of various types of binders with special reference of their resistance to water, Solvent, rubbing, cold track, oxidation etc.	04
4.3	Evaluation and quality control	01
<b>5.</b>	<b>Lacquers:</b>	
5.1	Lacquers emulsions and Thinners	02
5.2	Production of lacquers from various source-Nitrocellulose, PVC, Cellulose acetate butyrate, PU Etc.,	02
5.3	Thinner formation, lacquer emulsions,.	02
5.4	quality control	01
6.1	Analysis of chrome tanning agents- Moisture	04
6.2	Analysis of Cr <sub>2</sub> O <sub>3</sub> content	04
6.3	Analysis of basicity, Degree of olation.	04
6.4	Analysis of Alum tanning agents.Analysis of formaldehyde.Chemical	04
6.5	Analysis of vegetable tanned/chrome tanned/combination tanned leathers.	04
6.6	Physical testing of heavy and light leather	04
6.7	Spectrophotometry, chromatography and electrophoresis	04
<b>Total hours</b>		<b>70</b>

**NLT-310: LEATHER TRADES ENGINEERING**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:** The objective of this course is to enable the students understand:

- mechanism and development of tannery machines
- The fundamental concepts of development of hydraulic and pneumatic steering mechanisms accessories and control applied to tannery machines.
- Detailed study of Beam-house, tanning and finishing machines
- Drainage and disposal in tanneries.
- Maintenance of tannery buildings.

**Course Outcome**

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand mechanism and development of tannery machines	Understand
<b>CO2</b>	Understand hydraulic and pneumatic steering mechanisms accessories	Understand
<b>CO3</b>	Understand working of Beam-house, tanning and finishing machines.	Understand
<b>CO4</b>	Understand internal transport & Drainage and disposal in tanneries	Understand
<b>CO5</b>	Understand maintenance of tannery buildings.	Understand

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO1 1</b>	<b>PO1 2</b>
<b>CO1</b>	3						2					2
<b>CO2</b>	3						3	2				
<b>CO3</b>	3											2
<b>CO4</b>	2						2	2				
<b>CO5</b>	1											
<b>Average</b>	2.4						2.3	2				2

1: Slight (Low)      2: Moderate (Medium)      3: Substantial (High)      *If there is no correlation, put “-*

## **Course Level Assessment Questions**

### **Course Outcome 1(CO1)**

1. Clutch mechanism
2. Balancing and Vibration
3. Helically bladed cylinders, Bush, ball, roller and ring oil bearings, cam, springs and their application.

### **Course Outcome 2(CO2)**

1. Air compressors, dust control equipment, blowers.
2. Automatic controls and their application.
3. Drying mechanisms and different types of dryers.

### **Course Outcome 3(CO3)**

1. Study of machines used in a tannery.
2. Foundation and Erection of machinery.
3. Latest development of leather processing vessels.

### **Course Outcome 4(CO4)**

1. Internal transport
2. Safety precautions.
3. Drainage and disposal in tanneries.

### **Course Outcome 5(CO5)**

1. Maintenance of tannery buildings.
2. Tanning machinery maintenance.
3. Automatic and mechanization of tanneries

## **SYLLABUS**

### **Module- I :**

#### **MACHINE MECHANISMS**

Clutch mechanism, crank-slede and straight motion and lever mechanism and development of tannery machines, Balancing and Vibration - their application in high speed slicking action for helically bladed cylinders, Bush, ball, roller and ring oil bearings, cam, springs and their application and function in tannery machines, TAIC machine drying technology, Pazsucco, Embossing machine, drying technology.

**Module-II :****TANNERY EQUIPMENTS**

Development of hydraulic and pneumatic steering mechanisms accessories and control applied to tannery machines, air compressors, dust control equipment, blowers, etc. Automatic controls and their application in all Instruments, drying mechanisms and different types of dryers.

**Module-III:****TANNING FINISHING MACHINES**

Detailed study of Beam-house, tanning and finishing machines, their description, construction with sketch, selection, Foundation and Erection of machinery. Latest development of leather processing vessels.

**Module-IV:****TRANSPORTATION & DISPOSAL**

Internal transport, safety precautions, power, water and steam distribution, drainage and disposal in tanneries.

**Module-V:****MAINTENANCE OF TANNERY BUILDINGS:**

Electrical, steam and water lines, tanning machinery, routing prevent maintenance, automatic and mechanization of tanneries.

**References and suggestive readings:**

1. Sharp house, J.H., "Leather Technician's Handbook".
2. Mechanical Engineering Text Book.

**Course content and lecture schedule**

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>MACHINE MECHANISMS</b>	
1.1	Clutch mechanism, crank-slede and straight motion and lever mechanism and development of tannery machines,	02
1.2	Balancing and Vibration - their application in high speed slicking action for helically bladed cylinders, Bush, ball, roller and ring oil bearings, cam, springs and their application and function in tannery machines	02

1.3	TAIC machine drying technology, Pazsucco, Embossing machine, drying technology	02
<b>2.</b>	<b>TANNERY EQUIPMENTS</b>	
2.1	Development of hydraulic and pneumatic steering mechanisms accessories and control applied to tannery machines	02
2.2	air compressors, dust control equipment, blowers, etc.	02
2.2	Automatic controls and their application in all Instruments, drying mechanisms and different types of dryers.	02
<b>3.</b>	<b>TANNING FINISHING MACHINES</b>	
3.1	Detailed study of Beam-house, tanning and finishing machines, their description, construction with sketch, selection,	03
3.2	Foundation and Erection of machinery	01
3.3	Latest development of leather processing vessels.	02 2
<b>4.</b>	<b>TRANSPORTATION &amp; DISPOSAL</b>	
4.1	Internal transport.	01
4.2	Safety precautions.	02
4.3	Power, water and steam distribution.	01
4.4	Drainage and disposal in tanneries.	02
<b>5.</b>	<b>MAINTENANCE OF TANNERY BUILDINGS</b>	
5.1	Maintenance of tannery buildings: Electrical, steam and water lines, tanning machinery.	03
5.2	Routing prevent maintenance.	02
5.3	Automatic and mechanization of tanneries.	01
<b>Total hours</b>		<b>30</b>

## NCT-322 PROCESS EQUIPMENT DESIGN

**L T P C**  
**3 0 0 3**

**Course Objective:** The objective of this course is to acquire basic understanding of design parameters, complete knowledge of configuration and design procedures for commonly used process equipment in important operations.

**Course Outcomes:**

CO1	Understand the basics of process equipment design and important parameters of equipment design	Understand, Apply
CO2	Design internal pressure vessels and external pressure vessels.	Evaluate , Apply
CO3	Analyze, synthesize and design processes for process heat exchangers.	Understand, Evaluate      Apply,
CO4	Integrate and apply techniques and knowledge acquired to design distillation	Analyze, Evaluate      Apply,
CO5	Design of storage tanks, other important equipment : evaporator	Analyze, Evaluate      Apply,

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	-	3	-	-	1	1	-	2
CO2	3	3	3	2	3	3	-	-	1	-	-	2
CO3	3	3	3	2	3	1	-	-	1	-	-	3
CO4	3	3	3	2	3	1	-	-	1	-	-	3
CO5	3	3	3	2	3	1	-	-	1	-	-	3
Avg	3	2.8	2.8	1.8	3	1.8	0	0	1	1	0	2.6

**Syllabus**

**Module-I:**

Introduction to Equipment Design Introduction: Classification of engineering materials, engineering properties of Ferrous metals, Non ferrous metals, alloys & Ceramic materials Structure-Property relationship in materials. Deformation of Materials Fracture: Elastic deformation, Plastic deformation, Creep. Corrosion And Prevention: Direct Corrosion, electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, factor influencing corrosion rate, Control and of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, protective coatings. Corrosion charts, Metal forming & Metal joining techniques – Different types

**Module-II:**

Type of pressure vessels, Thin cylinder theory for internal pressure. Code & standard for pressure vessels (IS:2825: 1969), Design considerations, classification of pressure vessels as per codes, design of cylindrical and spherical shells under internal and external pressure, selection and design of heads such for pressure vessel.

### **Module-III**

Introduction, Basic design procedure and theory, Heat exchanger analysis: the effectiveness NTU method, Overall heat-transfer coefficient, Fouling factors (dirt factors), Shell and tube exchangers: construction details, Tubes, Shells, Tubesheet layout (tube count), Shell types (passes), Shell and tube designation, Baffles, Support plates and tie rods, Tube sheets (plates), Shell and header nozzles (branches), Design methods, Kern's method, Bell's method, Shell and bundle geometry, Effect of fouling on pressure drop, Pressure-drop limitations.

### **Module-IV**

Design methods for binary distillation systems, Basic equations, McCabe-Thiele method, The Smoker equations, Batch distillation, Steam distillation, Plate efficiency, Prediction of plate efficiency. Approximate column sizing, Plate contactors, Selection of plate type, Plate-design procedure.

### **Module-V**

Storage Tanks: Introduction and Classification of storage tanks; Design of storage tanks and few other important equipments: Evaporator, Dryer, Centrifuge etc

### **Text Books**

1. L. E. Brownell and E. H. Young, "Process Equipment Design", Wiley, 2004.
2. B. C., Bhattacharya "Introduction of Chemical Equipment Design", CBS Publishers, 2003.
3. D.Q., Kern, Process Heat Transfer, International Student Edition, McGraw Hill, 2002.
4. R.E. Treybal, "Mass Transfer Operations", 3rd ed. New York: McGraw-Hill, 2017.

### **Reference Books**

- 1.M.V. Joshi "Process Equipment Design 2/e", Macmillan India, 1981(reprint 1985).
2. E. E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Vol. 2, 3rd Ed., Gulf Publishers. 1997

Web Links:

<https://archive.nptel.ac.in/courses/103/107/103107207/>

<https://archive.nptel.ac.in/courses/103/105/103105210/>

## NCT-324 PROCESS MODELING AND SIMULATION

L    T    P    C  
3    0    0    3

### Course Objective:

This course explores the basic concepts and steady state equations of simple systems in chemical process industries. It deals with the techniques for derivation of system model equations, data analysis and visualization. The course aims to present the basic idea and concept on process model with detailed analysis and solution of model equations for steady operation.

### Course Outcomes:

CO1	Understand create and analyze the conservation principles, classification of models and numerical methods	Understand, & Analyze
CO2	Understand, analyze & evaluate the degree of freedom, system design variables, and flow of information in system	Understand, Analyze & evaluate
CO3	Apply the concepts to analyze and create models giving rise to nonlinear algebraic equation (NAE) systems based upon input and output data.	Apply, Analyze & Design
CO4	Apply the concepts to analyze and create models giving rise to Differential Algebraic Equations (DAEs) & Partial Differential Equations (PDEs) systems based upon input and output data.	Apply, Analyze, Evaluate, Design
CO5	Develop simulation approaches based on the concepts to solve the model equations (ANE, DAE & PDEs)	Apply, Analyze, Evaluate

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs	
CO1	3	3	3	3	2	-	-	1	-	1	1	2		
CO2	3	3	3	3	3	-	-	1	-	1	1	2		
CO3	3	3	3	2	3	-	-	1	-	1	1	2		
CO4	3	3	3	2	2	-	-	1	-	1	1	2		
CO5	3	3	3	3	3	-	-	1	-	1	2	3		
Avg	3	3	3	2.6	2.6	-	-	1	-	1	1.2	2.2		

### Syllabus

#### Module I (6 hours)

Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models: Linear vs. Non-linear, Lumped parameter vs. Distributed parameter; Static vs. Dynamic,

Continuous vs. Discrete; Numerical Methods: Iterative convergence methods, Numerical integration of ODE- IVP and ODE-BVP.

**Module II (6 hours)**

Concept of degree of freedom analysis: System and its subsystem, System interaction, Degree of freedom in a system e.g. Heat exchanger, Equilibrium still, Reversal of information flow, Design variable selection algorithm, Information flow through subsystems, Structural effects of design variable selection, Persistent Recycle.

**Module III (6 hours)**

Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc. Review of solution strategies for nonlinear algebraic equation (NAE).

**Module IV (6 hours)**

Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based approaches for staged processes; Modeling of differential contactors-distributed parameter models of packed bed; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs) & Partial Differential Equations (PDEs).

**Module V (6 hours)**

Simulation and their approaches, Modular, Sequential, Simultaneous and Equation solving approach, Simulation software and their applications. Review of available numerical software libraries.

**Text Books**

- [1] A. K. Jana, "Chemical Process Modelling and Computer Simulation", PHI, 2011.
- [2] Asghar Hussain, "Chemical Process Simulation", Wiley Eastern Ltd., New Delhi, 1986.
- [3] M.M. Denn, "Process Modelling", Wiley, New York, 1990.

