# M.D. UNIVERSITY, ROHTAK

# SCHEME OF STUDIES AND EXAMINATION
# (Under NEP-2020)

# B. Tech (TEXTILE CHEMISTRY)
# SEMESTER 3RD AND 4TH

## 'H' Scheme (Under NEP-2020)

## Effective from:
## Academic Session 2026-27 (for 2nd Year)

1. Definition of Credit:

| | |
|---|---|
| 1 Hr. Lecture (L) per week | 1 credit |
| 1 Hr. Tutorial (T) per week | 1 credit |
| 1 Hr. Practical (P) per week | 0.5 credits |
| 2 Hours Practical (Lab) per week | 1 credit |

2. Structure of the Undergraduate Engineering program:

| Sr. No. | Category |
|---|---|
| 1 | Humanities and Social Sciences including Management courses |
| 2 | Basic Science Courses |
| 3 | Engineering Science courses |
| 4 | Program Core Courses (Branch specific) |
| 5 | Professional Elective courses relevant to chosen specialization/branch |
| 6 | Open Elective Courses (from Humanities, Technical Emerging or other Subjects) |
| 7 | Project work, Seminar and Internship in Industry or elsewhere |
| 8 | Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition] etc. (non-credit) |

3. Course code and definition:

| **Course Code** | **Definitions** |
|---|---|
| L | Lecture |
| T | Tutorial |
| P | Practical |
| BSC | Basic Science Courses |
| ESC | Engineering Science Courses |
| HSMC | Humanities and Social Sciences including Management courses |
| PCC | Professional Core Courses |
| LC | Laboratory Courses |
| MC | Mandatory Courses |
| PT | Practical Training |
| PEC | Professional Elective courses |
| OEC | Open Elective courses |
| PRROJ/SEM | Seminar Employment Enhancement Courses (Project/Summer Internship/ Seminar) |

**PROGRAM OUTCOMES (PO)**

Engineering Graduates will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO6. Analyse and evaluate societal and environmental aspects while solving complex engineering problems, considering their impact on sustainability with reference to economy, health, safety, legal frameworks, culture, and the environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO8. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO9. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO10. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**PROGRAM SPECIFIC OUTCOMES (PSO)**

PSO1 (Core Textile Manufacturing and Chemical Processing): Apply knowledge of fibre, yarn, and fabric manufacturing along with principles of chemistry, materials science, and textile processing to design, optimize, and innovate colouration, finishing, and functionalization processes for diverse textile applications.

PSO2 (Chemical Analysis and Quality Evaluation): Analyze textile materials, dyes, chemicals, and auxiliaries using modern testing, characterization, and quality assessment techniques to ensure product quality, safety, and compliance with national and international standards.

PSO3 (Research, Innovation, and Professional Practice): Develop sustainable and advanced textile processing solutions using modern analytical tools, digital technologies, and research methodologies for technical, smart, and value-added textiles, while fostering innovation, entrepreneurship, professional ethics, and environmental responsibility.

# Semester-3

| Sr. No. | Course Code | Course Title | Hours per week | | | Total Contact Hrs. per week | Credit | Examination Scheme (Marks) | | | | Duration of Exam (Hours) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | | Internal awards | Theory | Practical | Total | |
| 1 | 26PCC-TT/TC/FAE-201H | Structure and Properties of Fibres | 3 | 1 | 0 | 4 | **4** | 30 | 70 | | 100 | 3 |
| 2 | 26PCC-TT/TC/FAE-203H | Yarn Manufacture-I | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 3 | 26PCC-TT/TC/FAE-205H | Fabric Manufacture-I | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 4 | 26PCC-TC-207H | Polymer Technology | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 5 | 26ESC-TT/TC/FAE-209H | Textile Chemical Processing-I | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 6 | 26BSC-TT/TC/FAE-211H | Statistical Methods and Applications in Textile | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 7 | 26LC-PCC-TT/TC/FAE-203H | Yarn Manufacture Lab-I | 0 | 0 | 2 | 2 | **1** | 5 | | 20 | 25 | 3 |
| 8 | 26LC-PCC-TT/TC/FAE-205H | Fabric Manufacture Lab-I | 0 | 0 | 2 | 2 | **1** | 5 | | 20 | 25 | 3 |
| 9 | 26LC-ESC-TT/TC/FAE-209H | Textile Chemical Processing Lab-I | 0 | 0 | 2 | 2 | **1** | 5 | | 20 | 25 | 3 |
| | | **Total** | | | | 25 | 22 | | | | 550 | |
| | **Honors course** | | | | | | | | | | | |
| 1 | 26PCC-TT/TC/FAE-213H | Fibre Science and Technology | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 2 | 26LC-PCC-TT/TC/FAE-213H | Fibre Science and Technology Lab | 0 | 0 | 2 | 2 | **1** | 5 | | 20 | 25 | 3 |
| | | **Total** | | | | 5 | **4** | | | | 100 | |

**26PCC-TT/TC/FAE-201H Structure and Properties of Fibres**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC/FAE-201H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Structure and Properties of Fibres | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 3 | 1 | 0 | 4 | |
| **Classwork** | 30 Marks | | | | |
| **Examination** | 70 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- Provide fundamental understanding of the fundamental concepts of fibre architectures.
- Explain the physical and molecular structure of various types of natural, manmade and regenerated fibres used in textile industry.
- Enable students to understand the relationship between polymer structure and mechanical and moisture related property.
- Familiarise students with the thermal, optical, friction and electrical properties of fibres.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Understand and explain the fundamental concepts and classifications of fibre architectures.

**CO2:** Describe the chemistry and structure of natural, manmade, and regenerated fibres commonly used in the textile industry.

**CO3:** Analyze the relationship between polymer structure and the mechanical and moisture-related properties of fibres.

**CO4:** Explain the thermal, optical, friction and electrical properties of textile fibres and their significance in end-use performance.

**CO - PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 3 | 1 | - |
| CO2 | 3 | 2 | - | 1 | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO3 | 2 | 3 | 1 | 2 | - | - | 1 | - | - | - | 1 | 3 | 3 | 1 |
| CO4 | 2 | 3 | 1 | 2 | 1 | - | 1 | - | - | - | 1 | 2 | 3 | 2 |
| Wt. Avg. | 2.50 | 2.25 | 1.00 | 1.67 | 1.00 | - | 1.00 | - | - | - | 1.00 | 2.75 | 2.25 | 1.50 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.69 |

**Note:** Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

**Internal structure of fibre:** Requirements for fibre formation from linear polymers, Molecular architecture. Amorphous and crystalline phases, crystallinity and orientation, crystal size etc. X-ray analysis of partial crystalline fibre structure.

**Cellulosic Fibres**: Chemistry and structure of cellulose fibres. **Cotton:** chemical composition, morphology, properties, and applications. Brief idea of properties and application of bast and leaf fibres.

**UNIT – II**

**Protein Fibres**: Chemistry of structures of protein fibres. **Wool:** chemical structure, morphology, properties and application, **Silk:** chemical composition, properties and application.

**Manmade and regenerated fibres:** Molecular structure, properties, and application of Polyester, Polyolefin, Polyacrylonitrile, Nylon. Introduction to important regenerated cellulose fibre e.g. Rayon, and Acetate; and regenerated protein fibre e.g.; Casein, Soy, Zein.

**UNIT – III**

**Mechanical property:** Relationship between polymer structure and mechanical properties of fibre like stress, strain, tenacity, initial modulus, yield point, toughness, elastic recovery, creep, stress relaxation.

**Moisture-related property:** Direct and indirect absorption of water molecules by a polymer molecule. Absorption of moisture in fibres, hysteresis. Moisture diffusion, moisture regain and moisture content, swelling.

**Electrical properties:** Dielectric, Electrical resistance and Static charge in fibres.

**UNIT – IV**

**Thermal properties:** Changes of state in polymers, Molecular motions and transition phenomenon. Glass transition and melting.

**Optical property:** Relationship between polymer structure and refractive index, Birefringence of different fibres.

**Frictional property:** Importance of frictional properties of fibres, Directional frictional effect of wool.

**Suggested Textbooks:**


1. Kozlowski, R. M. (Ed.). (2012). Handbook of natural fibres Woodhead Publishing Limited.
2. Eichhorn, S.J., Hearle J.W.S., Jaffe M. and Kakutani, T. (Ed.). (2009).; Handbook of Textile Fibre Structure: Volume-1: Fundamentals and Manufactured Polymer Fibres. Woodhead-Publishing Limited.
3. Eichhorn, S.J., Hearle J.W.S., Jaffe M. and Kakutani, T. (Ed.). (2009). Handbook of Textile Fibre Structure, Volume-2: Natural, regenerated, inorganic and specialist fibres Woodhead-Publishing Limited.
4. Kolanjikombil, M. (Ed.). (2018). The substrates: fibres, yarn and fabrics; Woodhead Publishing India Limited.
5. Gordon S. and Hsieh Y-L. (Ed.). (2007). Cotton: Science and Technology, Woodhead Publishing Limited.
6. Franck R. R. (Ed.). (2005). Bast and Other Plant Fibres. Woodhead Publishing Limited.
7. McIntyre, J. E. (Ed.). (2005). Synthetic fibres: nylon, polyester, acrylic, polyolefin. Woodhead Publishing Limited.
8. Hearle, J. W. S. and Morton, W. E. (2008) Physical properties of textile fibres, Fourth Edition, Woodhead Publishing Limited.

**26PCC-TT/TC/FAE-203H Yarn Manufacture-I**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC/FAE-203H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Yarn Manufacture-I | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- Provide fundamental understanding of ginning, blending, blowroom, carding and draw frame operations.
- Explain the role of preparatory processes in determining yarn quality and process efficiency.
- Enable students to analyse machinery parameters and their influence on fibre behaviour.
- Develop ability to evaluate process performance and identify quality-related issues.
- Familiarise students with recent technological developments in yarn preparatory processes.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Explain the objectives, principles, and machinery involved in ginning, blending, and blowroom processes.

**CO2:** Analyse blowroom and carding operations with respect to fibre control, cleaning efficiency, nep formation, and machine performance.

**CO3:** Apply principles of roller drafting, doubling, and auto-levelling at the draw frame stage for effective sliver preparation.

**CO4:** Evaluate preparatory process parameters using numerical problems and correlate process variables with yarn quality and production efficiency.

**CO - PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | 1 | - | - | - | - | - | 1 | 3 | 1 | - |
| CO2 | 2 | 3 | 1 | 2 | 1 | - | 1 | - | - | - | 1 | 3 | 2 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 2 | - | - | - | - | - | 1 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 3 | 2 | - | 1 | - | - | - | 1 | 3 | 3 | 2 |
| Wt. Avg. | 2.3 | 2.3 | 2.0 | 2.3 | 1.5 | - | 1.0 | - | - | - | 1.0 | 3.0 | 2.0 | 1.7 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.90 |

**Note:**
Examiner will set 9 questions in all, with two questions from each unit and one question covering all sections, which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total, selecting at least one from each unit.

**UNIT-I**

**Ginning:** Objectives of ginning, ginning machinery – roller gin and saw gin, pre-ginning machinery and its significance, post-ginning machinery and its significance, cotton contamination – types, sources, impact and control.

**Mixing and Blending:** Objectives of blending, different techniques of blending, advantages and disadvantages of blending techniques, indices of blending, selection of blend constituents.

**UNIT – II**

**Blowroom:** Objectives of blowroom, components and accessories, different zones in blowroom, blowroom machines, piano feed regulating motion, design of cone drums, lap forming mechanism, selection of blowroom lines for different cotton mixings and man-made fibres, numerical related to blowroom, performance assessment of blowroom, recent developments in blowroom.

**UNIT – III**

**Carding:** Objectives, principles of carding, stripping and brushing action, different zones of a carding machine, analysis of carding forces, mechanics of neps and hooks formation and their control, flexible and metallic card clothing, auto-levelling at card, performance assessment of a card, processing of cotton and man-made fibres on card, grinding of wire points, numerical related to carding machine, recent developments in carding.

**UNIT – IV**

**Draw Frame:** Objectives, principle of roller drafting, roller drafting arrangements and weighting systems, concept of ideal drafting and drafting wave, drafting forces, doubling and its significance, hooks removal at draw frame, principle of roller setting, processing of cotton and man-made fibres on draw frame, auto-levelling, roller lapping, performance assessment of draw frame, numerical related to draw frame, recent developments in draw frame.

**Suggested Textbooks:**

1. Lawrence, C. A., Fundamentals of Spun Yarn Technology, CRC Press, UK.
2. Klein, W., The Technology of Short-Staple Spinning, The Textile Institute, Manchester.
3. Rieter Machine Works Ltd., Manual of Spinning, Rieter, Switzerland.
4. Lord, P. R., Handbook of Yarn Production, Woodhead Publishing.

**26PCC-TT/TC/FAE-205H Fabric Manufacture-I**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC/FAE-205H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Fabric Manufacture-I | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- To Introduce students to various fabric manufacturing methods such as weaving, knitting, nonwoven, and braiding, along with their product range and applications.
- To Develop understanding of yarn winding operations including package formation, tensioning, yarn clearing, splicing, winding parameters, and winding machine types.
- To Familiarize students with warping and sizing processes, their objectives, machinery, control systems, sizing materials, and related production and material calculations.
- To explain the construction and working of looms, primary motions (shedding, picking, beat-up), and different shedding and picking mechanisms used in modern weaving.
- To enable students to understand and analyze take-up, let-off, and auxiliary loom motions, warp and weft control mechanisms, and defect-prevention systems for efficient fabric production.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Explain various fabric manufacturing methods including weaving, knitting, nonwoven and braiding, and perform calculations related to woven fabric parameters such as crimp, cover, areal density, warp and weft.

**CO2:** Describe and analyze yarn winding, warping, and sizing processes including machines, control systems, yarn tensioning, fault clearing, and related production and material calculations.

**CO3:** Explain the construction and working of weaving machines and primary loom motions including shedding, picking, and beat-up mechanisms, and solve numerical problems related to loom parameters.

**CO4:** Analyze take-up, let-off, and auxiliary loom motions, warp and weft stop mechanisms, and weft insertion control systems to ensure efficient and defect-free fabric production.

**CO - PO -PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | - | - | - | - | - | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | 1 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 3 | 2 | 2 | - | - | - | - | - | 1 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 2 | - | 1 | - | - | - | 1 | 3 | 3 | 2 |
| Wt. Avg. | 2.8 | 2.5 | 2.3 | 2.0 | 1.8 | - | 1.0 | - | - | - | 1.0 | 3.0 | 2.3 | 1.8 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 2.03 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

**Introduction**: to various fabric manufacturing methods like weaving, knitting, nonwoven and braiding, product range and applications, sequence of woven fabric manufacture, Warp, weft, crimp, cover, areal density and related calculations

**Winding:** Objectives of winding, types of packages, yarn withdrawal from different packages, Yarn tensioning, additive and multiplicative tensioners, optimization of winding tension, Yarn clearing, principles of mechanical and electronic clearers, classimat faults, winding cuts, splicing and knotting, Wind, wind per double traverse, angle of wind, Types of winders, drum driven and spindle driven winders, expression for winding speeds, cone winding, package density, problems in winding, patterning, gain, step precision winder.

**UNIT-II**

**Warping:** Objectives of warping, passage of warp, warping creels, efficiency of warping. Beam warping or direct warping, machines, Yarn tension in warping, leasing and beaming, control systems in warping. Sectional warping, objectives, passage of warp, Calculations related to beam and sectional warping.

**Sizing:** Objectives of sizing, sizing-weaving curve. Sizing ingredients, chemistry of size materials, calculations related to production, size add-on, size pick up and water evaporation. Sizing of different yarns, design of sow box.

**UNIT-III**

**Loom:** classification of looms, primary motions. Introduction to shedding mechanisms, distinct and indistinct shed, tappet shedding system, expression of lift of the tappets. Principles of dobby and jacquard shedding. Picking systems, shuttle picking, cone over pick, cone under pick systems. Beat-up mechanism Construction and working of beat-up mechanism, Movement of sley, beat up, sley eccentricity and the factors which influence it, calculation related to sley eccentricity, effects of sley eccentricity on beat up force and timing available for shuttle passage

**UNIT-IV**

**Secondary motions:** Take up motions, objectives, negative and positive take up motions. Let off motions, negative and Barlett- let off motions.

**Auxiliary motions** Weft stops motions, side wet fork and centre weft fork motion. Warp protector motions, loose reed and fast reed mechanisms. Warp stop motions mechanical warp stop motion and electrical warp stop motion. Weft feelers, bobbin change mechanism, weft mixing, Multiple drop box motions.

**Alternative NPTEL/SWAYAM Course:**

| SNo | NPTEL course name | Instructor | Host Institute |
|---|---|---|---|
| 1. | Fabric Manufacturing I | Prof. A. Majumdar | IITD |

**Suggested Textbooks:**


1. Fundamentals of Yarn Winding by Miland Koranne, CRC Press, New Delhi, 2025.
2. Textile Sizing by Bhuvenesh C. Goswami, Rajesh D. Anandjiwala, David Hall, CRC Press, 2004.
3. Principles of Weaving by R. Marks and A. T. C. Robinson, Textile Institute, 1976.
4. Principles of Woven Fabric Manufacturing by A. Majumdar, CRC Press, 2016.
5. Weaving: Conversion of Yarn to Fabric by P. R. Lord and M. H. Mohamed, Woodhead Publishing, 1982.
6. Principles of Fabric Formation by P. K. Banerjee, CRC Press, 2015.
7. Textile Mathematics by J. E. Booth (Volume III), Textile Institute.

## 26PCC-TC-207H Polymer Technology

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TC-207H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Polymer Technology | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**Course Objectives:**

The course is designed to impart the following:

- To educate the students on the subject of polymers that constitute one of the most important materials used presently.
- The course will include fundamentals of synthesis, characterization, and properties of polymers.
- Also, it will include discussion on the applications of polymers, as well as challenges pertaining to contemporary polymer research.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Define different terminologies used in polymer science and technology.
**CO2:** Understand the concepts of condensation and addition polymerization reactions and different techniques of polymer processing.
**CO3:** Apply the knowledge and ideas of polymers application in textile industry.
**CO4:** Analyse various properties of polymers used in textile for their optimum performance on end use.

**CO-PO-PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | 1 | - |
| CO2 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | 1 | 3 | 1 | 1 |
| CO3 | 2 | 2 | 3 | 1 | 1 | - | 1 | - | - | - | 1 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 1 | - | 1 | - | - | - | 1 | 2 | 3 | 2 |
| Wt. Avg. | 2.50 | 2.00 | 2.00 | 1.33 | 1.00 | - | 1.00 | - | - | - | 1.00 | 2.50 | 1.75 | 1.67 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.68 |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 04 parts of 2.5 marks from all units and remaining eight questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

## UNIT-I

**Introduction to polymer:** Brief historical background of polymer, Importance of polymer science, Definition and terminologies related to polymers – Monomers, Concept of macromolecules, Macromonomers, Telechelic polymer or oligomer, Polymers, Repeat unit, Structural unit, Degree of polymerization, Skeletal structure of polymers, Homopolymer and Copolymer; Classification of polymers – based on Origin, Chain configuration, Polymerization reaction product, Thermal behaviour, Crystallinity, Application and mechanical properties, Volume, Polymerization mechanism; Nomenclature of polymers and copolymers, Molecular weight of polymers.

**Step-growth polymerization**: Historical perspective, Condensation reactions, Addition reactions, Functionality of monomers, Linear step polymerization - DP Vs conversion, Carothers equation, Molecular weight control by stochiometric control, Molecular weight control by addition of chain stoppers, Molecular weight distribution, Kinetics of step-growth polymerization, Equilibrium consideration, Synthesis of some important linear polymers – Polyester, Polyamide, Polycarbonate, Aramids, Polysulfones/Polyketones, Polyetherimides, General requirements for achieving high MW, Non-linear step polymerization. (10)

## UNIT-II

**Chain-growth polymerization**: Types and feasibility of chain polymerization, Mechanism and Kinetics of radical chain polymerization, Various types of initiators, Molecular weight and kinetic chain length, other types of radical initiators, Transfer reactions, Thermodynamics of Chain Polymerization, MW distribution, Ceiling temperature.

**Polymerization processes:** Homogeneous polymerization - Melt polymerizations, Solution polymerizations, Multi phase polymerization - Emulsion polymerization, Suspension, Bead, or pearl polymerization, Heterogeneous polymerization - Precipitation polymerization, Polymerization with heterogeneous catalyst, Interfacial polymerization, and Solid-state polymerization, Common processes for free radical polymerization processes - Bulk polymerization, Solution polymerization, Suspension polymerization, Dispersion polymerization Emulsion Polymerization; Reversible - deactivation radical polymerizations (RDRP), Polymers synthesized using radical chain polymerization – Polyethylene, Polystyrene, Poly vinyl chloride, Ionic polymerization, Polymer stereochemistry and Zeigler - Natta coordination polymerization, Ring-opening polymerization, Chain copolymerization. (12)

## UNIT-III

**Polymers in Solution:** Thermodynamics of polymers in solution, Ideal solution of small molecules, Non-ideal solutions, Lattice theory for solutions of polymers, Flory - Huggin's theory - Applications, Usefulness, and Deficiency of Flory - Huggin's theory, Dilute polymer solution, Modification of Flory-Huggins theory, Regular solutions and solubility parameter, Polymer phase separation and fractionation.

**Characterization of polymer:** Chain dimension, Frictional properties of polymers, Mark-Houwink equation, Determination of molecular weight of polymer, Membrane osmometry, End group analysis, Dilute solution viscometry, Determination of chain dimension, Light scattering, Gel permeation chromatography, Mass spectroscopy of polymers. (12)

## UNIT – IV

**Polymer processing:** Processing of thermoplastics, Melt polymer processing, Extrusion process, Injection moulding, Extrusion blow moulding, Structural foam moulding, Thermoset polymers, Additive of polymers, Polymer blends.

**Polymer properties:** Mechanical properties - Types of deformation, Test types, Tensile test, Impact test; Thermal properties: Amorphous state - Thermal transitions, Glass transition temperature, Free volume theory, Crystallinity in polymers, Thermodynamics of Tm and Tg, Determination of Tg and Tm, Differential scanning calorimetry (DSC), Differential thermal analysis (DTA), Degree of crystallinity, Thermal degradation, Thermo-gravimetric analysis (TGA), Thermo-mechanical properties - Viscoelastic properties, Dynamic mechanical analysis (DMA), Polymer rheology, Other properties (Optical, Electrical, Barrier, Environmental, Fire resistance, Surface properties). (8)

**Suggested Textbooks:**


1. Organic Chemistry of Synthetic High Polymers by Robert W Lenz
2. Textbook of Polymer Science by Fred W Billmeyer
3. Polymer Science and Technology of Plastics and Rubber by P Ghosh
4. Polymer Chemistry by Paul C Hiemenz
5. Introduction to Polymer Chemistry by Charles E Carraher

## 26PCC-TT/TC/FAE-207H Textile Chemical Processing – I

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC/FAE-207H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Textile Chemical Processing – I | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- To understand preparatory wet processing of cotton fabric and chemistry involved in the various chemical pre-treatment of textiles.
- To know the concept of Pre-treatments with relevant machines and procedure.
- To familiarize students with the basic concept of dyeing with various terms used in dyeing.
- To make students learn about dyeing of cellulosic and protein fibres with different classes of colouring materials.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Define the fundamentals of preparatory wet processing and chemistry involved in chemical treatments, and also explain basic dyeing terminology used in textile processing.

**CO2:** Understand the principles and mechanisms of various pre-treatment processes, and the procedural steps involved in preparatory wet processing and dyeing.

**CO3:** Apply appropriate pre-treatment and dyeing methods for cellulosic and protein fibres using different classes of colouring materials.

**CO4:** Analyze the effects of pre-treatment and dyeing processes on fibre properties, shade quality, and evaluate the suitability of dyes, chemicals, and machines for different textile materials.

**CO – PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 3 | 1 | - |
| CO2 | 3 | 2 | 1 | - | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO3 | 2 | 3 | 3 | 1 | 1 | - | 1 | - | - | - | - | 3 | 2 | 1 |
| CO4 | 2 | 3 | 2 | 3 | 1 | - | 1 | - | - | - | 1 | 3 | 3 | 2 |
| Wt. Avg. | 2.5 | 2.25 | 2 | 2 | 1 | - | 1 | - | - | - | 1 | 3 | 2 | 1.5 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.83 |

**Note:** Examiner will set 9 questions in all, with two questions from each unit and one question covering all sections, which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total, selecting at least one from each unit.

**UNIT-I**

**Introduction to Preparatory Processes**: Natural and added impurities in cotton, wool, silk, manmade textiles. Sequence of chemical processing of different types of fibre-based textiles.

**Singeing**: Objective, types of singeing, details of various singeing methods with advantages and disadvantages, evaluation method, singeing machines.

**Desizing**: Objective, types, method details and mechanism of removal of starch in various methods, Efficiency of desizing.