**Reference Books**

- [1] C.D. Holland, "Fundamentals of Modelling Separation Processes", Prentice Hall, (1975)
- [2] D. F. Rudd and C. C. Watson, "Strategy of Process Engineering", Wiley international, 1971
- [3] W.L., Luyben "Process Modeling, Simulation, and Control for Chemical Engineering", Mc Graw Hill.

**Web Links**

<https://archive.nptel.ac.in/courses/103/107/103107096/>

## NCT-326 PROCESS OPTIMIZATION

L   T   P   C  
3   0   0   3

### Course Objective

The primary goal of this course is to provide an overview of state-of-the-art optimization algorithms, and the theoretical principles that underpin them, and to provide students with the modeling skills necessary to describe and formulate optimization problems and their use for solving several types of practically relevant optimization problems arising in process systems engineering.

### Course Outcomes:

<b>CO1</b>	To identify different types of optimization problems	Understand, Apply
<b>CO2</b>	To explain different optimization techniques	Apply, Evaluate
<b>CO3</b>	To solve various multivariable optimization problems	Analyze, Evaluate
<b>CO4</b>	To solve problems by using Linear Programming	Apply, Evaluate
<b>CO5</b>	To solve optimization problems of staged and discrete processes, understand the concept of specialized & Non-traditional Algorithm	Understand, Apply, Evaluate

**Table: Correlation of POs, PSOs v/s COs**

PO/ CO	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	P O10	P O11	PSO 1	PSO 2
<b>CO1</b>	3	1	2	2	1	-	-	1	3	-	-	2	
<b>CO2</b>	3	3	3	3	2	-	-	1	3	-	-	2	
<b>CO3</b>	3	3	3	3	3	-	-	1	3	-	-	2	
<b>CO4</b>	2	3	3	1	3	-	-	1	2	-	-	2	
<b>CO5</b>	2	3	3	1	2	-	-	1	1	-	-	3	
<b>Average</b>	2.6	2.6	2.8	2	2.2	-	-	1	2.4	-	-	2.2	

### Syllabus

**Module 1 (6 hours)** Introduction to process optimization; formulation of various process optimization problems and their classification. Basic concepts of optimization-convex and concave functions, necessary and sufficient conditions for stationary points.

**Module 2 (6 hours)** Optimization of one-dimensional functions, unconstrained multivariable optimization- direct search methods. Bracketing methods: Exhaustive search method, Region elimination methods: Interval halving method, Fibonacci search method, Golden section search method.

**Module 3 (5 hours)** Linear Programming: Primal Simplex method, Artificial starting solution, Dual Simplex method, Primal-Dual relationship, Simplex method.

**Module 4 (8 hours)** Multivariable Optimization Algorithms: Optimality criteria, Unidirectional search, direct search methods, Powell's conjugate direction method. Gradient-based methods: Cauchy's (steepest descent) method, Newton's method. Constrained Optimization Algorithms: Kuhn-Tucker conditions, Transformation methods: Penalty function method, method of multipliers, Direct search for constraint minimization: Variable elimination method

**Module 5 (5hours)**. Dynamic programming, Introduction to Specialized & Non-traditional Algorithms: Genetic Algorithm

**Text Books**

- 1 T.F. Edgar and D.M. Himmelblau, "Optimization of Chemical Processes", Mc Graw Hill, International editions, chemical engineering series, 2001
2. S. S. Rao, Engineering Optimization Theory and Practice, Fifth Edition, John Wiley & Sons, Inc., 2019
3. G.S. Beveridge and R.S. Schechter, "Optimization theory and practice", Mc Graw Hill, Newyork, 1970.

**Reference book:**

1. Hamdy A. Taha, " Operation Research", Pearson, 2008

**Web Links**

<https://archive.nptel.ac.in/courses/103/105/103105139/>

## OLT-302 LEATHER MANUFACTURE FROM SKINS AND HIDES

**L T P C**  
**2 0 0 2**

**OBJECTIVE:** The objective of this course is to enable the students

- To understand General physical and chemistry of proteins.
- To understand pretanning process.
- To understand concept of tanning.
- To understand principle of dyes, oils, binders etc.
- To understand effluent disposal, machine in leather processing and footwear making.

### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	To understand General physical and chemistry of proteins.	Understand
<b>CO2</b>	To understand pretanning process.	Understand
<b>CO3</b>	To understand concept of tanning.	Understand
<b>CO4</b>	To understand principle of dyes, oils, binders etc.	Understand
<b>CO5</b>	To understand effluent disposal, machine in leather processing and footwear making.	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3											
<b>CO2</b>	3					2						
<b>CO3</b>	3	2	3	2								2
<b>CO4</b>	3	2	3	2								2
<b>CO5</b>	3	2		2		2						2
<b>Average</b>	3	2	3	2		2						2

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)    *If there is no correlation, put “-”*

### Course Level Assessment Question

#### Course Outcome 1(CO1)

1. Various fibrous and non-fibrous proteins, Non proteinous skin components
2. General physical and chemistry of proteins.

3. Primary structure of collagen

**Course Outcome 2(CO2)**

1. Keratin, Reticulin, Elastin
2. Pretanning process

**Course Outcome 3(CO3)**

1. Concept of tanning
2. Theory of neutralization
3. Combination tannages.

**Course Outcome 4(CO4)**

1. Classification of leather dyes.
2. Oils & fats.
3. Classification and types of leather finishes.

**Course Outcome 5(CO5)**

1. Tannery effluents
2. Different machine used in leather processing.
3. Making of footwear

**SYLLABUS**

**Module-I:**

Various fibrous and non-fibrous proteins, Non proteinous skin. General physical and chemistry of proteins. Chemical constitution of hides and skins. Reaction of proteins with acids, bases and salts. Primary structure of collagen, effect of enzymes on collagen.

**Module-II:**

Keratin, Reticulin, Elastin, histology of hides and skins-cell, tissue, fibers, muscles, glands, epidermics, pretanning process-soaking, liming, deliming, bating, degreasing, pickling & depickling).

**Module-III:**

Concept of tanning and leather, leather properties dependent on tanning, Vegetable tannins and vegetable tanning, classification of vegetable tannins, vegetable tanning materials and their properties, hydrolysable and condensed tannins, Mechanism of vegetable tanning, process of vegetable tanning, synthetic tannins, chrome complexes and their structures, method of chrome tanning, preparation of chrome liquors & Powders, mechanism of chrome tannage. Study of

Aluminum, Zirconium, iron, Titanium, Sodium silicate & polyphosphates. Theory of neutralization, combination tannages

#### Module-IV:

Principle of color chemistry, classification of leather dyes, color matching, theory and mechanism of dyeing, oils, fats, classification and types of leather finishes, pigments, binders, intro cellulose lacquers, wax emulsions, silicon emulsion.

#### Module-V:

Tannery effluents, effluent disposal, leather machinery-different machine used in leather processing. Anatomy of human foot, closing, making of footwear, classification of leather goods, method and material for construction.

#### References and suggested readings:

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

### Course content and lecture Schedule

Module No.	Topic	No.of lectures
<b>1</b>		
<b>1.1</b>	Various fibrous and non-fibrous proteins, Non proteinous skin components.	<b>02</b>
<b>1.2</b>	General physical and chemistry of proteins. Chemical constitution of hides and skins. Reaction of proteins with acids, bases and salts.	<b>02</b>
<b>1.3</b>	Primary structure of collagen, effect of enzymes on collagen.	<b>02</b>
<b>2</b>		
<b>2.1</b>	Keratin, Reticulin, Elastin, histology of hides and skins-cell, tissue, fibers, muscles, glands, epidermics,	<b>02</b>
<b>2.2</b>	pretanning process-soaking, liming, deliming,	<b>02</b>
<b>2.3</b>	bating, degreasing, pickling & depickling	<b>02</b>
<b>3</b>		
<b>3.1</b>	Concept of tanning and leather, leather properties dependent on tanning, Vegetable tannins and vegetable tanning, classification of vegetable tannins, vegetable tanning materials and their properties, hydrolyable and condensed tannins,	<b>02</b>
<b>3.2</b>	Mechanism of vegetable tanning, process of vegetable tanning, synthetic tannins, chrome complexes and their structures, method of chrome tanning, preparation of chrome liquors & Powders, mechanism of chrome tannage. Study of Aluminium, Zirconium, iron, Titanium, Sodium silicate & polyphosphates.	<b>02</b>

<b>3.3</b>	Theory of naturalisation, combination tannages.	<b>02</b>
<b>4</b>		
<b>4.1</b>	Principle of color chemistry, classification of leather dyes, color matching, theory and mechanism of dyeing,	<b>02</b>
<b>4.2</b>	oils, fats, classification and types of leather finishes,	<b>02</b>
<b>4.3</b>	pigments, binders, intro cellulose lacquers, wax emulsions, silicon emulsion,	<b>02</b>
<b>5</b>		
<b>5.1</b>	Tannery effluents, effluent disposal,	<b>02</b>
<b>5.2</b>	Leather machinery-different machine used in leather processing.	<b>01</b>
<b>5.3</b>	Anatomy of human foot.	<b>01</b>
<b>5.4</b>	closing, making of footwear, classification of leather goods, method and material for construction	<b>02</b>
	<b>Total hours</b>	<b>30</b>

## SEMESTER VII

### NLT-421 LEATHER AUXILIARIES TECHNOLOGY

**L T P C**  
**3 1 0 4**

<b>OBJECTIVE:</b> The objective of this course is to enable the students understand <ul style="list-style-type: none"><li>• The role of leather auxiliaries in up gradation of leather.</li><li>• To analyze of tanning agents &amp; evaluation and quality control</li><li>• To know Chemistry and technology of organic and inorganic pigments</li><li>• To understand the preparation and properties of various types of binders.</li><li>• Lacquers emulsions and Thinners</li><li>• Use and application of auxiliaries &amp; how it help in leather processing manufacturing</li></ul>
---

#### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the role of leather auxiliaries in up gradation of leather.	Understand
<b>CO2</b>	To analyze of tanning agents & evaluation and quality control	Understand
<b>CO3</b>	Understand the Chemistry and technology of organic and inorganic pigments	Understand
<b>CO4</b>	Understand the preparation and properties of various types of binders	Understand
<b>CO5</b>	Production of lacquers from various source-Nitrocellulose	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO2</b>	3	–	–	–	–	–	–	–	–	–	–	–
<b>CO3</b>	3	2	–	–	–	–	–	–	–	–	–	–
<b>CO4</b>	2	2	–	1	–	–	2	–	–	–	–	–
<b>CO5</b>	1	–	2	–	–	–	2	–	2	–	–	1
<b>Average</b>	2.4	2	2	1	–	–	2	–	2	–	–	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put “-”*

#### Course Level Assessment Question

##### Course Outcome 1(CO1)

1. An overview of Indian leather auxiliaries' industry development

2. Important aspects of auxiliaries' production
3. Instrumentation and quality control.

#### **Course Outcome 2(CO2)**

1. Fatliquoring Chemicals
2. Sulphation, Sulphonation, Sulphitation.
3. Chemistry and technology of dyes.

#### **Course Outcome 3(CO3)**

1. Chemistry and technology of organic and inorganic pigments.
2. Factors controlling brilliancy, transparency, opacity, solvent, thermal and light resistances
3. Evaluation and quality control.

#### **Course Outcome 4(CO4)**

1. Preparation and properties of various types of binders.
2. Protein and resin binders.
3. Evaluation and quality control

#### **Course Outcome 5(CO5)**

1. Lacquers emulsions and Thinners.
2. Nitrocellulose, PVC, Cellulose acetate butyrate & PU.
3. Thinner formation.

### **Syllabus:**

#### **Module-I:**

The role of leather auxiliaries in up gradation of leather, an overview of Indian leather auxiliaries industry development, important aspects of auxiliaries production such as plant and equipment design, unit operations and unit process, Instrumentation and quality control.

#### **Module- II:**

**Fatliquaring agents:** Vegetable tanning agents and systems manufacturers unit processes involved, evaluation and quality control. Fatliquoring Chemicals, Oils, and Fats-extraction, fatliqor preparations, Sulphation, Sulphonation, Sulphitation synthetic fatliquors-quality control, Dyes: Chemistry and technology of acid, basic, direct, premetalised, Reactive and solvent dyes.

#### **Module-III:**

**Pigments:** Chemistry and technology of organic and inorganic pigments, Products mixture and machinery requirements for pigment dispersions with or without binders for leather finishing,

Factors controlling brilliancy, transparency, opacity, solvent, thermal and light resistances, Evaluation and quality control.

#### Module-IV:

**Binders:** Protein and resin binders- preparation and properties of various types of binders with special reference of their resistance to water, Solvent, rubbing, cold track, oxidation etc. Evaluation and quality control.