**Scouring**: Objectives, mechanism of removal of impurities, recipe and controlling parameters involved. Scouring of natural, manmade and blended textiles, evaluation of scouring efficiency, faults in scouring and bleaching, J-Box and kier machines. (10)

**UNIT-II**

**Bleaching**: Objectives of bleaching, Hypochlorite and Hydrogen peroxide bleaching methods and their mechanism of action, controlling parameters involved, and efficiency of bleaching.

**Mercerization**: Objectives, mechanism related to various physical and chemical changes in cotton during mercerization, process parameters involved in each method, assessment of efficiency of mercerization; Barium activity number, its determination and interpretation, different types of mercerizing machines.

**Heat setting**: Objectives and mechanism of heat setting, different methods of heat setting and their effectiveness, Heat setting conditions and controls. (10)

**UNIT-III**

**Colouring materials:** Types of colouring materials, concept of dyes, pigments and ingrain colours, different classifications of dyes, dye–fibre interactions.

**Dyeing of cellulosic fibres:** Basic of direct dye with their application technology and after treatments, Basics of reactive dye with their classification and method of application, basics of vat and solubilized vat with different application techniques, indigo dye and its application on denim; Fundamentals of azoic and sulphur dyes with their method of applications and limitations. (12)

**UNIT-IV**

**Dyeing of synthetic fibres and their blends:** Dyeing technology of manmade textiles with disperse, basic and acid dyes, Concept of mass colouration.

**Processing of Protein Fibres:** Pretreatment for wool, setting and milling process in wool and degumming of silk. Dyeing process for wool and silk using acid and metal complex dyes. (10)

**Suggested Textbooks:**


1. Chemical Technology in Pretreatment Processes of Textiles, by S. R. Karmarkar.
2. Dyeing and Chemical Technology of Textile Fibres, by E. R. Trotman.
3. Technology of Bleaching and Mercerizing, by V. A. Shenai.
4. Fundamentals and Practices in Colouration of Textiles, by J. N. Chakraborty.
5. Technology of Dyeing, by V. A. Shenai.

**26BSC-TT/TC/FAE-211H Statistical Methods and Applications in Textile**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26BSC-TT/TC/FAE-211H | | | | |
| **Category** | Basic Science Course | | | | |
| **Course title** | Statistical Methods and Applications in Textile | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- To introduce fundamental concepts of statistics including measures of central tendency, dispersion, moments, skewness, and kurtosis.
- To develop an understanding of probability theory and standard probability distributions for modelling uncertainty.
- To enable students to analyse relationships between variables using correlation, regression, and curve fitting techniques.
- To acquaint students with sampling methods and hypothesis testing for statistical inference and decision-making.
- To impart knowledge of Statistical Quality Control tools for monitoring, controlling, and improving industrial processes.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Compute and interpret descriptive statistical measures and apply correlation and regression techniques to real data.

**CO2:** Apply probability laws and standard distributions (Binomial, Poisson, Normal) to solve practical problems.

**CO3:** Perform hypothesis testing using Z, t, F, $\chi^2$ tests and ANOVA for data-based decision making.

**CO4:** Construct and interpret control charts and acceptance sampling plans for quality control in industrial applications.

**CO – PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 1 | 3 | 2 | - | - | - | - | - | 1 | 1 | 3 | 1 |
| CO2 | 2 | 3 | 1 | 2 | 2 | - | - | - | - | - | 1 | 1 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 3 | 2 | - | - | - | - | - | 1 | 1 | 3 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | - | - | - | 1 | 2 | 3 | 2 |
| Wt. Avg. | 2.00 | 3.00 | 1.75 | 2.75 | 2.25 | 1.00 | 1.00 | - | - | - | 1.00 | 1.25 | 2.75 | 1.50 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.84 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

**Basic Statistics:** Measures of Central tendency, Dispersion, Moments, Skewness and Kurtosis (definition, properties and associated numerical only); Correlation, Karl Pearson's coefficient of correlation, rank correlation, Regression, line's of regression and curve fitting (linear and parabolic).

**UNIT-II**

**Probability and Probability Distributions:** Concept of probability, additive and multiplicative laws of probability (Statements and associated numerical only); Random variables (Discrete and Continuous); Mathematical expectation (definition, properties and associated numerical only); Discrete and Continuous probability distributions: Univariate Binomial, Poisson and Normal distributions (properties and applications).

**UNIT-III**

**Sampling and Testing of Hypothesis:** Introduction to sampling theory, Statistical Hypothesis, Testing of hypothesis, Test of significance for large and small samples (Z-test, t-test and F-test), Chi-square ($\chi 2$) test for goodness of fit and Analysis of variance (one-way and two-way classifications).

**UNIT-IV**

**Statistical Quality Control:** Introduction to Statistical Quality Control (SQC); objectives and advantages of SQC. Control Charts for Variables: $\bar{X}$-chart and R-chart (construction, interpretation and associated numerical problems). Control Charts for Attributes: p-chart, np-chart and c-chart (construction, interpretation and associated numerical problems).
**Acceptance Sampling:** Concept of sampling inspection, single and double sampling plan, Operating Characteristic (OC) curve (concept and applications).

**Suggested Text Books:**


1. Fundamentals of Mathematical Statistics / Applied Statistics, by S.C. Gupta and V.K. Kapoor
2. Fundamentals of Statistics, by Goon, Gupta and Dasgupta
3. Statistical Quality Control, by B.C. Gupta
4. Fundamentals of Mathematical Statistics, by Veer Bala Rastogi
5. Business Statistics, by Gupta and Gupta
6. Theory and problems of probability and Statistic, by Murray P Spiegel
7. Introduction to Statistical Quality Control, Douglas C. Montgomery

**26LC-PCC-TT/TC/FAE-203H Yarn Manufacture Lab-I**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26LC-PCC-TT/TC/FAE-203H | | | | |
| **Category** | Professional Core Lab Course | | | | |
| **Course title** | Yarn Manufacture Lab-I | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 0 | 0 | 2 | 1 | |
| **Classwork** | 05 Marks | | | | |
| **Examination** | 20 Marks | | | | |
| **Total** | 25 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**Course Outcomes:**

The yarn manufacturing laboratory course will consist of experiments illustrating the principles of spinning preparation relevant to the study of textile engineering. The students will be able to:

- To learn and understand the various lab skills related to machine operations and maintenance.
- To apply the knowledge of the important lab experiments in solving complex Engineering problems regarding process parameters.
- To determine Cleaning Efficiency and Neps Removal Efficiency for laps and slivers.
- To study the machine mechanisms such as Drafting Systems, and Gearing Calculations for Blowroom, Card, and Draw frame.

**LIST OF EXPERIMENTS**

1. To study the gearing and functions of blowroom machines.
2. Calculate the fibre openness in bale, lap and sliver.
3. To study the gearing diagram of a Blowroom scutcher to calculate rotational speeds of beaters, feed roller, calender rollers, shell roller and production of a blowroom line.
4. Calculate the Cleaning Efficiency (%) at blowroom and carding stage.
5. Calculate the nep generation/removal % at blowroom and carding stage.
6. To study and draw the passage of material through the Carding machine and identify different zones of a carding machine.
7. To study the Carding machine gearing plan and calculate the rotational speeds, individuals drafts, actual draft, mechanical draft, draft constant, coils/layer, flat speed (cm/min), production constant and production in kg/hr. Also understand the importance of different change places on the machine.
8. To study about the Carding machine settings (gauging) at different points and their influence on sliver quality.
9. To study the procedure of setting the carding machine for producing a particular hank of sliver. Also produce the sliver of a known linear density on carding machine.

10. To study and draw the passage of material through the Draw frame machine and understand the function of individual parts.
11. To study the Draw frame machine gearing and calculate Break Draft, Main Draft, Total Draft, Different draft constant and machine production. Also understand the importance of different change places on the machine.
12. To study the procedure of setting the drawframe machine for producing a particular hank of sliver. Also produce the sliver of a known linear density on drawframe machine.
13. To understand the procedure for setting drafting rollers settings based on Fiber Staple Length to control drafting waves and ensure quality.

**Suggested Books:**


1. Technology of Short-staple Spinning by W. Klein, The Textile Institute.
2. Spun Yarn Technology by Eric Oxtoby, Butterworth-Heinemann.
3. Process Control in Spinning by A.R. Garde and T.A. Subramanian.
4. Manual of Cotton Spinning by Textile Institute.

**26LC-PCC-TT/TC/FAE-205H Fabric Manufacture Lab-I**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26LC-PCC-TT/TC/FAE-205H | | | | |
| **Category** | Professional Core Lab Course | | | | |
| **Course title** | Fabric Manufacture Lab-I | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 0 | 0 | 2 | 1 | |
| **Classwork** | 05 Marks | | | | |
| **Examination** | 20 Marks | | | | |
| **Total** | 25 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**Course Outcomes:**
After completion of the course, students will be able to:

- To analyse the winding and warping processes and calculate production parameters such as winding speed, machine efficiency, warp length, warp weight, and number of yarn packages for given fabric specifications.
- To explain and evaluate the working principles and operating parameters of various shuttle loom mechanisms, including picking, beat-up, let-off, take-up, warp stop motion, and weft stop motion.
- To understand and analyse advanced shuttle loom mechanisms such as multiple box motion for weft patterning and automatic pirn change systems.
- To prepare woven fabric samples using different weave structures (plain, twill, satin) with variations in pick density and determine constructional parameters such as EPI and PPI.
- To analyse and evaluate woven fabric samples by determining constructional and performance parameters, including weave type, yarn count, fabric cover factor, GSM, and size add-on percentage.

**List of experiments**

1. To study the winding process and calculate winding speed, production, and machine efficiency of a winding machine.
2. To study the warping process and determine warp length, warp weight, and number of yarn packages for a given fabric specification.
3. To study the shuttle picking mechanism of a shuttle loom.
4. To study the crank beat-up mechanism in a shuttle loom.
5. To study the let-off and take-up mechanisms in a shuttle loom and calculate the required operating parameters.
6. To study the warp stop motion in shuttle looms.
7. To study the weft stop motion in shuttle looms.
8. To study the multiple box motion for weft patterning in shuttle looms.
9. To study the automatic pirn change mechanism in shuttle looms.
10. To prepare woven fabric samples using different weave structures (plain, twill, satin) with variation in pick density and measure ends per inch (EPI) and picks per inch (PPI).
11. To carry out sizing of woven fabric samples and determine sizing parameters such as size add-on by measuring fabric weight before and after sizing.

12. To analyse woven fabric samples by determining constructional parameters such as weave type, ends per inch (EPI), picks per inch (PPI), yarn count, fabric cover and fabric GSM.

**Suggested Textbooks:**


1. Principles of Weaving by R. Marks and A. T. C. Robinson, Textile Institute, 1976.
2. Principles of Woven Fabric Manufacturing by A. Majumdar, CRC Press, 2016.
3. Weaving: Conversion of Yarn to Fabric by P. R. Lord and M. H. Mohamed, Woodhead Publishing, 1982.
4. Principles of Fabric Formation by P. K. Banerjee, CRC Press, 2015.
5. Textile Sizing by B. C. Goswami, R. Anandjiwala and Hall, Woodhead Publishing.
6. Textile Mathematics by J. E. Booth (Volume III), Textile Institute.

**26LC-PCC-TT/TC/FAE-207H Textile Chemical Processing Lab-I**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26LC-PCC-TT/TC/FAE-207H | | | | |
| **Category** | Professional Core Lab Course | | | | |
| **Course title** | Textile Chemical Processing Lab-I | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 0 | 0 | 2 | 1 | |
| **Classwork** | 05 Marks | | | | |
| **Examination** | 20 Marks | | | | |
| **Total** | 25 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**Course Outcomes (CO):**

By the end of the Course, Students will be able to:

- Learn basic concepts of preparatory wet processing treatments of cotton, wool, silk fabric and the fundamentals of textile pigments and dyes.
- Apply knowledge of suitable dyeing and colouration methods for cotton and protein-based textiles using different dye classes, and pigment application techniques.
- Understand the application of different classes of dyes on natural and synthetics textiles.
- Understand the application methods of acid, basic and metal complex dyes on protein textiles.
- Analyze the performance and effectiveness of preparatory treatments and dyeing methods by evaluating fabric quality, dye uptake, fastness properties, and process efficiency for cotton and protein textiles

**List of Experiments**

1. Desizing of cotton by the enzymatic and oxidative methods. Evaluation of desizing efficiency.
2. Scouring of cotton by the alkaline method and evaluation of scouring efficiency.
3. Bleaching of cotton using sodium hypochlorite and hydrogen peroxide. Assessment of the bleaching process.
4. Scouring of wool by alkaline method and bleaching by the hydrogen peroxide method.
5. Degumming of silk by the alkaline method and bleaching by the hydrogen peroxide method.
6. Mercerization of cotton using the conventional alkali method and comparative evaluation of dye uptake.
7. Dyeing of the cotton fabric with direct dyes and aftertreatment using CDFA.
8. Dyeing of cotton fabric with reactive dyes.
9. Dyeing of the cotton fabric with vat dyes.
10. Dyeing of the cotton fabric with solubilised vat dyes.
11. Dyeing of the cotton with sulphur dye.
12. Dyeing of wool or silk with Acid Dye.
13. Dyeing of wool or silk with Metal-complex Dye.
14. Application of pigment colour to textile materials.

15. Dyeing of PET via HTHP method.
16. Dyeing of nylon with acid dyes.
17. Dyeing of acrylic with basic dye.

**Suggested Books:**


1. Chemical Technology in Pretreatment Processes of Textiles by S. R. Karmarkar.
2. Technology of Bleaching and Mercerizing by V. A. Shenai.
3. Fundamentals and Practices in Coloration of Textiles by J. N. Chakraborty.
4. Technology of Dyeing by V. A. Shenai.
5. Dyeing and Chemical Technology of Textile Fibres by E. R. Trotman.

**26PCC-TT/TC/FAE-213H Fibre Science and Technology**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC/FAE-213H | | | | |
| **Category** | Professional Core Course (Honors) | | | | |
| **Course title** | Fibre Science and Technology | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- Provide a fundamental understanding of the fundamental concepts of fibre architectures.
- Explain the physical and molecular structure of various types of natural, manmade and regenerated fibres used in textile industry.
- Enable students to understand the relationship between polymer structure and important properties of fibre like mechanical, moisture, thermal, optical, friction and electrical property.
- Familiarise students with the dye/finishing agent interaction with fibre and fibre degradation.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Understand physical and molecular structures of natural, manmade, and regenerated fibres commonly used in the textile industry.

**CO2:** Analyze the relationship between polymer structure and the mechanical, electrical, optical, thermal and moisture-related properties of fibres.

**CO3:** Evaluate the mechanical, thermal, optical, friction, electrical and moisture related properties of textile fibres and their significance in end-use performance.

**CO4:** Understand the chemistry of dye/finishing agent interaction with fibre and degradation behavior of fibres.

**CO - PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 3 | 1 | 1 |
| CO2 | 2 | 3 | 1 | 2 | 1 | - | 1 | - | - | - | 1 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | - | 1 | - | - | - | 1 | 2 | 3 | 3 |
| CO4 | 3 | 2 | 2 | 2 | 1 | - | 1 | - | - | - | 1 | 3 | 2 | 2 |
| Wt. Avg. | 2.5 | 2.3 | 1.7 | 2.3 | 1.3 | - | 1.0 | - | - | - | 1.0 | 2.8 | 2.3 | 2.0 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.91 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinee have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

**Theories of fine structure of fibres:** Requirements for fibre formation from linear polymers, Miceller theories, Fringed Micelle Model, Chain Folding and Fibre Annealing, Three phase model, Characterization methods of investigation of molecular structures. Detail study of X-ray diffraction method. Determine crystal size and crystalline orientation by X-ray diffraction pattern.
**Tensile property:** Stress-strain, elastic and plastic deformations, Creep Behaviour explanation by Molecular Theory, stress-relaxation of fibres, Change of properties as a result of mechanical Conditioning, Effect of cyclic loading, Simple Spring and dashpot models simulating fibres (MAXWELL MODEL and KELVIN-VOIGT MODEL).

**UNIT – II**

**Moisture relation with textile material:** Absorption of moisture in fibres, Directly and indirectly attached water molecules with polymer, Absorption in crystalline and non-crystalline regions, hysteresis-a molecular explanation, Quantitative theories of absorption, Pierce's theory, Fick's law of moisture diffusion, Swelling anisotropy, Heat of sorption.
**Electrical property:** Di-electric properties and its measurement, factors affecting the dielectric properties of textile materials, Electrical resistance of fibres and its measurement, Static electricity and measurement of static charge in fibres.

**UNIT – III**

**Thermal property:** Changes of state in polymers, Molecular motions and transition phenomenon, First order and second order transition phenomenon, Reversible and Irreversible Changes, Concept of heat setting and pleating.
**Optical property:** Refractive index, Electric Polarisation, measurement of refractive index and Birefringence. Effect of molecular orientation on Birefringence. Absorption and dichroism, Reflection and lustre.

**UNIT – IV**

**Frictional property:** Static and kinetic friction, Effect of operational parameters, measurement. The nature of friction: General theory, Lubricating Condition, Combination of rubbing friction and hydrodynamic friction.
**Chemistry of fibre dyeing and degradation:** Chemistry of degradation products of cellulose, Effect of acids, alkalis, oxidizing and reducing agents, Dye–fibre interactions (basic concepts), Finishing chemicals and their interaction with cellulosic fibres. Chemistry of degradation and effect on physical and chemical properties of protein fibres and important synthetic fibres like PET, Acrylic, Nylon, PE, PP.

**Suggested Text Books:**


1. Hearle, J. W. S. and Morton, W. E. (2008) Physical properties of textile fibres, Fourth Edition, Woodhead Publishing Limited.
2. Kozlowski, R. M. (Ed.). (2012). Handbook of natural fibres Woodhead Publishing Limited.
3. Eichhorn, S.J., Hearle J.W.S., Jaffe M. and Kakutani, T. (Ed.). (2009).; Handbook of Textile Fibre Structure: Volume-1: Fundamentals and Manufactured Polymer Fibres. Woodhead-Publishing Limited.
4. Eichhorn, S.J., Hearle J.W.S., Jaffe M. and Kakutani, T. (Ed.). (2009). Handbook of Textile Fibre Structure, Volume-2: Natural, regenerated, inorganic and specialist fibres Woodhead-Publishing Limited.

5. Kolanjikombil, M. (Ed.). (2018). The substrates: fibres, yarn and fabrics; Woodhead Publishing India Limited.
6. Gordon S. and Hsieh Y-L. (Ed.). (2007). Cotton: Science and Technology, Woodhead Publishing Limited.
7. Franck R. R. (Ed.). (2005). Bast and Other Plant Fibres. Woodhead Publishing Limited.
8. McIntyre, J. E. (Ed.). (2005). Synthetic fibres: nylon, polyester, acrylic, polyolefin. Woodhead Publishing Limited.

**26LC-PCC-TT/TC/FAE-213H Fibre Science and Technology Lab**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26LC-PCC-TT/TC/FAE-213H | | | | |
| **Category** | Professional Core Lab Course (Honors) | | | | |
| **Course title** | Fibre Science and Technology Lab | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-III |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**Course Outcomes (CO):**

By the end of the Course, Students will be able to:

- Identify and classify natural, manmade, and regenerated fibres based on physical appearance, microscopic structure (longitudinal and cross-sectional views), burning behaviour, and chemical solubility characteristics.
- Analyze and evaluate homogeneous fibre blends using physical and chemical methods to determine qualitative and quantitative composition of blended fabrics.
- Determine and interpret the physical properties of fibres, including partial water retention, axial swelling, and volume swelling.
- Investigate and evaluate the thermal property (specific heat) of cotton fibre.

**LIST OF EXPERIMENTS**

1. To identify the different natural and manmade fibre by their physical appearance.
2. To study the microscopic view (longitudinal and cross-sectional view) of natural fibres.
3. To study the microscopic view (longitudinal and cross-sectional view) of manmade and regenerated fibres.
4. To study the burning behaviour of natural and synthetic fibres.
5. To study the chemical solubility behaviour of fibres.
6. To analyse the homogenous fibre blends by physical and chemical methods.
7. To determine the qualitative and quantitative proportion of components of a blended fabric.
8. To calculate the partial water retention of fibre.
9. To determine the axial and volume swelling of fibre.
10. To investigate the specific heat of cotton fibres.

**Reference Books:**


1. Houck M. M. (Ed.) (2009). Identification of Textile Fibers, Woodhead Publishing Limited.
2. Murthy, H.V.S (2015). Introduction to Textile Fibres, Woodhead Publishing Limited.
3. Cook J. G. (5th Ed. 1984). Handbook of Textile Fibres: Natural Fibres,
4. Hearle, J. W. S. and Morton, W. E. (2008) Physical properties of textile fibres, Fourth Edition, Woodhead Publishing Limited.

# Semester-4

| Sr. No. | Course Code | Course Title | Hours per week | | | Total Contact Hrs. per week | Credit | Examination Scheme (Marks) | | | | Duration of Exam (Hours) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | | Internal awards | Theory | Practical | Total | |
| 1 | 26PCC-TT/TC/FAE-202H | Fibre Manufacturing Technology | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 2 | 26PCC-TT/TC/FAE-204H | Yarn Manufacture-II | 3 | 1 | 0 | 4 | **4** | 30 | 70 | | 100 | 3 |
| 3 | 26PCC-TT/TC/FAE-206H | Fabric Manufacture-II | 3 | 1 | 0 | 4 | **4** | 30 | 70 | | 100 | 3 |
| 4 | 26PCC-TT/TC/FAE-208H | Textile Chemical Processing-II | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 5 | 26PCC-TT/TC-210H | Woven Textile Designs and Applications | 3 | 1 | 0 | 4 | **4** | 30 | 70 | | 100 | 3 |
| 6 | PEC-I | Refer to Table 1 | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 7 | 26LC-PCC-TT/TC/FAE-204H | Yarn Manufacture Lab-II | 0 | 0 | 2 | 2 | **1** | 5 | | 20 | 25 | 3 |
| 8 | 26LC-PCC-TT/TC/FAE-206H | Fabric Manufacture Lab-II | 0 | 0 | 2 | 2 | **1** | 5 | | 20 | 25 | 3 |
| 9 | 26LC-PCC-TT/TC/FAE-208H | Textile Chemical Processing Lab-II | 0 | 0 | 2 | 2 | **1** | 5 | | 20 | 25 | 3 |
| 10 | 26AU-ENV-202-H | Environmental Science | 2 | 0 | 1 | 3 | **0** | Refer Note 1 | | | | |
| | | **Total** | | | | 30 | 24 | | | | 600 | |
| | For Honors course | | | | | | | | | | | |
| 1 | 26PCC-TC-218H | Synthesis of Dyes and Pigments | 3 | 0 | 0 | 3 | **3** | 25 | 50 | | 75 | 3 |
| 2 | 26LC-PCC-TC-218H | Synthesis of Dyes and Pigments Lab | 0 | 2 | 2 | 2 | **1** | 5 | | 20 | 25 | 3 |
| | | **Total** | | | | **5** | 4 | | | | 100 | |

**List of Program Electives-I (Table 1)**

| PEC – I (Professional Elective Course-I) | | |
|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** |
| 1. | 26PEC-TC-216H | Theory of Colouration and Chemistry of Dyes |
| 2. | 26PEC-TT/TC-212H | Clothing Science |
| 3. | 26PEC-TT/TC-214H | Computer Aided Textile Designing |

**Note-1:** AU is a mandatory non–credit course in which students will be required to obtain passing marks in theory. The marks in this qualifying paper will not be included in determining the percentage of marks obtained for the award of the degree. However, these marks will be shown in the detailed marks certificate of the student.

**Marks Distribution:**

- Internal Assessment: 30 marks
- Theory Examination: 70 marks

The institute will conduct the theory examination at its own level.

**Note-2**: At the end of the 4th semester, each student has to undergo Practical Training of 4/6 weeks in an Industry/ Institute/ Professional organization/ Research Laboratory/ training centre, etc., and submit a typed report along with a certificate from the organization and its evaluation shall be carried out in the 5$^{th}$ Semester.

**26PCC-TT/TC/FAE-202H Fibre Manufacturing Technology**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC/FAE-202H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Fibre Manufacturing Technology | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- Provide a basic foundation in polymer science, including polymer classification, structure–property relationships, and fundamental parameters governing fibre formation.
- Introduce polymerization mechanisms and techniques relevant to textile polymers, with emphasis on industrially important synthetic and regenerated fibres.
- Develop an understanding of synthetic fibre spinning technologies, covering wet, dry, melt, gel, and high-speed spinning processes and their influence on fibre structure and performance.
- Familiarize students with the manufacturing processes, properties, and applications of major regenerated and synthetic fibres such as cellulosic, polyester, polyamide, acrylic, and polyolefin fibres.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Define and describe the fundamental concepts of polymers, including classification of polymers, polymerization mechanisms, copolymerization techniques, and the essential characteristics of fibre-forming polymers.

**CO2:** Explain the principles, process sequences, and operating parameters of melt, wet, dry, and solution spinning systems used for the manufacture of synthetic, regenerated, and advanced fibres.

**CO3:** Analyze the relationship between polymer structure, spinning method, processing conditions, and the resulting physical, mechanical, and chemical properties of fibres produced by different manufacturing systems.