#### Module-V:

**Lacquers:** Lacquers emulsions and Thinners-Production of lacquers from various source-Nitrocellulose, PVC, Cellulose acetate butyrate, PU Etc., Thinner formation, lacquer emulsions, quality control.Global policies and regulations. Social and environmental challenges of Leather waste in India. Leather and environment. Salient features of the Leather waste management (PWM) rules. Waste treatment of various Leather plants, estimation of power requirement and efficiency of size reduction operation of Leathers

#### References and suggested readings:

1. Flaherty, Roddy, Lollar, "The Chemistry and Technology of Leather" Vol. III
2. Dutta. S.S., "An Introduction to the Principles of Leather Manufacture".

#### Course contents and lecture schedule

Module No.	Topic	No. of lectures
<b>1.</b>	<b>The role of leather auxiliaries in up gradation of leather</b>	
1.1	The roll of leather auxiliaries in up gradation of leather	02
1.2	an overview of Indian leather auxiliaries industry development,	01
1.3	Important aspects of auxiliary's production such as plant and equipment design.	01
1.4	Unit operations and unit process & Instrumentation.	02
1.5	quality control	01
<b>2.</b>	<b>Fatliquaring agents &amp; Dyes:</b>	
2.1	Fatliquaring agents	01
2.2	Vegetable tanning agents and systems manufacturers unit processes involved, evaluation and quality control. Fatliquoring Chemicals	02
2.3	Oils, and Fats-extration, fatliquor preparations.	02
2.4	Sulphation, Sulphonation, Sulphitation synthetic fatliquors-quality control.	02
2.5	Chemistry and technology of Dyes.	01
2.6	acid, basic, direct, premetalised dyes etc.	02
2.7	Reactive and solvent dyes.	02
<b>3.</b>	<b>Pigments:</b>	
3.1	Chemistry and technology of organic and inorganic pigments,	02
3.2	Products mixture and machinery requirements for pigment dispersions with or without binders for leather finishing,	02

3.3	Factors controlling brilliancy, transparency, opacity, solvent, thermal and light resistances	02
3.5	Evaluation and quality control.	01
<b>4.</b>	<b>Binders:</b>	
4.1	Protein and resin binders	02
4.2	preparation and properties of various types of binders with special reference of their resistance to water, Solvent, rubbing, cold track, oxidation etc.	04
4.3	Evaluation and quality control	01
<b>5.</b>	<b>Lacquers:</b>	
5.1	Lacquers emulsions and Thinners	02
5.2	Production of lacquers from various source-Nitrocellulose, PVC, Cellulose acetate butyrate, PU Etc.,	02
5.3	Thinner formation, lacquer emulsions,.	02
5.4	quality control	01
<b>Total hours</b>		<b>40</b>

## NLT-423 POLYMER SCIENCE

**L T P C**  
**3 1 0 4**

**OBJECTIVE:** To impart basics and fundamental knowledge on polymer science for leather applications:

- Introduction to polymers.
- Synthesis of polymers used in leather.
- Characterization methods of polymers.
- Processing techniques for polymers.
- Polymer recycling.

**Cou  
rse  
Out**

**come**

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the fundamental concepts of polymer.	Understand
<b>CO2</b>	Understand the synthesis of polymers used in leather.	Understand
<b>CO3</b>	Understand the characterization methods of polymers.	Understand
<b>CO4</b>	Understand the processing techniques for polymers used in leather.	Understand
<b>CO5</b>	Understand polymer recycling and its application.	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	3					3					3
<b>CO2</b>	3	3					3					3
<b>CO3</b>	3	3					3					3
<b>CO4</b>	3	3					3					3
<b>CO5</b>	3	3					3					3
<b>Average</b>	3	3					3					3

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no*

*correlation, put “-”*

### Course level assessment questions

#### Course Outcome 1(CO1)

1. Introduction to polymers.
2. Properties of polymers.

3. Kinetics.

#### **Course Outcome 2(CO2)**

1. Synthesis of polymers.
2. Polymer manufacturing.
3. Polymerization.

#### **Course Outcome 3(CO3)**

1. Molecular weight of polymers.
2. Polymer characterization.
3. Spectroscopic methods.

#### **Course Outcome 4(CO4)**

1. Compounding of polymers.
2. Polymer processing.
3. Preparation and properties of polymers.

#### **Course Outcome 5(CO5)**

1. Polymer recycling
2. De polymerization.
3. Biodegradable polymers.

### **SYLLABUS**

#### **Module-I:**

##### **INTRODUCTION**

Introduction to natural and synthetic polymers; Terms and fundamental concepts; Step-growth polymerization, Carother's equation, Functionality, Crosslinking; PET manufacturing; Chain growth polymerization, Free radical polymerization, Kinetics of free-radical initiation, termination, chain transfer, Mayo's equation, cage effect, auto acceleration, inhibition and retardation.

#### **Module-II:**

##### **SYNTHESIS OF POLYMERS USED IN LEATHER**

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

**Module-III:****CHARACTERIZATION METHODS**

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

**Module-IV:****PROCESSING TECHNIQUES FOR POLYMERS USED IN LEATHER**

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

**Module-V:****POLYMER RECYCLING**

Recycling, remoulding, depolymerisation, incineration, biodegradable polymers for leather applications.

**Recommended Books:**

1. Joel R., "Fried Polymer Science and Technology", Journal of Chemical Association, ACS Publications, 2004.
2. Fred W Billmeyer, "Textbook Of Polymer Science", John Wiley & Sons, 1984-03.
3. Hearle, J.W.S, "Polymers and their Properties", E. Horwood, New York, 1982.
4. Lenz RW , "Organic Chemistry of Synthetic High Polymers", Interscience Publishers, New York, 1967.
5. Anil Kumar; Rakesh K Gupta, "Fundamentals of Polymers", McGraw-Hill, New York, 1998.
6. Stephen Z. D. Cheng and Bernhard Wunderlich, "Polymer Science", Polymer Physics Ed., 1986
7. Mishra G. S., "Introductory Polymer Chemistry", John Wiley & Sons, Dhanpat Rai & Co. Pvt. Ltd., 2003.
7. Gowariker V.R., Viswanathan N. V., and Jayadev Sreedhar, "Polymer Science", New Age International (P) Limited publishers, Bangalore, 2001.
8. William D. Callister, Jr, "Materials Science and Engineering – An Introduction", Sixth Edition, John Wiley & Sons, Inc., 2004.

### Course contents and lecture schedule

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>INTRODUCTION TO POLYMER</b>	
1.1	Introduction to natural and synthetic polymers	02
1.2	Terms and fundamental concepts	01
1.3	Step-growth polymerization, Carother's equation, Functionality, Crosslinking, Free radical polymerization	02
1.4	Chain growth polymerization, Free radical polymerization, Kinetics of free-radical initiation	01
1.5	Kinetics of free-radical initiation, termination, chain transfer, Mayo's equation, cage effect, auto acceleration, inhibition and retardation	02
<b>2.</b>	<b>SYNTHESIS OF POLYMERS USED IN LEATHER</b>	
2.1	Polypropylene manufacturing; Acrylic manufacturing; Atom transfer radical polymerization	01
2.2	Ionic polymerization, ring opening polymerization; Nylon-6 manufacturing	01
2.3	Co-polymerization and its importance. Copolymer equation, reactivity ratio, tailor making of copolymer properties;;	02
2.4	Techniques of chain polymerization; Bulk, solution, emulsion, micro emulsion and suspension polymerization	02
2.5	Chemical modification of fibres; Polymer solution, Flory's theory; Interaction parameter	02
<b>3.</b>	<b>CHARACTERIZATION METHODS</b>	
3.1	Molecular weight and its distribution by: End group analysis, osmometry	02
3.2	Light scattering, ultra-centrifugation, gel permeation chromatography, intrinsic viscosity	03
3.3	Spectroscopic methods of polymer characterization such as, FTIR. UV, NMR and others.	03
<b>4.</b>	<b>PROCESSING TECHNIQUES FOR POLYMERS USED IN LEATHER</b>	
4.1	Compounding of polymers - fillers, plasticizers, antioxidants	02
4.2	UV stabilizers, colouring agents and flame retardants. Polymer processing - compression	02
4.3	Moulding, injection, extrusion, Calendaring and film casting; polymers	02
4.4	Preparation and properties of polyesters, polyamides, epoxy and silicone polymers; Conductive polymers, super absorbent	03
<b>5.</b>	<b>POLYMER RECYCLING</b>	

5.1	Recycling, remoulding,	03	NL T- 425 LE AT
5.2	Depolymerisation, incineration	02	
5.3	Biodegradable polymers for leather applications.	02	
<b>Total hours</b>		<b>30</b>	

### HER DYES AND DYESTUFFS CHEMISTRY

**L T P C**  
**3 1 0 4**

**OBJECTIVE:** To impart basics and fundamental knowledge on dyes and dyestuffs for leather applications:

- Introduction to dyes and dyestuffs.
- Manufacturing process of dyes.
- Unit processes for dyes.
- Unit processes for dyestuffs.
- Tannery waste.

**Cou  
rse  
Out**

**come**

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the fundamental concepts of dyes and dyestuffs.	Understand
<b>CO2</b>	Understand the manufacturing process of dyes and dyestuffs used in leather.	Understand
<b>CO3</b>	Understand the unit process for dyes.	Understand
<b>CO4</b>	Understand the unit process for dyestuff.	Understand
<b>CO5</b>	Understand the tannery waste.	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	3					3					3
<b>CO2</b>	3	3					3					3
<b>CO3</b>	3	3					3					3
<b>CO4</b>	3	3					3					3
<b>CO5</b>	3	3					3					3
<b>Average</b>	3	3					3					3

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no*

*correlation, put “-”*

## **Course level assessment questions**

### **Course Outcome 1(CO1)**

1. Introduction to dyes and dyestuffs.
2. Principle, source and origin of dyes.
3. Natural and synthetic dyes.

### **Course Outcome 2(CO2)**

1. Manufacturing of dyes.
2. Classification of dyes according to their mode of application.
3. Classification of dyes based on chemical constitution.

### **Course Outcome 3(CO3)**

1. Nitration
2. Amination by reduction
3. Amination by ammonolysis.

### **Course Outcome 4(CO4)**

1. Alkylation
2. Condensation & addition reactions
3. Miscellaneous unit process.

### **Course Outcome 5(CO5)**

1. Environmental considerations
2. Solid hazardous wastes
3. Liquid effluents

## **SYLLABUS**

### **Module-I:**

#### **INTRODUCTION TO DYES**

Dyes, dyeing and principles of dyeing, sources and origin of dyes, natural dyes, synthetic dyes.

### **Module-II:**

#### **CLASSIFICATION OF DYES**

Intermediate and dye manufacturing, classification of dyes according to their mode of application, classification of dyes based on chemical constitution.

### **Module-III:**

#### **UNIT PROCESS I**

Nitration, amination by reduction, amination by ammonolysis, halogenation.

### **Module-IV:**

## UNIT PROCESS II

Alkylation, condensation & addition reactions, miscellaneous unit process.

### Module-V:

#### TANNERY WASTE

Environmental considerations, solid hazardous wastes, liquid effluents.

#### References and suggested readings

1. R. Norris Shreve, "Chemical process industries".
2. W. Smith, R Chapman, "Chemical process industries".

### Course contents and lecture schedule

Module No.	Topic	No. of Lectures
<b>1.</b>	<b>Introduction to Dyes :</b>	
1.1	Dyes	01
1.2	Dyeing and principles of dyeing	02
1.3	Sources and origin of dyes	02
1.4	Natural dyes	02
1.5	Synthetic dyes	02
<b>2.</b>	<b>Classifications of Dyes :</b>	
2.1	Intermediate and dye manufacturing	02
2.2	Classification of dyes according to their mode of application	03
2.3	Classification of dyes based on chemical constitution	03
<b>3.</b>	<b>Unit Processes I :</b>	
3.1	Nitration	02
3.2	Amination by reduction	02
3.3	Amination by ammonolysis	02
3.4	Halogenation	02
<b>4.</b>	<b>Unit Processes II :</b>	
4.1	Alkylation	02
4.2	Condensation	02
4.3	Addition reactions	02
4.4	Miscellaneous unit process	02
<b>5</b>	<b>Tannery waste:</b>	
5.1	Environmental considerations	02
5.2	Solid hazardous wastes	02

5.3	Liquid effluents	03
<b>Total hours</b>		<b>40</b>

### NLT-441 FOOTWEAR TECHNOLOGY

**L T P C**  
**3 0 0 3**

**OBJECTIVE:** The objective of this course is to enable the students understand:

- Different types of upper and lining leathers.
- History of shoe.
- Principles of cutting.
- Principles and methods of pre-lasting and lasting.
- Various methods of shoe construction.