**CO4:** Apply fundamental knowledge of polymer chemistry and fibre manufacturing parameters for appropriate synthetic fibre manufacturing for specific textile and technical applications.

**CO – PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 3 | 1 | - |
| CO2 | 3 | 2 | 1 | - | 1 | - | - | - | - | - | 1 | 3 | 1 | 1 |
| CO3 | 2 | 3 | 2 | 1 | 1 | - | 1 | - | - | - | 1 | 3 | 3 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 2 | - | 1 | - | - | - | 1 | 3 | 2 | 3 |
| Wt. Avg. | 2.5 | 2.3 | 2.0 | 2.0 | 1.3 | - | 1.0 | - | - | - | 1.0 | 3.0 | 1.8 | 2.0 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.88 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections, which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

**Basic concepts of polymers:** Classification of polymers; Definition of monomer, oligomer, high polymer, Cohesive energy density, Solubility parameter, Glass transition temperature, Functionality and Degree of polymerization; Concept of basic determinants of fibre-forming polymer; Concept of rubber, plastic and fibre; Copolymerization: Concept of graft and block co-polymerization and their importance.

**Polymerization Methods and Techniques:** Introduction to polymerization methods, kinetics of condensation and addition polymerization with special reference to polyesters, polyamides. Study of various techniques of polymerisation such as bulk, solution, suspension, emulsion, solid state, plasma polymerization. Concept of amorphous and crystalline polymers. (12)

**UNIT-II**

**Melt Spinning:** Concept, and essential requirements of melt spinning, Total sequence of polymer flow in the melt spinning process, Concept of high-speed spinning, Concept of LOY, MOY, POY, HOY, FOY yarns. Drawing of melt-spun fibers, Heat setting of thermosetting fibers.

Manufacture of polyester fibres: raw materials, melt preparation, extrusion, quenching, drawing, and heat setting; side-chain reactions occurring during processing. Manufacture of polyamide fibres (Nylon-6 and Nylon-66): polymer melt formation, spinning, drawing, and stabilization. Manufacture of polyolefin fibres (Polyethylene and Polypropylene): melt spinning process, molecular orientation, and crystallinity development. (10)

**UNIT-III**

**Solution Spinning:** Concept and type of solution spinning. **Wet Spinning:** Concept and principle of wet spinning. Manufacture of viscose and polynosic rayon fibres using wet spinning: raw materials, preparation of spinning dope, spinning conditions, role of the coagulation bath and regeneration mechanism, washing, and post-treatments. Manufacture of acrylic and modacrylic fibres by wet spinning: polymer preparation, solvent systems, spinning bath composition, fibre formation, and drawing. Micro-fibres: Production and Application of Micro-fibres. **Nano-fibres:** Concept of Nano-fibres, materials and production techniques for nanofibers. Bicomponent fibres. (12)

**UNIT-IV**

**Dry Spinning:** Principle and mechanism of dry spinning. Manufacture of cellulose acetate fibres: raw materials, dope preparation, dry spinning process, solvent recovery, and fibre finishing. Manufacture of acrylic and modacrylic fibres by dry spinning: process parameters and fibre characteristics. Physical, mechanical, and chemical properties of dry-spun fibres and their end-use applications.

**Dry-jet wet spinning:** Concept of solution spinning without chemical regeneration. Manufacture of Lyocell (Tencel) fibres: dope preparation, spinning, solvent recovery, and environmental advantages. (10)

**Suggested Text Books:**


1. Textbook of polymer science by Fred W. Billmeyer, Jr.
2. Polymers and their properties by J.W.S. Hearle.
3. Polymer science and technology of plastics and rubbers by Dr. Premamoy Ghosh
4. Polymer Science by V. R. Gowariker, New Age International Publishers
5. Manufactured Fibre Technology by V.B.Gupta and V.K.Kothari
6. Production of Synthetic Fibre by A.A.Vaidy
7. Handbook of Fiber Chemistry edited by Menachem Lewin, CRC Press, Taylor and Francis Group

## 26PCC-TT/TC/FAE-204H Yarn Manufacture-II

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC/FAE-204H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Yarn Manufacture-II | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 3 | 1 | 0 | 4 | |
| **Classwork** | 30 Marks | | | | |
| **Examination** | 70 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- Provide fundamental understanding of lap preparation, combing, speed frame, ring frame, and doubling operations.
- Explain the mechanisms of drafting, twisting, and winding across various spinning stages.
- Enable students to analyse machinery parameters and their influence on yarn quality.
- Develop ability to evaluate process performance, calculate production/efficiency, and identify defects.
- Familiarise students with recent technological developments in combing, roving, and ring spinning processes.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Explain the objectives, principles, and machinery involved in lap preparation, combing, and doubling processes.

**CO2:** Analyse speed frame and ring frame operations with respect to drafting systems, package formation, and twisting mechanisms.

**CO3:** Apply principles of spinning geometry, traveler selection, and process control to optimize yarn quality.

**CO4:** Evaluate preparatory process parameters using numerical problems and correlate process variables with yarn quality and production efficiency.

**CO - PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | 1 | - | - | - | - | - | 1 | 3 | 1 | - |
| CO2 | 2 | 3 | 1 | 2 | 1 | - | - | - | - | - | 1 | 3 | 2 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 2 | - | 1 | - | - | - | 1 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 3 | 2 | - | 1 | - | - | - | 1 | 3 | 3 | 2 |
| Wt. Avg. | 2.3 | 2.3 | 2.0 | 2.3 | 1.5 | - | 1.0 | - | - | - | 1.0 | 3.0 | 2.0 | 1.7 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.90 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinee have to attempt 5 questions in total, selecting at least one from each unit.

**UNIT-I**

**Combing:** Objectives of lap preparation, different systems of lap preparation, Modern concept of lap preparation, Configuration of fibre feed and its effect on quality of product, Objectives of combing, detailed study of the Rectilinear comber, Timing diagram for combing operation. setting of comber, control of noil percentage, Type of feed, Influence of type of feed on noil extraction, Performance assessment of Combing, Numerical related to combing, developments in combing.

**UNIT – II**

**Speed Frame:** Objectives of speed frame, Mechanism of drafting, twisting and winding. Basic principle of designing of cone drum, Differential motions, Building motions, Drafting systems, common defects in roving packages, Processing of man-made fibres on speed frame, Performance assessment of speed frame, Numerical related to speed frame, developments in speed frame.

**UNIT – III**

**Ring Frame:** Objective, principle and mechanism involved in drafting, twisting and winding. Function of different drafting elements, Design and construction of spindle, Types of spindle drive, Ring and its type, Design and construction of traveler. Different combination of ring and traveler, Concept of twist multiplier and yarn contraction, Building mechanism, Importance of spinning geometry and its elements, Mechanism of package formation. Limitations of large package spinning.

**UNIT – IV**

**Ring Frame (Continued):** Limitation of ring spinning and factors responsible for loss in efficiency, Processing of manmade fibre on ring-frame, Concept of average count and 20s conversion, Causes of end breakage and its control, Numerical related to ring spinning, developments in ring frame. **Doubling:** Objective of doubling, Study of ring doubler and TFO (Two for one) machine, Calculations related to yarn doubling, Yarn reeling, Yarn bundling.

**Suggested Text Books:**


1. Lawrence, C. A., Fundamentals of Spun Yarn Technology, CRC Press, UK.
2. Klein, W., The Technology of Short-Staple Spinning, Vol 3 and 4,The Textile Institute, Manchester.
3. Rieter Machine Works Ltd., Manual of Spinning, Rieter, Switzerland.
4. Lord, P. R., Handbook of Yarn Production, Woodhead Publishing.
5. Oxtoby, E., Spun Yarn Technology, Butterworth and Co. Ltd

**26PCC-TT/TC/FAE-206H Fabric Manufacture-II**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC/FAE-206H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Fabric Manufacture-II | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 3 | 1 | 0 | 4 | |
| **Classwork** | 30 Marks | | | | |
| **Examination** | 70 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- To introduce students to the fundamentals of shuttleless weaving and compare the limitations of shuttle weaving with modern shuttleless technologies.
- To develop understanding of projectile weaving machines, including torsion bar picking, projectile circulation, weft transfer mechanisms, and weft insertion sequence.
- To familiarize students with rapier weaving technology, covering classification, weft transfer systems, rapier drives, timing diagrams, and performance calculations.
- To explain the principles, components, and working of air-jet weaving machines, including air-guide systems, nozzle arrangements, air drag theory, and weft control mechanisms.
- To impart knowledge of water-jet weaving machines, focusing on jet pump design, nozzle settings, water quality requirements, and fabric moisture extraction systems.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Explain the principles of shuttleless weaving and analyze the construction, working, merits, demerits, and application domains of projectile and rapier weaving machines.

**CO2:** Describe the sequence of weft insertion in projectile and rapier looms, analyze weft transfer mechanisms, and perform numerical calculations related to weft velocity, timings, and figure of merit.

**CO3:** Explain the construction and working of air-jet weaving machines, including nozzle systems, air-guide arrangements, air drag theory, and evaluate factors affecting weft insertion performance and quality.

**CO4:** Analyze the working of water-jet weaving machines, including jet pump design, nozzle settings, water quality requirements, and perform calculations related to weft velocity and insertion timing.

**CO – PO - PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | - | - | - | - | - | 1 | 3 | 1 | 2 |
| CO2 | 2 | 3 | 2 | 2 | 2 | - | - | - | - | - | 1 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 2 | 2 | - | 1 | - | - | - | 1 | 3 | 3 | 3 |
| CO4 | 2 | 3 | 2 | 3 | 2 | - | 2 | - | - | - | 1 | 3 | 2 | 3 |
| Wt. Avg. | 2.3 | 2.8 | 2.0 | 2.0 | 1.8 | - | 1.5 | - | - | - | 1.0 | 3.0 | 2.0 | 2.5 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 2.08 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections, which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinee have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

Introduction to Shuttleless weaving: Restrictions as well as merits of Shuttle weaving, types of shuttleless looms, their development, typical speeds, production rates and application domain. Projectile weaving machine: Principle of weft insertion, typical specification and features of modern projectile looms. Merits, demerits and standard application domain, Torsion bar picking, construction, working, settings, mechanics, Path of weft, function of each component, projectile types, projectile circulation, weft transfer to projectile, projectile brake, Sequence of weft insertion, typical timings, projectile velocity calculation.

**UNIT-II**

Rapier Weaving Machine: Principle of weft insertion, typical specification and features of modern rapier looms, Merits, demerits and standard application domain, Classification of rapier looms, brief description of each type under classification. Gabler and Dewas system of weft insertion and their comparison, Path of weft in modern rigid and flexible rapier looms, function of each component in the path, sequence of weft insertion, Rapier heads, negative and positive weft transfer at shed centre, their comparison, Typical timings, synchronous and asynchronous rapier movement, calculation of rapier/weft velocities.

**UNIT-III**

Airjet weaving machine: Principle of weft insertion, typical specification and features of modern air jet looms, Merits, demerits and standard application domain, Path of weft, function of each component, sequence of weft insertion, typical timings Types, design, working of accumulators and main nozzles.

Types of air-guide systems, their design and comparison, Types, spacing, arrangement, blowing action of relay nozzles, stretch nozzle, Air supply to nozzles, blowing sequence and timing control, Calculation of weft velocity, number of relay nozzles and timings of different nozzles, Quality of air required, Air drag theory, factors affecting air drag force, Weft breaks in air jet looms - reason and control devices.

**UNIT-IV**

Water jet weaving machine: Principle of weft insertion, typical specification and features of modern water jet looms, Merits, demerits and standard application domain, Path of weft, function of each component, sequence of weft insertion, typical timings, calculation of weft velocity, Nozzle and jet pump design, working and settings, Quality of water required, water extraction from fabric in loom.

**Alternative NPTEL/SWAYAM Course:**

| S. No | NEPTEL course name | Instructor | Host Institute |
|---|---|---|---|
| 1. | Fabric Manufacturing II | Prof. A. Majumdar | IITD |

**Suggested Text Books:**


1. Principles of Weaving by R. Marks and A. T. C. Robinson, Textile Institute, 1976.
2. Principles of Woven Fabric Manufacturing by A. Majumdar, CRC Press, 2016.
3. Weaving: Conversion of Yarn to Fabric by P. R. Lord and M. H. Mohamed, Woodhead Publishing, 1982.
4. Principles of Fabric Formation by P. K. Banerjee, CRC Press, 2015.
5. Handbook of Weaving by Sabit Adanur, CRC Press, 2000

**26PCC-TT/TC/FAE-208H Textile Chemical Processing-II**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC/FAE-208H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Textile Chemical Processing-II | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- To provide a comprehensive understanding of textile printing techniques, including conventional, modern, and special styles, with emphasis on their principles, machinery, print paste formulations, and applications.
- Introduce students to advanced printing technologies such as pigment, transfer, and digital printing, highlighting their mechanisms, advantages, limitations, and industrial relevance.
- To impart detailed understanding of textile finishing processes, including mechanical and chemical finishes, tailored for cellulosic, protein, synthetic, and blended textiles.
- To provide an overview of functional finishes such as anti-crease, water repellent, soil release, flame-retardant, and softening finishes with their evaluation.
- To provide an overview of specialized finishing processes for wool and silk to enhance performance, aesthetics, and durability of protein-based textiles.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Understand the principles, construction, working, advantages, and limitations of various textile printing methods, including block, screen, roller, transfer, pigment, and digital printing.

**CO2:** Explain printing styles such as direct, discharge, and resist printing on natural, man-made, and blended textile substrates.

**CO3:** Evaluate the fastness properties of coloured textiles—including washing, light, rubbing, perspiration, sublimation, and dry-cleaning fastness—using standard testing procedures.

**CO4:** Analyze and describe the chemistry involved, mechanism, application, and performance evaluation of functional finishes such as anti-crease, water repellency, soil release, flame retardancy, and softening treatments of textiles.

**CO-PO-PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | 1 | - | - | - | - | - | 1 | 3 | 1 | - |
| CO2 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO3 | 2 | 3 | 1 | 3 | 2 | - | - | - | - | - | 1 | 2 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | - | 1 | 3 | 2 | 3 |
| Wt. Avg. | 2.75 | 2.50 | 1.50 | 2.00 | 1.67 | 1.00 | 2.00 | 1.00 | - | - | 1.00 | 2.75 | 2.00 | 2.00 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.85 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections, which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinee have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

**Printing:** Introduction to printing methods, block, screen and roller printing. Advantages and disadvantages of each method. Construction and working of the roller printing machine, photoelectric method of screen preparation.

**Print Paste, and Printing after treatments:** Constituent and characteristics of print paste, classification and mechanism of working of thickeners. Importance of steaming, curing, and ageing of prints, and the mechanism of each process.

**Printing Styles:** Direct, discharge, and resist styles of printing on natural, manmade and blended textiles. (11)

**UNIT-II**

**Transfer Printing:** classification, mechanism of transfer in each type. Transfer printing of natural, man- made and blended textiles. Transfer printing machines.

**Pigment Printing:** Mechanism and recipe details of pigment printing.

**Digital Printing:** Basics of digital printing with an elementary idea of the machine.

**Special styles of printing:** Tie and dye, Batik printing, Brasso, Foil, 3D effect, etc.

**Evaluation of Fastness properties:** Washing fastness, Light fastness, Rubbing fastness, Sublimation fastness, Perspiration fastness and Other fastness: Fastness to water, Fastness to seawater, Fastness to chlorinated water, Fastness to Perspiration, Fastness to Dry Cleaning using perchloroethylene solvent. (12)

**UNIT-III**

**Finishing:** Objectives of Finishing, Importance of Textile Finishing, Classification and types of Finishing, Process Sequence for Finishing for Cellulosic, Protein, Synthetics and their blended textiles.

**Mechanical Finishing:** Concept and overview of machinery for mechanical finishes, including Calendering, Decatising, Raising, Sueding, Felting, Sanforizing, Stentering, and Aero Finishing.

**Anticrease finish:** Problem of creasing and anti-crease finish on cotton, choice of chemical, catalyst and process parameters. Drawbacks and advantages associated with the use of various anti-crease chemicals. Concept of formaldehyde-free anti-crease and durable press finish. (10)

**UNIT-IV**

**Water repellent finish:** Concept of Water repellency and waterproof finishes. Application and evaluation of water repellent finish on textiles.

**Soil release finish:** classification of soil, mechanism and application of soil releases finishes on textiles.

**Flame-retardant finish:** burning cycle and its importance to the hypothesis for flame retardants. Limiting Oxygen Index, Basic ideas for application of flame-retardant finish on various textiles. Basic idea of Softeners and their application.

**Wool and silk finish:** Basic idea and overview of wool finishing processes such as fulling, felting, anti-shrink treatments, milling, and mothproofing. Silk finishing processes such as weighting of silk, Scroopy finishing, Tamponing, antistatic and crease-resistant treatments. (11)

**Suggested Text Books:**


1. Textile Technology and Dyeing of Textile Fibres, by E. R. Trotman Griffin Publication, London.
2. Textile Printing, by V. A. Shenai, Sevak Publisher, Bombay.
3. Chemical Processing of Synthetic Fibres and Blends, by K. V. Datye and A. A. Vaidya, Wiley Publication, New York.
4. Textile Printing, by L. W. C. Miles, Society of Dyers and Colourists.
5. Textile Finishing, by V. A. Shenai, Sevak Publisher, Bombay.
6. Principles of Textile Finishing, by A. K. R. Chaudhury, The Textile Institute Book Series.
7. Chemical Finishing of Textiles, by W. D. Schindler and P. J. Hauser, Woodhead Publishing.

**26PCC-TT/TC-210H Woven Textile Designs and Applications**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TT/TC-210H | | | | |
| **Category** | Professional Core Course | | | | |
| **Course title** | Woven Textile Designs and Applications | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 3 | 1 | 0 | 4 | |
| **Classwork** | 30 Marks | | | | |
| **Examination** | 70 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

The course is designed to make the students understand:

- To introduce the fundamental concepts of fabric structure, weave notation, drafting plans, peg plans, denting, and classification of woven fabrics.
- To develop understanding of basic and decorative weave structures such as plain, twill, satin, absorbent, crepe, Bedford cord, stripe, and check weaves along with their construction and end uses.
- To enable analysis and design of color and weave effects by appropriate selection of weave structures and yarn arrangements for aesthetic and functional fabrics.
- To familiarize students with advanced woven fabric constructions including welt, pique, terry, backed fabrics, double cloth, figured fabrics, and leno structures through graphical representation and applications.
- To train students to perform technical fabric calculations related to yarn count, crimp, EPI, PPI, cover factor, fabric cover, and raw material requirements for woven fabrics.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Explain the fundamentals of fabric structure, weave notation, drafting, peg plans, denting, and classify woven fabrics including basic weaves and their derivatives.

**CO2:** Analyze and design absorbent, crepe, Bedford cord, stripe, check weaves, and colour–weave effects by selecting suitable weave structures for specific end uses.

**CO3:** Illustrate and interpret advanced woven structures such as welt, pique, terry, and backed fabrics, and their graphical representations with respect to construction and applications.

**CO4:** Design complex woven fabrics, including double cloth, figured fabrics, leno, damask, brocades, tapestry structures, and perform fabric calculations related to yarn, cover, crimp, EPI, PPI, and fabric cover.

**CO – PO- PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | 1 | - | - | - | - | - | 1 | 3 | 1 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 1 | - | 1 | - | - | - | 1 | 3 | 2 | 3 |
| CO3 | 2 | 3 | 2 | 2 | 1 | - | 1 | - | - | - | 1 | 3 | 2 | 3 |
| CO4 | 2 | 3 | 3 | 3 | 2 | - | 2 | - | - | - | 1 | 3 | 3 | 3 |
| Wt. Avg. | 2.3 | 2.8 | 2.3 | 2.3 | 1.3 | - | 1.3 | - | - | - | 1.0 | 3.0 | 2.0 | 2.5 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 2.07 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinee have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

**Introduction:** Concept of fabric designing through fabric structure and textile printing. Importance of fabric structure and analysis, detection of directions of warp and weft, classification of woven fabrics, method of fabric presentation, weaving plans. Notation of Weave, drafting plan, peg plan and denting, different types of drafting plans.

**Basic Weaves**: Method of construction, features and uses of plain weave and its derivatives, twill weave and its derivatives, Satin and sateen weaves and their derivatives and applications.

**UNIT-II**

**Absorbent Fabrics:** Method of preparation, features and uses of Diamond, Honey comb weaves, Huck-a-back and mock -leno weaves. Crepe Weave: Special feature, construction of the weave, method of preparation, classification and uses.

**Bedford cord weaves**: Method of construction, features, cross-sectional view, derivatives and uses. Stripe and Check Weaves Features, criteria for selection of weaves for combination.

**Colour and Weave Effect:** Weave and colour combinations, method of preparation of Continuous line effect, Hounds tooth, Birds eye, Crows foot, Hair lines and Step pattern.

**UNIT-III**

**Welt and pique structures:** Different types and graphical representation and applications

**Terry Weaves:** Terry pile, formation of pile, simple terry weaves, terry pile forming mechanism, velvets and velveteen

**Backed fabrics:** Definition, features, classification and usage. Graphical representation, warp backed and weft backed cloth, reversible backed fabric, wadded backed fabric.

**UNIT-IV**

**Double Cloth:** Definition, features, classification and uses. Method of preparation of self-stitched and centre stitched double cloths, their salient feature and uses, Wadded double cloth.

**Complex designs:** Damask fabrics, leno gauze fabrics, brocades and tapestry structures.

Difference between jacquard design and dobby design, figuring capacity for particular design

Calculations of crimp, count, cover factor, EPI, PPI and fabric cover. Technical specifications of important fabrics

**Suggested Text Books:**

1. Textile Design and Colour by W Watson
2. Watson's Advanced Textile Design by W Watson
3. Grammar of Textile Design by H Nisbet

## 26PEC-TT/TC-212H Clothing Science

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PEC-TT/TC-212H | | | | |
| **Category** | Professional Elective Course | | | | |
| **Course title** | Clothing Science | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- Understanding of specific characteristics of human clothing.
- Gaining knowledge about the fabric handle and aesthetic properties of fabric required for human clothing.
- Understanding the human physiology and comfort characteristics of clothing
- Understanding the safety aspects of garments.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Explain the fabric selection process for clothing and basic concepts of comfort
**CO2:** Analyze the human physiology and the role of clothing for human comfort
**CO3:** Apply the principles of heat and moisture transmission through the clothed body
**CO4:** Evaluate objective and subjective measures of comfort

**CO – PO - PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | - | 1 | 1 | - | - | - | 1 | 2 | 2 | 2 |
| CO2 | 2 | 3 | 1 | 2 | - | 2 | 1 | - | - | - | 1 | 1 | 2 | 3 |
| CO3 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | - | - | - | 1 | 2 | 2 | 3 |
| CO4 | 2 | 3 | 2 | 3 | 2 | 1 | 1 | - | - | - | 1 | 1 | 3 | 3 |
| Wt. Avg. | 2.3 | 2.8 | 1.8 | 2.3 | 1.5 | 1.5 | 1.3 | - | - | - | 1.0 | 1.5 | 2.3 | 2.8 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.89 |

**Note:**
Examiner will set 9 questions in all, with two questions from each unit and one question covering all sections, which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total, selecting at least one from each unit.

**UNIT-I**

**Concept of fabric selection and procurement for clothing**: Types of fabric required in accordance with geographic, demographic factors, fabric properties, aesthetics and desirable performance attributes of clothing.

**Clothing Classification as per intended application**: Vanity, functional etc. Fabric properties for serviceability of fabrics, Concept of tailor ability of woven and knitted clothing.

**UNIT-II**

**Fabric parameters affecting fabric texture**.

**Significance of dimensional Stability of Fabrics**: Mechanism of fabric shrinkage - Relationship between Hygral Expansion, Relaxation shrinkage.

**Clothing Comfort**: Brief introduction to the various processes related to comfort, Application of the science of clothing comfort, basic concepts of psychology and comfort.

**UNIT-III**

**Aesthetic properties**: General aspects and measurement of aesthetic properties and changes in aesthetic behaviour.

**Neurophysiological Processes of Comfort**: Neurophysiological basis of sensory perceptions, perceptions of sensations related to mechanical, thermal and moisture stimuli.

**Thermal transmission**: Thermoregulatory mechanisms of human body, heat transfer theories, thermal conductivity of fibrous materials, steady state and transient measurement techniques for heat transfer.

**Moisture Transmission**: Transfer of liquid moisture and vapour transfer through fibrous materials, dynamic Transmission of heat and moisture.

**Tactile Aspects of Comfort**: Fabric mechanical properties and tactile- pressure sensations like fabric prickliness, itchiness, stiffness, softness, smoothness, roughness and scratchiness, fabric hand value, **Size and Fit related comfort**: Clothing comfort aspects in relations with garment size and fit.

**Objective and subjective evaluation of clothing comfort**.

**UNIT-IV**

**Concept of Functional Properties of garments**: Elasticity, elastic recovery, residual strain; thermal insulation; water repellence, water resistance and waterproof; wicking: vertical and horizontal transportation of liquid; water absorbency; UV protection; soil release.