**Cou  
rse**

**Outcome**

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the Different types of upper and lining leathers.	Understand
<b>CO2</b>	Understand the History of shoe.	Understand
<b>CO3</b>	Understand the Principles of cutting.	Understand
<b>CO4</b>	Understand the Principles and methods of pre-lasting and lasting.	Understand
<b>CO5</b>	Understand the Various methods of shoe construction.	Understand

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	3											
<b>CO2</b>	3	2	1									
<b>CO3</b>	3	2	3	2	3							
<b>CO4</b>	3	2			1	1						
<b>CO5</b>	3	2	2	3	3	1	2	2				
<b>Average</b>	3	2	2	2.5	2.3	1	2	2				

1: Slight (Low)      2: Moderate (Medium)      3: Substantial (High)      *If there is no correlation, put “-”*

### **Course level assessment questions**

#### **Course Outcome 1(CO1)**

1. Different types of soling materials.
2. Different types of adhesives used in footwear industry.
3. Shoe dressing materials etc.

#### **Course Outcome 2(CO2)**

1. History of shoe.
2. Fashion & designs.
3. Preparation of standards and section for men, ladies & children.

#### **Course Outcome 3(CO3)**

1. Principles of cutting.
2. skiving, punching and gimping
3. Top line and other edge treatments.

#### **Course Outcome 4(CO4)**

1. Sole attaching.
2. Upper preparation.
3. Quality control and fault finding problems- solving.

#### **Course Outcome 5(CO5)**

1. Various methods of shoe construction.
2. Shoe room techniques.

## **SYLLABUS**

### **Module-I:**

#### **FOOTWEAR MATERIALS AND COMPONENTS**

Different types of upper and lining leathers; Different types of soling materials; Different types of adhesives used in footwear industry; Kinds of insole boards, Grinderies; Fasteners; Shoe dressing materials etc.

### **Module-II :**

#### **DESIGN AND PATTERN DEVELOPMENT**

History of shoe; Purposes and styles; Fashion & designs; Preparation of standards and section for men, ladies & children; Classic and other types of shoes and boots.

**Module-III:**

**CUTTING, PRE-CLOSING AND CLOSING**

Principles of cutting – Hand, machine; Clicking room design and management. Checking incoming work, stitch making, skiving, punching and gimping, heat embossing, flow moulding, toe puff attachment, attaching linings and scrims, trimming linings, finishing off closed seams. Top line and other edge treatments, local reinforcements, attaching fastners and trims.

**Module-IV:**

**PRELASTING AND LASTING**

Principles and methods of pre-lasting and lasting for different types of construction; Sole attaching; Lasted margin; Upper preparation; Sole preparation; Sole cementing; Upper 76 cementing; Bottom fillers and shanks; Adhesive drying, Heat activation, Spotting, Pressing, Last slipping, Health and safety, Quality control and fault finding problems- solving.

**Module-V:**

**METHODS OF SHOE CONSTRUCTION**

Various methods of shoe construction; shoe room techniques.

**Recommended Books:**

1. Cott, N.F., “American Shoe Making”, Shoe Trades Publishing Co., Cambridge.1993.
2. “Apparel International” Published by P.F collier and sons, U.K, 1961.
3. “Shoes and Leather News”,Published by bureau of foreign and domestic commerce, Dept of commerce, US, 1940.

**Course contents and lecture schedule**

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>FOOTWEAR MATERIALS AND COMPONENTS</b>	
1.1	Different types of upper and lining leathers.	01
1.2	Different types of soling materials.	01
1.3	Different types of adhesives used in footwear industry.	01
1.4	Kinds of insole boards.	01
1.5	Grinderies; Fasteners; Shoe dressing materials etc.	01
<b>2.</b>	<b>DESIGN AND PATTERN DEVELOPMENT</b>	
2.1	History of shoe.	01

2.2	Purposes and styles; Fashion & designs.	01
2.3	Preparation of standards and section for men, ladies & children;	02
2.4	Classic and other types of shoes and boots.	02
<b>3.</b>	<b>CUTTING, PRE-CLOSING AND CLOSING</b>	
3.1	Principles of cutting – Hand, machine; Clicking room design and management.	02
3.2	Checking incoming work, stitchmaking, skiving, punching and gimping, heat embossing, flow moulding.	02
3.3	toe puff attachment, attaching linings and scrim.	02
3.4	Trimming linings, finishing off closed seams..	02
3.5	Top line and other edge treatments, local reinforcements, attaching fasteners and trims.	01
<b>4.</b>	<b>PRELASTING AND LASTING</b>	
4.1	Principles and methods of pre-lasting and lasting for different types of construction; Sole attaching.	02
4.2	Lasted margin; Upper preparation; Sole preparation; Sole cementing; Upper 76 cementing.	02
4.3	Bottom fillers and shanks; Adhesive drying, Heat activation, Spotting.	01
4.4	Pressing, Last slipping.	01
4.5	Health and safety, Quality control and fault finding problems- solving.	01
<b>5.</b>	<b>METHODS OF SHOE CONSTRUCTION</b>	
5.1	Various methods of shoe construction.	02
5.2	Shoe room techniques.	01
<b>Total hours</b>		<b>30</b>

### NLT-443 FOOTWEAR MATERIAL AND COMPONENTS

**L T P C**  
**3 0 0 3**

**OBJECTIVE:** The objective of this course is to enable the students understand:

- Uppers and lining.
- Soling material and adhesives
- Insoles and grinderies
- Fasteners
- Dressing materials.

**Cou**  
**rs**  
**e**  
**Out**  
**com**  
**e**  
**On**  
**the**

successful completion of the course, students will be able to

<b>CO1</b>	Understand the Different types of upper and lining leathers.	Understand
<b>CO2</b>	Understand soling material and adhesives.	Understand
<b>CO3</b>	Understand the insoles and grinders	Understand
<b>CO4</b>	Understand the fasteners	Understand
<b>CO5</b>	Understand the dressing materials	Understand

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	3											
<b>CO2</b>	3	2	1									
<b>CO3</b>	3	2	3	2	3							
<b>CO4</b>	3	2			1	1						
<b>CO5</b>	3	2	2	3	3	1	2	2				
<b>Average</b>	3	2	2	2.5	2.3	1	2	2				

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no*

*correlation, put “-”*

### **Course level assessment questions**

#### **Course Outcome 1(CO1)**

1. Different types of upper and lining leathers
2. Defects, grain characteristics.
3. Comfort properties

#### **Course Outcome 2(CO2)**

1. Different types of soling materials
2. Different types of adhesives

#### **Course Outcome 3(CO3)**

1. Kinds of insole boards
2. Synthetic fibre, non wovens
3. Performance and evaluation of toe puff, steel shanks etc.

#### **Course Outcome 4(CO4)**

1. Materials, manufacture, use and properties of elastics
2. Buckles and trims
3. Shoelaces

#### **Course Outcome 5(CO5)**

1. Dressing materials
2. Waxes, cream

### **SYLLABUS**

#### **Module-I:**

##### **UPPERS AND LINING**

**Leather:** Different types of upper and lining leathers, manufacturing techniques, defects, grain characteristics, stretch direction, cuttability, area measurement, evaluation-strength, wear and comfort properties.

**Coated Fabrics & Poromerics:** Types of yarn, thread manufacturing, twist, coated fabric, method of weaving-braiding, knitting, coated of fabric, synthetic leather and poromerics, method of evaluation.

#### **Module-II:**

##### **SOLING MATERIAL AND ADHESIVES**

Different types of soling materials-leather, rubber, PU, PVC, EVA, TPR, resin rubber methods of manufacture, assessment and application.

Different types of adhesives used in footwear industry- latex, polychloroprene, polyurethane-single and double component hot melt adhesives, methods of manufacturing, evaluation techniques and applications.

#### **Module-III:**

**INSOLES AND GRINDERIES:** Kinds of insole boards, leathers, cellulose, synthetic fibre, non wovens, seat boards, manufacture, performance, evaluation. Manufacture, performance and evaluation of toe puff, steel shanks, heels and tapes and bindings.

#### **Module-IV:**

**FASTENERS:** Materials, manufacture, use and properties of elastics, touch and close fasteners, slide fasteners, buckles and trims, and shoelaces.

#### **Module-V:**

**DRESSING MATERIALS:** Shoe polishes, waxes, cream: Different types of dressing materials, formulation technique, application and evaluation.

#### **Recommended Books:**

1. Modern Shoemaking Series, SATRA, UK Publications.
2. Quality manual for leather manufacture, LTM-CLRI Publication, Chennai.
3. Ganga Radhakrishnan, Polymers in Footwear Manufacture, Indian Leather Publications, Chennai.
3. Juran, J.M., Gryna, F.M. Jr. Quality Control Handbook, 4th Edition, McGraw Hill Book Co. New York, 1988.

### Course contents and lecture schedule

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>UPPERS AND LINING</b>	
1.1	Leather: Different types of upper and lining leathers	01
1.2	Manufacturing techniques, defects, grain characteristics, stretch direction, cuttability, area measurement, evaluation-strength, wear and comfort properties.	02
1.3	Coated Fabrics & Poromerics: Types of yarn, thread manufacturing, twist, coated fabric.	02
1.4	Method of weaving-braiding, knitting, coated of fabric, synthetic leather and poromerics, method of evaluation.	02
<b>2.</b>	<b>SOLING MATERIAL AND ADHESIVES</b>	
2.1	Different types of soling materials-leather, rubber, PU, PVC, EVA, TPR.	02
2.2	Resin rubber methods of manufacture, assessment and application.	01
2.3	Different types of adhesives used in footwear industry- latex, polychloroprene, polyurethane- single and double component hot melt adhesives	02
2.4	Methods of manufacturing, evaluation techniques and applications.	02
<b>3.</b>	<b>INSOLES AND GRINDERIES</b>	
3.1	Kinds of insole boards, leathers, cellulose, synthetic fibre, non wovens, seat boards, manufacture, performance, evaluation.	02
3.2	Manufacture, performance and evaluation of toe puff, steel shanks, heels and tapes and bindings.	03
<b>4.</b>	<b>FASTENERS</b>	
4.1	Materials, manufacture, use and properties of elastics.	02
4.2	Touch and close fasteners, slide fasteners.	02
4.3	Buckles and trims, and shoelaces	01
<b>5.</b>	<b>DRESSING MATERIALS</b>	
5.1	Shoe polishes, waxes, cream.	02

5.2	Different types of dressing materials.	02
5.3	Formulation technique, application and evaluation.	02
<b>Total hours</b>		<b>30</b>

### NLT-445 LEATHER GOODS MANUFACTURING

**L T P C**  
**3 0 0 3**

**OBJECTIVE:** To impart knowledge on making leather goods :

- To understand the various components for the manufacture of leather goods.
- To understand the processing steps involved in the making of leather good and garments.
- To understand the different machineries involved in the products manufacture.
- To understand the techniques to design and develop leather goods and garments
- To understand organisation and management of leather goods and garments manufacturing unit

**Cou  
rse  
Out  
com**

**e**

On the successful completion of the course, students will be able to

<b>CO1</b>	To understand the various components for the manufacture of leather goods	Understand
<b>CO2</b>	To understand the processing steps involved in the making of leather good and garments	Understand

<b>CO3</b>	To understand the different machineries involved in the products manufacture.	Understand
<b>CO4</b>	To understand the techniques to design and develop leather goods and garments	Understand
<b>CO5</b>	To understand organisation and management of leather goods and garments manufacturing unit	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3		3		2							3
<b>CO2</b>	3		3		2							3
<b>CO3</b>	3		3		2							3
<b>CO4</b>	3		3		2							3
<b>CO5</b>	3		3		2							3
<b>Average</b>	3		3		2							3

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no*

*correlation, put “-”*

### **Course level assessment questions**

#### **Course Outcome 1(CO1)**

1. Classification and properties of Leather Goods and Garments.
2. Alternative material and their adaptability.
3. Operation sequences in leather goods production.

#### **Course Outcome 2(CO2)**

1. Production planning.
2. Cutting and clicking.
3. Assembly and quality control.

#### **Course Outcome 3(CO3)**

1. Machinery needs for leather goods and garments manufacture.
2. Various types of machines.
3. Working principles, operation and maintenance of machines.

#### **Course Outcome 4(CO4)**

1. Pattern design and development.
2. CAD applications for leather goods and garments.
3. Fashion and material trends.

#### **Course Outcome 5(CO5)**

1. Project Feasibility reports.
2. Analysis of International market trends for goods and garments.
3. Health and Safety.

## **SYLLABUS**

## **Module-I:**

### **OVERVIEW**

Classification of Leather Goods and Garments; Selection of Materials, grading and assorting of leathers for leather goods and garments; Property requirements for leather and other materials; Accessories for Leather goods and garments - Various types of fasteners, fittings and other accessories. Alternative materials and their adaptability for goods and garments. Operational sequences in leather goods and garments production.

## **Module-II:**

### **OPERATIONS**

- i. Production planning** - Nomenclature used for component identification in various leather garments skirts, jackets, trousers etc., and various leather goods – Wallet, hand bags, Executive bags etc. Process scheduling and line balancing.
- ii. Cutting and clicking** - Hand and machine cutting, Knives and tools – Preparation and handling. Pattern interlocking/nesting for material optimization. Factors influencing cutting value. Die-less cutting.
- iii. Assembling**- Pre assembly and assembly operations – skiving, splitting, folding, sewing etc. Various types of assembly techniques for leather goods and garments.
- iv. Quality** - Quality control measures in leather products manufacture.

## **Module-III:**

### **MACHINERY**

Machinery needs for leather goods and garments manufacture. Various types of sewing machines – flat bed, cylinder bed, post bed and other special sewing machines, different feed mechanisms. Clicking, splitting, skiving, folding, embossing, creasing machines – their working principles, operation and maintenance.

## **Module-IV:**

### **DESIGN AND DEVELOPMENT**

Pattern design and development – measurement/ sizing for various types of garments, pattern design of leather goods and garments, pattern grading for leather garments. CAD applications for leather goods and garments. Fashion and material trends.

## **Module-V:**

### **ORGANISATION AND MANAGEMENT**

Project Feasibility reports, plant lay out, costing and pricing for leather goods and garments. Analysis of International market trends for goods and garments – EU, USA and other markets. Social auditing of leather goods and garment units - occupational Health and Safety, ISO 9000 and 14000.

### **References and suggested readings**

1. Pattern Making Manual - Womens Garments, ESMOD, Paris, 1991.
2. Fashion Drawing Method, ESMOD, Paris, 1992.
3. Metric Pattern cutting for Menswear, Winifred Aldrich, BSP Professional Books, London, 1990.
4. Grading Manual, ESMOD, Paris, 1994.

5. Skiving Manual, First Edition, 1994 CLRI, Madras.
6. A course manual on leather garment pattern designing.
7. Leather garments making, NIMI publication, 2012.
8. Leather and sports goods – Pattern and Template marker, NIMI Publications, 2011

### Course contents and lecture schedule

Module No.	Topic	No. of Lectures
<b>1.</b>	<b>Overview :</b>	
1.1	Classification of Leather Goods and Garments; Selection of Materials, grading and assorting of leathers for leather goods and garments	02
1.2	Property requirements for leather and other materials; Accessories for Leather goods and garments - Various types of fasteners, fittings and other accessories	02
1.3	Alternative materials and their adaptability for goods and garments. Operational sequences in leather goods and garments production.	02
<b>2.</b>	<b>Operations:</b>	
2.1	<b>Production planning</b> - Nomenclature used for component identification in various leather garments skirts, jackets, trousers etc., and various leather goods – Wallet, hand bags, Executive bags etc. Process scheduling and line balancing.	02
2.2	<b>Cutting and clicking</b> - Hand and machine cutting, Knives and tools, Preparation and handling. Pattern interlocking/nesting for material optimization. Factors influencing cutting value. Dieless cutting.	02
2.3	<b>Assembling-</b> Pre assembly and assembly operations – skiving, splitting, folding, sewing etc. Various types of assembly techniques for leather goods and garments.	02
2.4	<b>Quality</b> - Quality control measures in leather products manufacture.	01
<b>3.</b>	<b>Machinery</b>	
3.1	Machinery needs for leather goods and garments manufacture. Various types of sewing machines – flat bed, cylinder bed, post bed.	02
3.2	Special sewing machines, different feed mechanisms. Clicking, splitting, skiving, folding, embossing,	02
3.3	Creasing machines – their working principles operation and maintenance.	01
<b>4.</b>	<b>Design and Development</b>	
4.1	Pattern design and development – measurement/ sizing for various types of garments,	02
4.2	Pattern design of leather goods and garments, pattern grading for leather garments.	02
4.3	CAD applications for leather goods and garments. Fashion and material trends.	02
<b>5</b>	<b>Organization and Management</b>	

5.1	Project Feasibility reports, plant lay out, costing and pricing for leather goods and garments.	02
5.2	Analysis of International market trends for goods and garments – EU, USA and other markets.	02
5.3	Social auditing of leather goods and garment units - occupational Health and Safety, ISO 9000 and 14000.	02
<b>Total hours</b>		<b>30</b>

### NLT-461 ANIMAL AND TANNERY BY-PRODUCT

**L T P C**  
**3 0 0 3**

**OBJECTIVE:** The objective of this course is to enable the students understand:

- Types of animal by-products
- Different Methods of Rendering
- Animal Blood, its products and their Utilization
- Collection and Conservation of Organs and Glands from Slaughtered Animal
- Present Industrial Status of Various By-products.

**Course Outcome**  
On the successful

completion of the course, students will be able to

<b>CO1</b>	Understand the Types of animal by-products	Understand
<b>CO2</b>	Understand Different Methods of Rendering	Understand
<b>CO3</b>	Understand Animal Blood, its products and their Utilization	Understand
<b>CO4</b>	Understand Collection and Conservation of Organs and Glands	Understand

	from Slaughtered Animal	
<b>CO5</b>	Understand the Present Industrial Status of Various By-products	Understand

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	3											
<b>CO2</b>	3	2	1									
<b>CO3</b>	3	2	3	2	3							
<b>CO4</b>	3	2			1	1						
<b>CO5</b>	3	2	2	3	3	1	2	2				
<b>Average</b>	3	2	2	2.5	2.3	1	2	2				

1: Slight (Low)                      2: Moderate (Medium)                      3: Substantial (High)                      *If there is no correlation, put “-”*

### **Course level assessment questions**

#### **Course Outcome 1(CO1)**

1. Present methods of collection, processing and utilization
2. Conservation techniques
3. Animals by-products

#### **Course Outcome 2(CO2)**

1. Bone products and their utilization
2. Keratinous protein
3. Keratinous based by-products and their uses

#### **Course Outcome 3(CO3)**

1. Present status of the industry in the country
2. Pet foods methods of preparation

#### **Course Outcome 4(CO4)**

1. Possible Scope and Utilization of slaughtered animal
2. Quality control including microbiological aspects of products

#### **Course Outcome 5(CO5)**

1. Glue making from tannery waste
2. Bone glue and deproteinisation of bone
3. Horn and hoof meal, Protein meals Shoe room techniques.

## **SYLLABUS**

**Module-I:****TYPES OF ANIMAL BY-PRODUCTS**

From abattoirs, meat processing plants, poultry, fishing and other sources including fallen animals, Present methods of collection, processing and utilization in developing countries vis-à-vis developed countries: conservation techniques and concept of two tier technology. Protein meals from animal's by-products including fallen animals and their significant in livestock feeds.

**Module-II:****DIFFERENT METHODS OF RENDERING**

Bone products and their utilization, Keratinous protein – various sources keratinous based by-products and their uses.

**Module-III:****ANIMAL BLOOD, ITS PRODUCTS AND THEIR UTILIZATION**

Alimentary tract and its processing into various products, present status of the industry in the country, pet foods methods of preparation in brief.

**Module-IV:****COLLECTION AND CONSERVATION OF ORGANS AND GLANDS FROM SLAUGHTERED ANIMAL**

Possible Scope of their Utilization – anaerobic digestion, its signification for the preparation of animal feed fuel gas, fertilizer, etc. Quality control including microbiological aspects of products processed from animal by-products

**Module-V:****PRESENT INDUSTRIAL STATUS OF VARIOUS BY-PRODUCTS IN THE COUNTRY**

Process studies on

- (a) Glue making from tannery waste
- (b) Bone glue and deproteinisation of bone
- (c) Horn and hoof meal, Protein meals by different method

**References and suggested books:**

1. Burnham, F. `Rendering – the invisible industry” , Aero Publishers, inc., CA 92028, 1978.
2. Mann, I. “Processing and Utilization of animal by-products”, Food and Agriculture organisation, Rome 1962.
3. Scaria, K. J., Mahendrakumar and Divakaran, S. “Animal by-products – processing and utilisation”, Central Leather Research Institute, Madras, 1981.
4. Mahendrakumar, “Hand Book of rural technology for the processing of animal by-products”, FAO Agriculture Services Bulletin 79, Food and Agriculture Organisation.
5. Divakaran, S. Animal Blood – Processing and utilisation, Food and Agriculture Organisation, 1978.

### Course contents and lecture schedule

Module No.	Topic	No. of Lectures
<b>1.</b>	<b>Types of animal by-products:</b>	
1.1	From abattoirs, meat processing plants, poultry, fishing and other sources including fallen animals	02
1.2	Present methods of collection, processing and utilization in developing countries vis-à-vis developed countries	01
1.3	conservation techniques and concept of two tier technology	01
1.4	Protein meals from animals by-products including fallen animals and their significant in livestock feeds.	02
<b>2.</b>	<b>Different Methods of Rendering:</b>	
2.1	Bone products and their utilization	03
2.2	Keratinous protein – various sources keratinous based by-products and their uses	03
<b>3.</b>	<b>Animal Blood, its products and their Utilization:</b>	
3.1	Alimentary tract and its processing into various products	02
3.2	present status of the industry in the country	02
3.3	pet foods methods of preparation in brief	02
<b>4.</b>	<b>Collection and Conservation of Organs and Glands from Slaughtered Animal:</b>	
4.1	Possible Scope of their Utilization – anaerobic digestion	02
4.2	its signification for the preparation of animal feed fuel gas, fertilizer, etc.	02
4.3	Quality control including microbiological aspects of products processed from animal by-products	02
<b>5.</b>	<b>Present Industrial Status of Various By-products in the Country:</b>	
5.1	Process studies on: Glue making from tannery waste	02
5.2	Bone glue and deproteinisation of bone	02
5.3	Horn and hoof meal, Protein meals by different method	02
<b>Total hours</b>		<b>30</b>

**NLT 463: PROFESSIONAL AREAS OF LEATHER TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:** The objective of this course is to enable the students understand:

- The fundamental concepts of leather biotechnology.
- Technology of Tannery by Products Utilization
- Entrepreneurship in Leather Sector
- Fashion Technology
- Leather Goods, Garment, and Saddlery Technology

**Course Outcome**

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the fundamental concepts of leather biotechnology.	Understand
<b>CO2</b>	Understand Technology of Tannery by Products Utilization	Understand
<b>CO3</b>	Understand Entrepreneurship in Leather Sector	Understand
<b>CO4</b>	Understand Fashion Technology	Understand

<b>CO5</b>	Understand Leather Goods, Garment, and Saddlery Technology	Understand
------------	--	------------

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO1 1</b>	<b>PO1 2</b>
<b>CO1</b>	3						2					2
<b>CO2</b>	3						3	2				
<b>CO3</b>	3											2
<b>CO4</b>	2						2	2				
<b>CO5</b>	1											
<b>Average</b>	2.4						2.3	2				2

1: Slight (Low)      2: Moderate (Medium)      3: Substantial (High)      *If there is no correlation, put “-*

### **Course Level Assessment Questions**

#### **Course Outcome 1(CO1)**

1. Proteins and nucleic acid & enzymology; Enzymes
2. Types of fermentation, Preparation of media
3. Collagen and its application in food, cosmetic and medical fields

#### **Course Outcome 2(CO2)**

1. Beam house products
2. Chemistry and processing
3. Recovery of chrome, Protein and biogas

#### **Course Outcome 3(CO3)**

1. Industrial enterprise
2. Resource management
3. Production planning

#### **Course Outcome 4(CO4)**

- 1 Meaning of clothing and fashion
2. Marketing, Business
3. Fashion promotion.

#### **Course Outcome 5(CO5)**

1. Classification of leather goods
2. Accessories
3. Saddlery and harness

## **SYLLABUS**

### **Module-I:**

#### **LEATHER BIOTECHNOLOGY**

Proteins and nucleic acid & enzymology; Enzymes; Classification and assay, characterization, Biotechnology in leather processing; Cleaner leather processing, Types of enzymes, Types of fermentation, Preparation of media, Waste management and utilization of collagenous tissues for biomedical and other applications; Treatment of tannery effluents, Energy recovery, Collagen and its application in food, cosmetic and medical fields.

### **Module-II:**

#### **Technology of Tannery by Products Utilization:**

Beam house products; Recovery of fats, proteins, chemicals and glue, Leather shavings and trimmings; Chemistry and processing into hydrolysates, glue gelatin, syntans, fertilizers, Recovery of salts and re-use; Recovery of chrome, Protein and biogas, Tannery hair, Process studies; Glue and protein meal from tannery fleshing

### **Module-III:**

#### **ENTREPRENEURSHIP IN LEATHER SECTOR:**

Industrial enterprise; Venture planning and development; Techno-Economic feasibility reports; Resource management; Production planning; Managing markets.