**Safety norms for textiles**: Toxicity: residual dye stuff and other finishing agent, Okeo-Tex norms, flammability.

**Suggested Text Books:**


1. Y Li, The Science of Clothing Comfort
2. B P Saville Lyman Fourt and Norman R S Hollies, Physical Testing of Textiles
3. Das, R Alagirusamy, Clothing: Comfort and Functions Science in Clothing Comfort

## 26PEC-TT/TC-214H Computer Aided Textile Designing

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PEC-TT/TC-214H | | | | |
| **Category** | Professional Elective Course | | | | |
| **Course title** | Computer Aided Textile Designing | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- To introduce the fundamentals of Computer-Aided Design systems and computer graphics.
- To develop understanding of CAD hardware and its applications in textile design and manufacturing.
- To impart knowledge of textile design repeat systems and pattern distribution methods.
- To develop skills in digital textile design using Adobe Photoshop.
- To develop vector-based textile pattern creation skills using Adobe Illustrator for production applications.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Explain the fundamentals of CAD systems, computer graphics, and their applications in textile and apparel industries.

**CO2:** Apply textile repeat systems and design distribution principles for developing surface patterns using CAD concepts.

**CO3:** Develop textile designs using Adobe Photoshop tools including layers, masking, colour adjustments, texture mapping, and digital effects.

**CO4:** Create vector-based textile patterns and repeat layouts using Adobe Illustrator tools and export them for production purposes.

**CO - PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | - | 3 | - | - | - | - | - | 1 | 1 | 1 | 2 |
| CO2 | 2 | 2 | 3 | 1 | 3 | - | 1 | - | - | - | 1 | 2 | 2 | 3 |
| CO3 | 1 | 2 | 3 | 1 | 3 | - | - | - | - | - | 1 | 1 | 2 | 3 |
| CO4 | 1 | 2 | 3 | 2 | 3 | - | - | - | - | - | 1 | 2 | 2 | 3 |
| Wt. Avg. | 1.8 | 1.8 | 2.5 | 1.3 | 3.0 | - | 1.0 | - | - | - | 1.0 | 1.5 | 1.8 | 2.8 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.83 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections, which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinee have to attempt 5 questions in total selecting at least one from each unit.

**UNIT I**

**Fundamentals of CAD:** Definition and history of Computer-Aided Design. Hardware and software requirements of CAD systems. Design process in CAD environment. Applications of CAD and CAM in textile and apparel industry. Introduction to computer graphics. Raster graphics and vector graphics. Features and differences between raster and vector graphics.

**UNIT II**

**CAD Hardware and Textile Design Structures:** Introduction to CAD hardware. Design workstation. Graphics terminal. Input and output devices. Central processing unit and secondary storage devices. Unit-repeating design. Drop device and drop reverse design. Systems of distribution with reference to diamond base, ogee base, and rectangular base lines. Construction of designs from incomplete repeat. Classification of border patterns, all-over patterns, and types of repeats.

**UNIT III**

**Adobe Photoshop for Textile Design:** Selection tools based on shape, colour, and mask. Colour specification tools. Image adjustment modes. Layer blending modes and options. Brush tools and dynamics options. Paint bucket and gradient tools. Clone tool, dodge, burn, colour replacement, and mixer tools. Layer masking. Texture mapping. Filter applications. Displacement maps and texture maps. Basic vector shape drawing tools. Editing shapes using anchor points.

**UNIT IV**

**Adobe Illustrator for Textile Design:** Adobe Illustrator interface and workspace. Artboards and layer management. Line, rectangle, ellipse, polygon, star, pencil, and paintbrush tools. Selection and direct selection tools. Paths, anchor points, and handles. Pen tool and Bezier curves. Shape builder tool and pathfinder operations. Object transformations including scaling, rotation, reflection, and shearing. Alignment and distribution of objects. Grouping, locking, and layer organization. Colour fill and stroke options. Gradient creation. Pattern creation and seamless repeat development. Exporting designs for printing and production.

**Suggested Text Books:**


1. M. P. Groover and E. W. Zimmers Jr., Computer Aided Design and Manufacturing.
2. J. D. Foley, A. van Dam, S. K. Feiner and J. F. Hughes, Computer Graphics: Principles and Practice.
3. D. Mearns and M. Pauline Baker, Watson’s Textile Design and Colour.
4. Z. Grosicki, Watson’s Textile Design and Colour, Newnes Butterworths, 1988.

**26PEC-TC-216H Theory of Colouration and Chemistry of Dyes**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PEC-TT/TC/FAE-214H | | | | |
| **Category** | Professional Elective Course | | | | |
| **Course title** | Theory of Colouration and Chemistry of Dyes | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- Understand fundamental principles of physical and organic chemistry relevant to colouration processes, including atomic structure, chemical bonding, thermodynamics, reaction kinetics, and acid–base equilibria.
- Explain the chemical basis of colour in organic molecules, including chromophores, auxochromes, and the structure–property relationships of dyes and pigments.
- Classify dyes and pigments based on chemical structure and application class, and relate their chemistry to end-use textile requirements.
- Understand the chemistry and mechanisms of dye application on cellulosic fibres using major dye classes such as direct, reactive, vat, and sulphur dyes.
- Analyze kinetic and thermodynamic aspects of dyeing processes, including diffusion, adsorption, and dye–fibre interactions, to optimize dyeing performance.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Explain basic concepts of physical and organic chemistry—atomic structure, bonding, chemical reactions, thermodynamics, pH, buffers, and redox systems—and apply them to textile colouration processes.

**CO2:** Identify and interpret the role of chromophores, auxochromes, functional groups, and molecular structure in the development of colour, fluorescence, and phosphorescence in organic dyes.

**CO3:** Describe the chemical reactions and mechanisms involved in the application of direct, reactive, vat, and sulphur dyes on cellulosic fibres, and evaluate the factors affecting dyeing performance.

**CO4:** Apply theoretical principles of dyeing kinetics, diffusion, adsorption, and aggregation to explain the rate and extent of see-up and fixation in dye–fibre systems.

**CO - PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | - | - | - | - | - | - | 1 | 3 | 1 | - |
| CO2 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | 1 | 3 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 2 | 1 | - | 1 | - | - | - | 1 | 3 | 3 | 2 |
| CO4 | 2 | 3 | 2 | 3 | 1 | - | 1 | - | - | - | 1 | 3 | 3 | 2 |
| Wt. Avg. | 2.5 | 2.5 | 1.5 | 2.0 | 1.0 | - | 1.0 | - | - | - | 1.0 | 3.0 | 2.3 | 1.7 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.84 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections, which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinee have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

**Basic of Physical and Organic Chemistry:** Atomic Structure, Valency and Bonding: Formation of Ionic Bonds, Formation of Covalent Bonds, Secondary Forces of Attraction.
Types of Chemical Reaction, Rates of Chemical Reactions and Chemical Equilibria, Effect of Temperature on Rate of Reaction, Catalysts, Thermodynamics of Reactions, 1st, 2nd and 3rd law of thermodynamics, Free Energy, Interpreting Thermodynamic Data.
Acids, Bases and Salts, pH Scale, Salts and Salt Hydrolysis, Buffer Solutions, Redox Reactions. Hydrocarbons - Aliphatic and Aromatic Hydrocarbons and Important Functional Groups. (12)

**UNIT-II**

**Chemistry of Dyes and Pigments:** Classification of Colourants, Colour in Organic Molecules, Classification of Dyes According to Chemical Structure - Azo Dyes, Anthraquinone Dyes, Methine and Polymethine Dyes, Nitro Dyes, Triarylmethane Dyes. Classification of Dyes According to Application Class. Dye intermediates and their chemistry. Different types of chromophores and auxochromes. Fluorescence and phosphorescence. Commercial Naming of Dyes and Pigments. (10)

**UNIT-III**

**Mechanism of Dye Application:** Chemistry and application mechanisms of major classes of dyes used for cellulosic fibres, namely direct, reactive, vat, and sulphur dyes includes the nature of dye–fibre interactions, chemical reactions involved during dyeing, fixation mechanisms, and post-dyeing treatments. Influence of process variables such as pH, temperature, electrolyte concentration, time, liquor ratio, and auxiliary chemicals on dye exhaustion, fixation, colour yield, and fastness properties for each dye class. (10)

**UNIT-IV**

**Theoretical Aspects of Dyeing:** Kinetic Aspects of Dyeing, Dye Aggregation, Diffusion - Measurement of the Diffusion Coefficient of Dyes, Activation Energy of Diffusion Rate of Dyeing, Adsorption - Physical Adsorption, Chemical Adsorption (Chemisorption), Adsorption Isotherms.
**Thermodynamic Studies of Dyeing Systems**: Standard Affinity, Standard Enthalpy and Standard Entropy of Dyeing, Determination of Thermodynamic Values for the Three Dye/Fibre System Types. (12)

**Suggested Text Books:**


1. Colour Chemistry, by R. L. M. Allen.
2. Chemistry of Synthetic Dyes, by K. Venkatraman.
3. Colour Chemistry – Synthesis, Properties and Applications of Dyes and Pigments, by H. Zollinger.
4. Industrial Dyes, by Klaus Hunger.
5. Chemistry of Synthetic Dyes and Pigments, by H. A. Lubs.
6. Textile Technology and Dyeing of Textile Fibres, by E. R. Trotman Griffin Publication, London.
7. Fundamentals and Practices in Colouration of Textiles, by J. N. Chakraborty.
8. Theory of Coloration of Textiles, by Alan Jhonson.
9. Theory of Coloration of Textiles, by C. L. Bird and Boston.

**26LC-PCC-TT/TC/FAE-204H Yarn Manufacture Lab-II**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26LC-PCC-TT/TC/FAE-204H | | | | |
| **Category** | Professional Core Lab Course | | | | |
| **Course title** | Yarn Manufacture Lab-II | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 0 | 0 | 2 | 1 | |
| **Classwork** | 05 Marks | | | | |
| **Examination** | 20 Marks | | | | |
| **Total** | 25 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**Course Outcomes:**

The laboratory course will consist of experiments illustrating the principles of Yarn Manufacturing relevant to the study of textile engineering. The students will be able to:

- To learn and understand the various lab skills related to machinery settings and material handling.
- To apply the knowledge of the important lab experiments in solving complex Engineering problems regarding drafting and twisting.
- To determine production, efficiency, draft, twist, and breakage rates for Combing, Speed Frame, and Ring Frame departments.
- To study the machine mechanisms such as Differential Motion and Building Motion,

**LIST OF EXPERIMENTS**

1. To study the design and gearing of lap former machine to calculate speeds, break draft, Main Draft, Total Draft, and machine production.
2. To study the design and working of a Rectilinear Comber and understand the function of key parts.
3. To study the Comber machine gearing diagram and calculate Nips per minute, Feed per nip, various drafts, and Production in Kg/hr.
4. To study the design and working of the Speed Frame (Roving Frame) and understand the drafting, twisting, and winding zones.
5. To study the Speed Frame gearing plan and calculate Break Draft, Main Draft, Total Draft, Draft Constant, Twist per Inch (TPI), Twist constant, Spindle speed, Bobbin speed, Bobbin rail speed, coils/inch and production in kg/hr/spindle.
6. To study the principle of conventional and Electromagnetic Building Motion mechanisms on the Speed Frame responsible for package build.
7. To set the roving frame for producing the roving of a known linear density. Also understand function of different change places on speed frame machine.
8. To study and draw the passage of material through the Ring Frame and understand the function of different parts of the Creel, Drafting zone, and Spindle zone.

9. To study the Ring Frame gearing diagram and calculate Drafts (Break and Main), Spindle Speed, traveller speed, Twist per Inch (TPI), winding length. production in grams per spindle shift.
10. To study the various parts of Spring-Loaded top arm of PK 235 and pneumatic loaded R2PX drafting system (Laxmi Rieter) and how load is adjusted in top arms.
11. To study the Bobbin Building Motion (Cam and Lever mechanism) on the Ring Frame.
12. To set the ring frame for producing the yarn of a known linear density. Also understand the function of different change places on the ringframe machine.
13. To study the passage of material and gearing of a Ring Doubling machine and calculate the delivery rate, twist per inch, spindle speed and resultant count.
14. To set the ring doubler for producing the double yarn of known twist.
15. To study the passage of material and working principle of a Two-For-One (TFO) Twister.

**Suggested Books:**


1. Technology of Short-staple Spinning by W. Klein, The Textile Institute.
2. Spun Yarn Technology by Eric Oxtoby, Butterworth-Heinemann.
3. Process Control in Spinning by A.R. Garde and T.A. Subramanian.