### **Module-IV:**

#### **FASHION TECHNOLOGY:**

Meaning of clothing and fashion, fashion movement, substance of the fashion industry, Designing, Marketing, Business fundamentals, Fashion promotion business.

### **Module-V:**

#### **LEATHER GOODS, GARMENT, AND SADDLERY TECHNOLOGY:**

Classification of leather goods and garment materials, accessories, production and planning, cutting and clicking, assembling, process scheduling, Design and development, Saddlery and harness.

### **References and suggested books:**

1. Rohm, H.J. and Reed, G. "A Comprehensive treaties on Biotechnology", Verlag Chemie, Weinheim, 1983.
2. Lehniger, A.L., "Principles of Biochemistry", Butterworth 1982.
3. Rao, T.V., "Human Resources Development: Experiences. Interventions, Strategies", Sage Publications, New Delhi, 1996.
4. Mann, I. "Process of Utilization of Animal By Products", FAO Rome, 1962.
5. Scaria, K.J. Mahendrakumar and Divakaran, S. "Animal By Products – Their processing and utilization" CLRI, Madras, 1961.
6. Fashion Drawing Method, ESMOD, Paris, 1992.

7. Training in Tanning Techniques and Leather Goods Manufacture – Course material, CLRI, Madras, 1990.

### Course contents and lecture schedule

Module No.	Topic	No. of Lectures
<b>1.</b>	<b>Leather Biotechnology:</b>	
1.1	Proteins and nucleic acid & enzymology; Enzymes; Classification and assay, characterization	01
1.2	Biotechnology in leather processing; Cleaner leather processing, Types of enzymes, Types of fermentation, Preparation of media	02
1.3	Waste management and utilization of collagenous tissues for biomedical and other applications	01
1.4	Treatment of tannery effluents, Energy recovery	01
1.5	Collagen and its application in food, cosmetic and medical fields	01
<b>2.</b>	<b>Technology of Tannery by Products Utilization:</b>	
2.1	Beam house products; Recovery of fats, proteins, chemicals and glue	01
2.2	Leather shavings and trimmings; Chemistry and processing into hydrolysates, glue gelatin, syntans, fertilizers	02
2.3	Recovery of salts and re-use; Recovery of chrome, Protein and biogas, Tannery hair	02
2.4	Process studies; Glue and protein meal from tannery fleshings	01
<b>3.</b>	<b>Entrepreneurship in Leather Sector:</b>	
3.1	Industrial enterprise; Venture planning and development	02
3.2	Techno-Economic feasibility reports, Resource management	02
3.3	Production planning, Managing markets.	02
<b>4.</b>	<b>Fashion Technology:</b>	
4.1	Meaning of clothing and fashion, fashion movement	02
4.2	substance of the fashion industry, designing, marketing	02
4.3	Business fundamentals, Fashion promotion business	02
<b>5.</b>	<b>Leather Goods, Garment, and Saddlery Technology:</b>	
5.1	Classification of leather goods and garment materials, accessories	02
5.2	production and planning, cutting and clicking, assembling, process scheduling	02
5.3	Design and development, Saddlery and harness	02
<b>Total hours</b>		<b>30</b>

**NLT-465 FASHION FORECASTING FOR LEATHER AND  
LEATHER PRODUCTS**

**L   T   P   C**  
**3   0   0   3**

**OBJECTIVE:** The objective of this course is to enable the students understand

- Historical evaluation and International trends
- Fashion consideration
- Product development
- Presentation Techniques
- Fashion forecast

**Course Outcome:**

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand historical evaluation and international trends	Understand
<b>CO2</b>	Understand fashion consideration	Understand
<b>CO3</b>	Understand the leather product styling	Understand
<b>CO4</b>	Understand the Market Strategy - Prototype Development	Understand
<b>CO5</b>	Understand fashion forecasting	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	–	–	–	–	–	–	–	–	–	–	–
CO2	3	–	–	–	–	–	–	–	–	–	–	–
CO3	3	2	–	–	–	–	–	–	–	–	–	–
CO4	2	2	–	1	–	–	2	–	–	–	–	–
CO5	1	–	2	–	–	–	2	–	2	–	–	1
<b>Average</b>	2.4	2	2	1	–	–	2	–	2	–	–	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put “-”

### Course Level Assessment Question

#### Course Outcome 1(CO1)

1. Historical evaluation of leather and leather products styling
2. Seasonal influences on fashion, cultural and geographical
3. Market research and track record

#### Course Outcome 2(CO2)

1. Design Criteria through effect of shape, color, etc.
2. Life cycle of fashion

#### Course Outcome 3(CO3)

1. Market Strategy - Prototype Development
2. Standard preparation - Second prototype

#### Course Outcome 4(CO4)

1. Organization of shows and preparation of art portfolios
2. The presentation and promotional activities

#### Course Outcome 5(CO5)

1. Direction of fashion trends in leather
2. Leather products production and marketing

## SYLLABUS

### Module I:

#### Historical Evaluation and International Trends

Historical evaluation of leather and leather products styling. Seasonal influences on fashion, cultural and geographical instances on leather and products fashion. Market research and track record

## Module II:

### Fashion Considerations

Design Criteria through effect of shape, colour, pattern, texture and decorative materials. Life cycle of fashion

## Module III:

### Product Development

Market Strategy - Prototype Development - Field test and evaluation - Standard preparation - Second prototype - Final run. Costing

## Module IV:

### Presentation Techniques

Organization of shows and preparation of art portfolios; advertising; effect of foreign languages in the presentation and promotional activities.

## Module V:

### Fashion Forecast

Direction of fashion trends in leather and leather products production and marketing.

## References and suggested readings

1. Cott, N.F., "*American Shoe Making*", Shoe Trades Publishing Co., Cambridge.1993.
2. "*Apparel International*" Published by P.F collier and sons, U.K, 1961.
3. "*Shoes and Leather News*", Published by bureau of foreign and domestic commerce, Dept of commerce, US, 1940.

## Course contents and lecture schedule

Module No.	Topic	No. of Lectures
<b>1.</b>	<b>Historical Evaluation and International Trends</b>	
1.1	Historical evaluation of leather and leather products styling	01
1.2	Seasonal influences on fashion	01
1.3	cultural on leather and products fashion	01
1.4	geographical instances on leather and products fashion	02
1.5	Market research and track record	01
<b>2.</b>	<b>Fashion Considerations</b>	

2.1	Design Criteria through effect of shape	01
2.2	Design Criteria through effect of color, pattern	02
2.3	Design Criteria through effect of texture and decorative materials	02
2.4	Life cycle of fashion	01
<b>3.</b>	<b>Product Development</b>	
3.1	Market Strategy - Prototype Development	02
3.2	Field test and evaluation	02
3.3	Standard preparation - Second prototype	02
3.4	Final run. Costing	02
<b>4.</b>	<b>Presentation Techniques</b>	
4.1	Organization of shows and preparation of art portfolios	02
4.2	Advertising; effect of foreign languages	02
4.3	Presentation and promotional activities	02
<b>5</b>	<b>Fashion Forecast</b>	
5.1	Direction of fashion trends in leather	02
5.2	leather products production	01
5.3	leather products marketing	01
<b>Total hours</b>		<b>30</b>

### NLT-481 INDUSTRIAL TRAINING

**L T P C**  
**0 0 4 2**

The students after summer internship of 6 to 8 weeks would be giving presentation on the work they performed or learned during training

**OBJECTIVE:** The objective of this course is to enable the students

- To expose to industrial environment
- To acquaint with the various machines for the manufacturing of Leathers
- For testing of raw materials and finished products
- Handle the research project.
- To improve professional attitude

#### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the work culture and human relationship.	Understand
<b>CO2</b>	Apply the theoretical knowledge in understanding the working of various	Apply

	machines	
<b>CO3</b>	Understand the process sequence and optimization of process parameters.	Understand
<b>CO4</b>	To get exposure to various conventional and model tools and equipments for testing of raw materials and finished products	Apply
<b>CO5</b>	To analyze the research problem and devise methodology/ steps to solve it	Analyze

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	1	3	2									
<b>CO2</b>	2	2	2		2	2						
<b>CO3</b>	2	3		2	3							
<b>CO4</b>		3	2	3	3							
<b>CO5</b>		3	3	3	3							
<b>Average</b>	1.6	2.8	2.5	2.6	2.7	2						

### OLT 401: ENTREPRENEURSHIP FOR LEATHER SECTOR

**L T P C**  
**2 0 0 2**

OBJECTIVE: To impart knowledge on making leather goods :

- To understand the Indian leather industry.
- To understand the management in leather sector.
- To understand the future trends in leather industry.
- To understand the entrepreneurship in leather sector.
- To understand the general aspects & future possibilities in leather sector.

**Course**

#### Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	To understand the Indian leather industry.	Understand
<b>CO2</b>	To understand the management in leather sector.	Understand
<b>CO3</b>	To understand the future trends in leather industry.	Understand

<b>CO4</b>	To understand the entrepreneurship in leather sector.	Understand
<b>CO5</b>	To understand the general aspects & future possibilities in leather sector.	Understand

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	3		3		2							3
<b>CO2</b>	3		3		2							3
<b>CO3</b>	3		3		2							3
<b>CO4</b>	3		3		2							3
<b>CO5</b>	3		3		2							3
<b>Average</b>	3		3		2							3

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no*

*correlation, put “-”*

### **Course level assessment questions**

#### **Course Outcome 1(CO1)**

1. An overview of the Indian leather industry.
2. Boosters to exporters.
3. Historical perspectives of Indian leather industry.

#### **Course Outcome 2(CO2)**

1. Organization and management
2. Technical feasibility appraisal and financial aspects.
3. Need for quality control and standards.

#### **Course Outcome 3(CO3)**

1. Future trends in leather industry
2. New finishing technology
3. Emerging technologies and genetic revolution

#### **Course Outcome 4(CO4)**

1. Entrepreneurship in leather sector
2. Forecasting and prospective
3. Factors influencing business environment.

#### **Course Outcome 5(CO5)**

1. Today's situation, recommendation, terminologies, new concepts.
2. Lack of awareness of market needs
3. Do's & Dont's in making-up

## **SYLLABUS**

### **Module-I:**

#### **AN OVERVIEW OF THE INDIAN LEATHER INDUSTRY**

Introduction, prospects brighten in the export front of leather industry, boosters to exporters, and historical perspectives of Indian leather industry.

### **Module-II:**

#### **MANAGEMENT IN LEATHER SECTOR**

Organization and management, Special features of the Leather industry, Technical feasibility appraisal and project reports, financial aspects: - fixed capital, working capital requirement, overheads, profitability, Technical aspects, Need for quality control and standards.

### **Module-III:**

#### **FUTURE TRENDS IN LEATHER INDUSTRY**

Introduction, Leather industry – future trends, Resources generation/ mobilization, processes and products, new finishing technology, Energy saving process, emerging technologies, genetic revolution, products, environment, pollution.

### **Module-IV:**

#### **ENTREPRENEURSHIP IN LEATHER SECTOR**

Entrepreneurship, the factors influencing the cost, forecasting and prospective, factors influencing business environment.

### **Module-V:**

#### **GENERAL ASPECTS – FUTURE POSSIBILITIES**

Vision statement, goals and objective, today's situation, recommendation, terminologies, new concepts, electronic commerce, lack of awareness of market needs, typical example of problems in production, Do's & Dont's in making-up.

### **References and suggested readings**

1. T.S.K Mahadevan, "Entrepreneurship- Organization and management in leather sector".

### **Course contents and lecture schedule**

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>AN OVERVIEW OF THE INDIAN LEATHER INDUSTRY</b>	
1.1	Introduction.	01

1.2	Prospects brighten in the export front of leather industry.	01
1.3	Boosters to exporters, and historical perspectives of Indian leather industry.	02
<b>2.</b>	<b>MANAGEMENT IN LEATHER SECTOR</b>	
2.1	Organization and management	01
2.2	Special features of the Leather industry, Technical feasibility appraisal and project reports	01
2.3	Financial aspects: - fixed capital, working capital requirement, overheads, profitability	01
2.4	Technical aspects, Need for quality control and standards.	01
<b>3.</b>	<b>FUTURE TRENDS IN LEATHER INDUSTRY</b>	
3.1	Introduction, Leather industry – future trends, , ,	01
3.2	Resources generation/ mobilization, processes and products	01
3.3	New finishing technology, Energy saving process, emerging technologies	01
3.4	Genetic revolution, products, environment, pollution.	01
<b>4.</b>	<b>ENTREPRENEURSHIP IN LEATHER SECTOR</b>	
4.1	Entrepreneurship	01
4.2	The factors influencing the cost	01
4.3	Forecasting and prospective	01
4.4	Factors influencing business environment	01
<b>5</b>	<b>GENERAL ASPECTS – FUTURE POSSIBILITIES</b>	
5.1	Vision statement, goals and objective	01
5.2	Today's situation, recommendation, terminologies, new concepts, electronic commerce, lack of awareness of market needs	01
5.3	Typical example of problems in production	01
5.4	Do's & Dont's in making-up.	01
<b>Total hours</b>		<b>20</b>

## NLT – 491: MINOR PROJECT

**L T P C**  
**0 0 12 6**

**OBJECTIVE:** The objective of this course is to enable the students

- To identify a Leather product that can be manufactured in India or a research problem and conduct experiment.
- To prepare a feasibility report for a project based on manufacturing of product.
- To present a lecture on the topic on power point format.
- To improve the communication skill of the students.

### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand a topic of latest developments/innovative technology.	Understand
<b>CO2</b>	Apply the knowledge to prepare a feasibility/dissertation report on this topic.	Apply

<b>CO3</b>	Deliver a lecture on the topic on power point format.	Apply
<b>CO4</b>	Improve the communication skill of the students.	Communication
<b>CO5</b>	Analyze environment and sustainability of related technology	Analyze

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	3			1		2	1		1			
<b>CO2</b>	2	2	2	1	1	2	3		2	3	3	2
<b>CO3</b>										3		2
<b>CO4</b>										3		2
<b>CO5</b>						2	3		2			2
<b>Average</b>	2.5	2	2	1	1	2	2.3		1.6	3	3	2

1: Slight (Low)                      2: Moderate (Medium)                      3: Substantial (High)                      *If there is no correlation, put “-”*

### NLT - 471: SEMINAR

**L T P C**  
**0 0 4 2**

<b>OBJECTIVE:</b> The objective of this course is to enable the students
<ul style="list-style-type: none"> <li>• Study a topic of latest developments/innovative technology on their own and to prepare a dissertation report on this topic.</li> <li>• Present a lecture on the topic on power point format.</li> <li>• Improve the communication skill of the students.</li> </ul>

#### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand a topic of latest developments/innovative technology.	Understand
<b>CO2</b>	Apply the knowledge to prepare a dissertation report on this topic.	Apply
<b>CO3</b>	Deliver a lecture on the topic on power point format.	Apply

<b>CO4</b>	Improve the communication skill of the students.	Communication
<b>CO5</b>	Analyze environment and sustainability of related technology	Analyze Environment & Sustainability

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3			1		2	1		1			
<b>CO2</b>	2	2	2	1	1	2	3		2	3	1	2
<b>CO3</b>										3		1
<b>CO4</b>										3		1
<b>CO5</b>						2	3		2			2
<b>Average</b>	2.5	2	2	1	1	2	2.3		1.6	3	1	1.5

### SEMESTER VIII

#### NLT-422: LEATHER BIOTECHNOLOGY

**L T P C**  
**3 1 0 4**

**OBJECTIVE:** The objective of this course is to enable the students

- To know about Protein and Nucleic Acid
- To know about Enzymology
- To know Genetics Engineering & Recombinant DNA Technology
- To understand Biotechnology for Hides/Skins Improvement
- Waste Management & Utilization.

#### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand about Protein and Nucleic Acid	Understand
------------	---	------------

<b>CO2</b>	Understand Enzymology	Understand
<b>CO3</b>	Understand Genetics Engineering & Recombinant DNA Technology	Understand
<b>CO4</b>	Understand Biotechnology for Hides/Skins Improvement	Understand
<b>CO5</b>	Understand Waste Management & Utilization.	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3						1					
<b>CO2</b>	3						2					
<b>CO3</b>	3	1				1	1					
<b>CO4</b>	3	1	2	2		2	2					
<b>CO5</b>	3	2	2	3	3	2	2	2	1			3
<b>Average</b>	3	1.3	2	2.5	3	1.6	1.6	2	1			3

1: Slight (Low)      2: Moderate (Medium)      3: Substantial (High)      *If there is no correlation, put “-”*

### Course Level Assessment Questions

#### Course Outcome 1 (CO1)

1. Chemistry of DNA & RNA
2. Structure conformation and function of Proteins
3. Structure and function, Separation principles on Proteins

#### Course Outcome 2(CO2)

1. Assay Characterization,
2. Mechanism of action immobilized enzymes.

#### Course Outcome 3 (CO3)

1. Principles and methods Essentials of Biotechnology
2. Products of Biotechnology
3. DNA Cloning strategies.

#### Course Outcome 4 (CO4)

1. Biotechnology for Hides/Skins Improvement
2. Application in animal nutrition
3. Use of enzyme options in beam house operation

### **Course Outcome 5(CO5)**

1. Waste Management & Utilization
2. Energy recovery
3. Collagen and its application in food, Cosmetics and fields

### **SYLLABUS**

#### **Module-I:**

##### **PROTEIN AND NUCLEIC ACID:**

Chemistry of DNA & RNA, Structure conformation and function of Proteins, Chemistry, Structure and function, Separation principles on Proteins.

#### **Module-II:**

##### **ENZYMولوجY:**

Classification, Assay Characterization, Mechanism of action immobilized enzymes.

#### **Module-III:**

##### **GENETICS ENGINEERING & RECOMBINANT DNA TECHNOLOGY:**

Principles and methods Essentials of Biotechnology, Products of Biotechnology, Restrictions of Enzymes, Vectors, DNA Cloning strategies.

#### **Module-IV:**

##### **BIOTECHNOLOGY:**

Biotechnology for Hides/Skins Improvement, Application in animal nutrition and animal production, Embryo Transfer, Gene Transfer, Transgenic animals, Use of enzyme options in beam-house operation, Soaking, Unhairing, Bating, and Degreasing, Types of Fermentation, Preparation of Media, Preparation of Inoculum, Separation and purification of products.

#### **Module-V:**

##### **WASTE MANAGEMENT & UTILIZATION:**

Waste Management & Utilization of Collagenous Tissue for Biomedical and other Application: General features of the organic and inorganic pollutants of Tannery stabilization and disposal of organic and chemical wastes and their biological treatment, Treatment of tannery effluents, Energy recovery, Collagen and its application in food, Cosmetics and fields.

#### **Recommended Books:**

1. White, Handler, Smith., "Principles of Bio-Chemistry".
2. Lehinger, A.L., Neston D.L. "Principles of Bio-Chemistry".
3. Reed R. "Science for Schedule of Leather Technology".

### Course contents and lecture schedule

Module No.	Topic	No. of Lectures
<b>1.</b>	<b>PROTEIN AND NUCLEIC ACID</b>	
1.1	Chemistry of DNA & RNA	03
1.2	Structure conformation and function of Proteins	02
1.3	Chemistry, Structure and function, Separation principles on Proteins	03
<b>2.</b>	<b>ENZYMOMOLOGY</b>	
2.1	Classification, Assay Characterization	02
2.2	Mechanism of action immobilized enzymes	02
<b>3.</b>	<b>GENETICS ENGINEERING &amp; RECOMBINANT DNA TECHNOLOGY</b>	
3.1	Principles and methods Essentials of Biotechnology	03
3.2	Products of Biotechnology, Restrictions of Enzymes	03
3.3	Vectors, DNA Cloning strategies	02
<b>4.</b>	<b>BIOTECHNOLOGY</b>	
4.1	Biotechnology for Hides/Skins Improvement, Application in animal nutrition and animal production	03
4.2	Embryo Transfer, Gene Transfer, Transgenic animals, Use of enzyme options in beam-house operation, Soaking, Unhairing, Bating, and Degreasing	03
4.3	Types of Fermentation, Preparation of Media, Preparation of Inoculum, Separation and purification of products.	03
<b>5.</b>	<b>WASTE MANAGEMENT &amp; UTILIZATION</b>	
5.1	Waste Management & Utilization of Collagenous Tissue for Biomedical and other Application	03
5.2	General features of the organic and inorganic pollutants of Tannery stabilization and disposal of organic and chemical wastes and their biological treatment	03
5.3	Treatment of tannery effluents, Energy recovery, Collagen and its application in food, Cosmetics and fields.	03
<b>Total hours</b>		<b>40</b>

## **NLT 424: COMPUTER AIDED LEATHER PRODUCT DESIGN**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**OBJECTIVE:** The objective of this course is to enable the students understand:

- The Anatomy of human foot.
- Different types of footwear
- Basic methods of cutting different components
- Different method of footwear construction

- Role of Computer aided design.

### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the Anatomy of human foot	Understand
<b>CO2</b>	Understand the Different types of footwear & their components.	Understand
<b>CO3</b>	Understand Basic methods of cutting different components	Understand
<b>CO4</b>	Understand the Different method of footwear construction.	Understand
<b>CO5</b>	Understand the Role of Computer aided design.	Understand

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3											
<b>CO2</b>	3	2	1									
<b>CO3</b>	3	2	3	2	2							
<b>CO4</b>	3	2			1	1						
<b>CO5</b>	3	2	2	3	2	1	2	2				
<b>Average</b>	3	2	2	2.5	1.6	1	2	2				

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no*

*correlation, put “-”*

### Course Level Assessment Questions

#### Course Outcome 1(CO1)

1. Anatomy of human
2. Function of the foot, Foot comfort and Common foot abnormalities.
3. Shoe sizing system and fittings.

### **Course Outcome 2(CO2)**

1. Different types of footwear
2. Basics concepts of design and pattern cutting.
3. leather materials for different components of footwear

### **Course Outcome 3(CO3)**

1. Basic methods of cutting different components
2. Tools and equipment for footwear making.
3. Closing of simple uppers.

### **Course Outcome 4(CO4)**

1. Different method of footwear construction.
2. Classification of Leather goods.
3. Material selection criteria for leather garments.

### **Course Outcome 5(CO5)**

1. CAD, CPU, Data storage, Input/output devices.
2. Operating system.
3. Application of software for Footwear.

## **SYLLABUS**

### **Module-I**

Anatomy of human foot, Function of the foot, Foot comfort and Common foot abnormalities, Foot and Last measurement, Shoe sizing system and fittings.

### **Module-II**

Designing and pattern making, Different types of footwear, Various components of footwear, Basics concepts of design and pattern cutting, Grading methods, Various allowances, Applications of computer aid designing, Materials of leather products- Selection of leather and non-leather materials for different components of footwear and garments.

### **Module-III**

Basic methods of cutting different components, Tools and equipment for clicking, marking, skiving, edge treatments, fitting, stitching and types of stitches, closing of simple uppers.

### **Module-IV**

Different method of footwear construction, Cemented, Direct vulcanized, Injection-moulded, Veldschoen, Machine welted, Slip and sting Lasted, Finishing and Treening operation, , Classification of Leather goods, Type and selection of materials, Methods of construction, Tools and Machinery. Classification of leather, Material selection criteria for leather garments. Lining materials, Factors such as light weight, Porosity, Water absorption, Accessories metal fittings for

garments, Designing methods, various components, Preparation of Standards & pattern of Garment/Material.

### Module-V

Computer aided design, CAD, CPU, Data storage, Input/output devices, Function of CPU, Main memory and backup storage devices, Selection of Input/output devices, Operating system, Application of software for Footwear.

### Recommended Books

1. Clarks,"Manual on shoe Making".
2. "Tips for shoe Making"
3. CLRI, SATRA, FDDI, Publication

### Course contents and lecture schedule

Module No.	Topic	No. of lectures
<b>1.</b>		
1.1	Anatomy of human foot.	02
1.2	Function of the foot, Foot comfort and Common foot abnormalities,	01
1.3	Foot and Last measurement.	01
1.4	Shoe sizing system and fittings.	02
<b>2.</b>	<b>Designing and pattern making:</b>	
2.1	Different types of footwear	02
2.2	Various components of footwear	01
2.3	Basics concepts of design and pattern cutting, Grading methods, Various allowances,.	02
2.4	Applications of computer aid designing,	01
2.5	Materials of leather products- Selection of leather and non-leather materials for different components of footwear and garments	02
<b>3.</b>		
3.1	Basic methods of cutting different components	02
3.2	Tools and equipment for clicking, marking, skiving, edge treatments, fitting, stitching.	02
3.3	Types of stitches.	01
3.4	Closing of simple uppers.	01
<b>4.</b>		
4.1	Different method of footwear construction, Cemented, Direct vulcanized Injection moulded, Veldschoen, Machine welted, Slip and sting Lasted,	02
4.2	Finishing and Treening operation.	02

4.3	Classification of Leather goods.	02
4.4	Type and selection of materials.	01
4.5	Methods of construction, Tools and Machinery, Classification of leather, Material selection criteria for leather garments	02
4.6	Lining materials, Factors such as light weight, Porosity, Water absorption,	02
4.7	Accessories metal fittings for garments, Designing methods, Various components, Preparation of Standards & pattern of Garment/Material	02
<b>5.</b>	<b>Bulk nano structured materials</b>	
5.1	Computer aided design, CAD, CPU, Data storage, Input/output devices, Function of CPU, Main memory and backup storage devices,	03
5.2	Selection of Input/output devices, Operating system,	02
5.3	Application of software for Footwear.	02
<b>Total Hours</b>		<b>40</b>

## NLT 426: TOTAL QUALITY MANAGEMENT

L T P C  
3 1 0 4

**OBJECTIVE:** To provide comprehensive knowledge about the principles, practices, tools and techniques of total quality management :

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

**Course Outcome**

On the successful completion of the course, students will be able to

<b>CO1</b>	To understand the need for quality, its evolution, basic concepts, contribution of quality gurus	Understand
<b>CO2</b>	To understand TQM framework, Barriers and Benefits of TQM.	Understand
<b>CO3</b>	To understand the TQM Principles.	Understand
<b>CO4</b>	To apply the various tools and techniques of TQM.	Apply
<b>CO5</b>	To apply QMS and EMS in any organization	Apply

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>					3	3	3		3			
<b>CO2</b>					3	3	3		3			
<b>CO3</b>					3	3	3		3			
<b>CO4</b>					3	3	3		3			
<b>CO5</b>					3	3	3		3			
<b>Average</b>					3	3	3		3			

1: Slight (Low)      2: Moderate (Medium)      3: Substantial (High)      *If there is no correlation, put “-”*

**Course level assessment questions**

**Course Outcome 1(CO1)**

1. Introduction.
2. Definition of TQM.
3. Benefits of TQM.

**Course Outcome 2(CO2)**

1. TQM principles.
2. Quality and feedback.
3. Supplier selection and rating.

**Course Outcome 3(CO3)**

1. New management tools
2. Performance and planning.
3. Design, stages and process of FMEA.

**Course Outcome 4(CO4)**

1. Quality function development.
2. TPM concepts
3. Performance and cost of quality.

**Course Outcome 5(CO5)**

1. Benefits of ISO Registration.
2. Standards and requirement of ISO 9000,ISO 9001 and ISO 14000.
3. Benefits of EMS.

**SYLLABUS****Module-I:****INTRODUCTION**

Need for quality, Evolution of quality, Definition of quality, Dimensions of product and service quality, Definition of TQM, Basic concepts of TQM, Gurus of TQM, TQM Framework, Barriers to TQM, Benefits of TQM.

**Module-II:****TQM PRINCIPLES**

Leadership--The Deming Philosophy, Quality council, Quality statements and Strategic planning-- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward and Performance Appraisal--Continuous process improvement –Juran Trilogy, PDCA cycle, 5s and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

**Module-III:****TQM TOOLS AND TECHNIQUES I**

The seven traditional tools of quality, New management tools, Six-sigma Process Capability, Bench marking, Reasons to bench mark, Bench marking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Bench Marking, FMEA, Intent of FMEA, FMEA Documentation, Stages, Design FMEA and Process FMEA.

**Module-IV:****TQM TOOLS AND TECHNIQUES II**

Quality circles, Quality Function Deployment (QFD), Taguchi quality loss function, TPM Concepts, improvement needs, Performance measures, Cost of Quality, BPR.

**Module-V:**

**QUALITY MANAGEMENT SYSTEM**

Benefits of ISO Registration, ISO9000 Series of Standards, Sector Specific Standards AS9100, TS16949 and TL9000, ISO9001 Requirements, Implementation, Documentation, Internal Audits, Registration, Environmental management system, ISO14000 Series Standards, Concepts of ISO14001, Requirements of ISO14001, Benefits of EMS.

**References and suggested readings**

1. R. Norris Shreve, “Chemical process industries”.
2. W. Smith, R Chapman, “Chemical process industries”.

**Course contents and lecture schedule**

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>Introduction :</b>	
1.1	Need for quality, Evolution of quality, Definition of quality Dimensions of product and service quality	03
1.2	Definition of TQM, Basic concepts of TQM, Gurus of TQM,	03
1.3	TQM Framework, Barriers to TQM and Benefits of TQM.	02
<b>2.</b>	<b>TQM Principles:</b>	
2.1	Leadership, The Deming Philosophy, Quality council, Quality statements and Strategic planning, Customer Satisfaction, Customer Perception of Quality	03
2.2	Feedback, Customer complaints, Service Quality, Kano Model and Customer retention, Employee involvement, Motivation, Empowerment	02
2.3	Team and Teamwork, Recognition and Reward and Performance Appraisal, Continuous process improvement, Juran Trilogy, PDSA cycle, 5s and Kaizen	03
2.4	Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.	02
<b>3.</b>	<b>TQM Tools and Techniques- I</b>	
3.1	The seven traditional tools of quality, New management tools, Six-sigma Process Capability	03
3.2	Bench marking, Reasons to bench mark, Bench marking process, What	02

	to Bench Mark, Understanding Current Performance	
3.3	Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Bench Marking	02
3.4	FMEA, Intent of FMEA, FMEA Documentation, Stages, Design FMEA and Process FMEA.	02
<b>4.</b>	<b>TQM Tools and Techniques- II</b>	
4.1	Quality circles, Quality Function Deployment (QFD)	02
4.2	Taguchi quality loss function, TPM Concepts	02
4.3	Improvement needs, Performance measures, Cost of Quality, BPR.	02
<b>5</b>	<b>Quality Management System</b>	
5.1	Benefits of ISO Registration, ISO9000 Series of Standards	02
5.2	Sector Specific Standards AS9100, TS16949 and TL9000, ISO9001 Requirements, Implementation, Documentation, Internal Audits, Registration, Environmental management system	03
5.3	ISO14000 Series Standards, Concepts of ISO14001, Requirements of ISO14001, Benefits of EMS.	02
<b>Total hours</b>		<b>40</b>

## OLT 402: LEATHER MACHINERY

**L T P C**  
**2 0 0 2**

**OBJECTIVE:** To provide orientation on the machineries used for leather and leather products manufacture:

- Understand the mechanical power transmission system
- Understand the working principles of leather processing machineries.
- Understand the working principles of leather product machineries.
- Apply the knowledge on transport systems and automation in leather product manufacture.
- Understand the awareness of layout and maintenance of tannery and leather product unit

**Course Outcome**

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand the mechanical power transmission system	Understand
<b>CO2</b>	Understand the working principles of leather processing machineries.	Understand
<b>CO3</b>	Understand the working principles of leather product machineries.	Understand
<b>CO4</b>	Apply the knowledge on transport systems and automation in leather product manufacture.	Apply
<b>CO5</b>	Understand the awareness of layout and maintenance of tannery and leather product unit	Understand

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>		3	2		3							3
<b>CO2</b>		3	2		3							3
<b>CO3</b>		3	2		3							3
<b>CO4</b>		3	2		3							3
<b>CO5</b>		3	2		3							3
<b>Average</b>		3	2		3							3

1: Slight (Low)      2: Moderate (Medium)      3: Substantial (High)      *If there is no correlation, put “-”*

**Course level assessment questions**

**Course Outcome 1(CO1)**

1. Mechanical power transmission system components
2. Introduction to Fluid power
3. Properties of fluids

**Course Outcome 2(CO2)**

1. Salient features and purpose of the various machinery used in beam house.
2. Salient features and purpose of the various machinery used in tanning yards

3. Salient features and purpose of the various machinery used in finishing yards

#### **Course Outcome 3(CO3)**

1. Salient features and purpose of the various machinery used in leather product manufacturing

#### **Course Outcome 4(CO4)**

1. Different types of material handling
2. Application of computer/microprocessor based machines
3. Die Less Cutting Systems

#### **Course Outcome 5(CO5)**

1. Layout for a small/medium tannery and leather product unit
2. Arrangements of machines as per the sequence
3. Preventive maintenance and safety

### **SYLLABUS**

#### **Module-I:**

#### **MECHANICAL POWER TRANSMISSION AND FLUID POWER SYSTEMS**

Mechanical power transmission system components- Belts, chains, Gears and Cams. Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids.

#### **Module-II:**

#### **PRINCIPLES AND OPERATION OF LEATHER PROCESSING MACHINERIES**

Salient features and purpose of the various machinery used in beam house, tanning and finishing yards - unhairing, fleshing, scudding, sammying, setting, shaving, staking, buffing, dedusting, glazing machines, finiflex, hydraulic press, curtain coating, roller coating, transfer coating, autospray, driers, measuring machine.

#### **Module-III:**

#### **PRINCIPLES AND OPERATION OF LEATHER PRODUCT MACHINERIES**

Salient features and purpose of the various machinery used in leather product manufacturing – Clicking, Splitting, Skiving, Sewing machines – Flat bed, Post bed, Cylinder bed machines, strap cutting machine, Lasting machines – Forepart lasting, Heel seat lasting, Side lasting, Post lasting machines, Heat setting, Pondering, Roughing, Heat activator, Sole pressing, Shoe polishing machine

#### **Module-IV:**

#### **TRANSPORT SYSTEMS AND AUTOMATION IN LEATHER PRODUCT MANUFACTURING**

Different types of material handling system in leather products industry. Manual, semi-automatic and automatic conveyor. Application of computer/microprocessor based machines for leather products making, Die Less Cutting Systems.

**Module-V:**

**LAYOUT AND MAINTENANCE**

Layout for a small/medium tannery and leather product unit. Arrangements of machines as per the sequence of operation for standard leather processing/ product making. Preventive maintenance and safety in the use of leather and leather product machineries.

**References and suggested readings**

3. R. Norris Shreve, “Chemical process industries”.
4. W. Smith, R Chapman, “Chemical process industries”.

**Course contents and lecture schedule**

<b>Module No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>1.</b>	<b>MECHANICAL POWER TRANSMISSION AND FLUID POWER SYSTEMS</b>	
1.1	Mechanical power transmission system components- Belts, chains, Gears and Cams.	02
1.2	Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids	02
<b>2.</b>	<b>PRINCIPLES AND OPERATION OF LEATHER PROCESSING MACHINERIES</b>	
2.1	Salient features and purpose of the various machinery used in beam house, tanning and finishing yards - unhairing, fleshing, scudding, ,	02
2.2	sammying, setting, shaving, staking, buffing, dedusting, glazing machines	01
2.3	Finiflex, hydraulic press, curtain coating, roller coating, transfer coating, autospray, driers, measuring machine.	01
<b>3.</b>	<b>PRINCIPLES AND OPERATION OF LEATHER PRODUCT MACHINERIES</b>	
3.1	Salient features and purpose of the various machinery used in leather product manufacturing – Clicking, Splitting, Skiving	01
3.2	Sewing machines – Flat bed, Post bed, Cylinder bed machines, strap cutting machine	01

3.3	Lasting machines – Forepart lasting, Heel seat lasting, Side lasting, Post lasting machines	01
3.4	Heat setting, Ponding, Roughing, Heat activator, Sole pressing, Shoe polishing machine	01
<b>4.</b>	<b>TRANSPORT SYSTEMS AND AUTOMATION IN LEATHER PRODUCT MANUFATURING</b>	
4.1	Different types of material handling system in leather products industry.	01
4.2	Manual, semi- automatic and automatic conveyor.	01
4.3	Application of computer/microprocessor based machines for leather products making, Die Less Cutting Systems.	02
<b>5</b>	<b>LAYOUT AND MAINTENANCE</b>	
5.1	Lay out for a small/medium tannery and leather product unit.	02
5.2	Arrangements of machines as per the sequence of operation for standard leather processing/ product making.	01
5.3	Preventive maintenance and safety in the use of leather and leather product machineries.	01
<b>Total hours</b>		<b>20</b>

### NLT 492: PROJECT

**L T P C**  
**0 0 24 16**

**OBJECTIVE:** The objective of this course is to enable the students

- To identify the project, product ideas may emerge mainly from survey of raw materials
- To prepare a detailed project report on fabrication of a product/equipment/process of a plant for production of Leathers product with complete lay-out or a research problem and conduct experiment.
- To assess the economic analysis and to prepare a feasibility report for a project based on manufacturing of product/equipment/process.
- To prepare the students for entrepreneurship. .
- To develop marketing skill in the students.

### Course Outcome

On the successful completion of the course, students will be able to

<b>CO1</b>	Understand a topic of latest developments/innovative technology	Understand
<b>CO2</b>	Apply the knowledge to prepare a feasibility/dissertation report on this topic.	Apply
<b>CO3</b>	Deliver a lecture on the topic on power point format.	Apply
<b>CO4</b>	Improve the communication skill of the students.	Communication
<b>CO5</b>	Analyze environment and sustainability of related technology	Analyze

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	2		1		2	1		3		2	
<b>CO2</b>	2	2	2	1	1	2	3		2	3	3	2
<b>CO3</b>										3		2
<b>CO4</b>										3		2
<b>CO5</b>						2	3		2			2
<b>Ave rage</b>	2.5	2	2	1	1	2	2.3		2.3	3	2.5	2

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

*If there is no*

*correlation, put “-”*