## 26LC-PCC-TT/TC/FAE-206H Fabric Manufacture Lab-II

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26LC-PCC-TT/TC/FAE-206H | | | | |
| **Category** | Professional Core Lab Course | | | | |
| **Course title** | Fabric Manufacture Lab-II | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 0 | 0 | 2 | 1 | |
| **Classwork** | 05 Marks | | | | |
| **Examination** | 20 Marks | | | | |
| **Total** | 25 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**Course Outcomes**

After completion of the laboratory, students will be able to:

- Identify and explain the construction and working of projectile, rapier, air-jet and water-jet looms
- Distinguish between rigid and flexible rapier weaving mechanisms
- Analyze weft insertion sequences and timing diagrams
- Perform numerical calculations related to weft velocity and loom performance

**LIST OF EXPERIMENTS**

1. Study of salient features and layout of shuttleless weaving machines: Study of different types of shuttleless weaving machines with emphasis on layout, speed, production rate and basic production calculations.
2. Study of shedding and bet-up mechanisms used in shuttleless weaving machines: Study of construction, working and settings of matched cam shedding and bet-up.
3. Study of take-up and let-off mechanisms in shuttleless weaving machines: Study of construction, working and settings of take-up and let-off mechanisms used in shuttleless looms, with emphasis on fabric control and calculations.
4. Projectile weaving machine: Study of salient features, construction and working of torsion bar picking mechanism, path of weft, projectile circulation, weft transfer, sequence of weft insertion, timings and related calculations.
5. Rigid rapier weaving machine: Study of salient features, path of weft, components in the weft path, weft transfer at shed center, rapier displacement curves, colour mixing, rapier drive, timings, settings and related calculations.
6. Flexible rapier weaving machine: Study of salient features, path of weft, components in the weft path, weft transfer at shed center, rapier displacement curves, colour mixing, rapier drive, timings, settings and related calculations.
7. Air-jet weaving machine: Study of salient features, path of weft, main nozzle, relay nozzles, air supply system, timing sequence, settings and calculations related to weft insertion.

8. Water-jet weaving machine and selvedge mechanisms: Study of salient features, path of weft, jet pump and nozzle, timing sequence, calculations, settings and study of different selvedge mechanisms used in shuttleless weaving machines.
9. Determination of Fabric Constructional Parameters of Plain/Twill/Satin Weave Fabric.

**Suggested Text Books:**


1. Principles of Weaving by R. Marks and A. T. C. Robinson, Textile Institute, 1976.
2. Principles of Woven Fabric Manufacturing by A. Majumdar, CRC Press, 2016.
3. Weaving: Conversion of Yarn to Fabric by P. R. Lord and M. H. Mohamed, Woodhead Publishing, 1982.
4. Principles of Fabric Formation by P. K. Banerjee, CRC Press, 2015.
5. Handbook of Weaving by Sabit Adanur, CRC Press, 2000

## 26LC-PCC-TT/TC/FAE-208H Textile Chemical Processing Lab-II

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26LC-PCC-TT/TC/FAE-208H | | | | |
| **Category** | Professional Core Lab Course | | | | |
| **Course title** | Textile Chemical Processing Lab-II | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 0 | 0 | 2 | 1 | |
| **Classwork** | 05 Marks | | | | |
| **Examination** | 20 Marks | | | | |
| **Total** | 25 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**Course Outcomes:**

On successful completion of the Textile Chemical Processing–II Laboratory, students will be able to:

- Perform printing operations on fabrics using direct, resist, and discharge printing styles with appropriate dyes, print pastes, and fixation methods.
- Apply advanced and special printing techniques such as pigment printing, transfer printing on polyester/blended textiles, and value-added styles including foil and brasso printing.
- Evaluate the colour fastness properties of dyed and printed textiles—including wash fastness and rubbing fastness—using standard AATCC test methods and grey scale rating systems.
- Apply and assess the performance of functional finishes such as anti-crease (resin finish), water repellency, and flame retardancy on textile materials using standard laboratory procedures.
- Analyze the effect of different finishing chemicals, including various types of softeners, on the handle, appearance, and performance characteristics of textile materials and interpret experimental results.

### LIST OF EXPERIMENTS

1. Printing of cotton fabric with a direct style of printing using screen printing with reactive dye.
2. Printing of cotton fabric with a resist style of printing using screen printing with reactive dye.
3. Printing of cotton fabric with a discharge style of printing using screen printing with vat dye.
4. Perform the printing of textile material using pigment colours.
5. Print the polyester or its blended textiles using the transfer printing technique.
6. Perform the foil printing and brasso style of printing on textiles.

7. Test the wash fastness of dyed/printed textile using AATCC method and evaluate the rating using the grey scale.
8. Test the rubbing fastness of dyed/printed textile using AATCC method and evaluate the rating using the grey scale.
9. Application and evaluation of resin finish for anti-creasing property to textile materials.
10. Application and evaluation of water repellent finish to textile materials.
11. Application and evaluation of flame-retardant finish to textile materials.
12. Application softener finishing to textile materials using different types of softeners.

**Suggested Books:**


1. Textile Printing, by L. W. C. Miles, Society of Dyers and Colourists.
2. Principles of Textile Finishing, by A. K. R. Chaudhury, The Textile Institute Book Series.
3. Chemical Finishing of Textiles, by W. D. Schindler and P. J. Hauser, Woodhead Publishing.
4. AATCC Lab Manual

**26AU-ENV-202-H Environmental Science**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26AU-ENV-202-H | | | | |
| **Category** | Audit Course (Mandatory) | | | | |
| **Course title** | Environmental Science | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 2 | 0 | 1 | 0 | |
| **Classwork** | 30 Marks | | | | |
| **Examination** | 70 Marks | | | | |
| **Total** | 100 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- People working in industries or elsewhere essentially require the knowledge of environmental science so as to enable them to work and produce most efficient, economical and eco-friendly finished product. It will guide the students living in a historic transitional period of burgeoning awareness of the conflict between human activities and environmental constraints to help and save the fragile and endangered planet with the natural resources already overexploited

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Solve various engineering problems applying environmentally sustainable approach to produce eco-friendly products.

**CO2:** Use relevant pollution control methods to solve domestic and industrial problems

**CO3:** To recognize eco-friendly and sustainable energy resources for combating global problems like climate change, acid rain and resource depletion etc.

**CO4:** To solve local solid hazardous and e-waste problems.

**CO-PO Mapping**

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

**Unit-1**

The Multidisciplinary nature of environmental studies. Definition, scope and importance. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Interaction between earth, man and environment. (2lectures)

**Unit-2 Natural Resources:**

Renewable and non-renewable resources: Natural resources and associated problems.

a) Forest resources: Use and over-exploitation; deforestation, case studies. Timber extraction, mining dams and their effects on forests and tribal people.
b) Water resources: Use and over-utilization of surface and ground water, floods,drought, conflicts over water, dams-benefits and problems.
c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
d) Food resources: World food problems, changes, caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, Water logging, salinity, case studies.
e) Energy resources: Growing energy needs; renewable and non-renewable energy source, use of alternate sources, case studies.
f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles. (8lectures)

**Unit-3 Ecosystem and biodiversity conservation**

- Structure of ecosystem, Biotic and Abiotic components
- Energy flow in the ecosystem.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Aquatic and terrestrial ecosystems
- Different level of biodiversity: Genetic, Species and ecosystem diversity.
- Value of biodiversity: consumptive use, productive use,social, ethical ,aesthetic and option values.
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation.
- Hot-spots of biodiversity.
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India.
- Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. (8lecture)

**Unit-4 Environmental Assessment and Management:**

- Aims and objectives of environmental impact assessment (EIA), Environmental Impact Statement (EIS) and environment management plan (EMP).Structure and role of central and state pollution control board, ISO14000: implementation in industries benefit.
- Environment Protection Act.
- Air (Prevention and Control of pollution) Act.
- Water (Prevention and Control of pollution)Act.
- Wildlife Protection Act.
- Forest Conservation Act.

- Issues involved in enforcement of environmental legislation.
- Public awareness. (6 lectures)

**Unit-5 Environmental pollution:**

- Definition, causes, effects and control measures of:
    a. Airpollution.
    b. Water pollution
    c. Soil pollution
    d. Marine pollution
    e. Noise pollution
    f. Thermal pollution
    g. Nuclear hazards
- Bag filters, cyclone separator, electrostatic precipitator, catalytic converter.
- Role of an individual in prevention of pollution.
- Pollution case studies.
- Disaster management: floods, earthquake, cyclone and landslides. (8lectures)

**Unit-6 Contemporary environmental issues:**

- From unsustainable to sustainable development.
- Urban problems related to energy, National solar mission.
- Water conservation, rain water harvesting, watershed management, Namami Gange and
- Yamuna action plan.
- Resettlement and rehabilitation of people: its problems and concerns case studies.
- Environmental ethics: Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, sea level rise, nuclear accidents and holocaust. Case studies.
- Waste land reclamation.
- Carbon sequestration and carbon credits, carbon foot print
- Waste management- Swachha Bharat Abhiyan
- Consumerism and waste products. (7lectures)

**Unit-7 Human population and the Environment.**

- Population growth, variation among nations. Population explosion-Family Welfare Programme.
- Environment and human health. Epidemiological issues: Fluorosis, Arsenocosis, Goitre, Dengue.
- Human Rights, Value Education, HIV/AIDS. Woman and ChildWelfare.
- Role of InformationTechnology in Environment and human health. Case Studies. (6lectures)

**Unit-8 Field Work:**

- Visit to a local area to document environmental assets - river/ forest/ grassland/ hill/ mountain.
- Visit to a local polluted site-urban/Rural/Industrial/ Agricultural.
- Study of water polluted site
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hillslopes,etc. (Fieldwork equal to15 lecture hours).

**Suggested Text Books / Reference Books:**


1. Agarwal, K.C. 2001 Environmental Biology, NidiPub. Ltd. Bikaner.
2. Bharucha, Frach, The Biodiversity of India, M Apin Publishing Pvt. Ltd. Ahmedabad-380013, India, E-mail:mapin@icenet.net (R).
3. Brunner R.C.1989, Hazardous Waste Incineration, Mc.GrawHill Inc. 480p.
4. Clark R.S., Marine pollution, Slanderson Press Oxford (TB).
5. Cunningham, W.P. Cooper,T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Pub.House, Mumbai 1196p.
6. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
7. Down to Earth, Centre for Science and Environment (R).
8. Gleick,H.P.,1993.Water in crisis,Pacific Institute for Studies in Dev. Environment & amp;Security Stockholm Env.Institute, OxfordUniv.Press,473p.
9. Hawkins R.E. Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay(R).
10. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment, Cambridge Uni. Press 1140p.
11. Jadhav ,H & amp; Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284p.
12. Mackinney, M.L .& Schoch, RM 1996, Environmental Science systems & amp; solutions, Webenhancededitі on.639p.
13. Mhaskar A.K., Mayyer Hazardous,Tekchno-Science Publications(TB).
14. MillerT.G.Jr.Environmental Science,Wadsworth Publishing Co. TB).
15. Odum,E.P.1971, Fundamentals of Ecology.W.B.Saunders Co.USA,574p.
16. Rao M.N.& amp; Datta,A.K.1987Waste Water Treatment.Oxford & amp;TBH Publ. Co. Pvt. Ltd.345p.
17. Sharma,B.K.2001,Environmental Chemistry,GoalPubl.House,Meerut.
18. Survey of the Environment,TheHindu(M).
19. Townsend C.,Harper J.and Michael Begon.Essentials of Ecology, BlackwellScience(TB).
20. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Comliances and Standards, Vol.I and II EnviroMedia (R).
21. TrideviR.K.andP.K.Goal,Introduction to air pollution, Techno Science Publications (TR).
22. WagnerK.D.,1998, Environmental Management, W.B. Saunders co. Philadelphia, USA 499p.
23. A text book environmenta leducation G.V.S.Publishers by Dr.J.P.Yadav.
    (M) Magazine (R) Reference (TB)Textbook


**The scheme of the paper will be as under:**

The subject of Environmental Science will be included as a qualify in paper in all UG Courses and the students will be required to qualify the same. The duration of the course will be 45 lectures.The examination will be conducted along with the semester examinations.

**Exam Pattern:** In case of awarding the marks,the paper will carry 100 marks.
Theory: 70marks, Practical/ Field visit:30 marks.

**The structure of the question paper will be:**
Part-A: Short Answer Pattern : 10marks
Part-B: Essay Type with in built choice : 60marks
Part-C: Field Work(Practical) : 30marks

**Instructions for Examiners:**

Part A: Question No.1 is compulsory and will contain five short-Answer type questions of 2 marks each covering the entire syllabus.
Part B: Eight essay-type questions (with built-in choice)will be set from the entire syllabus, and the candidate will be required to answer any four of them. Each essay-type question will be of 15marks. The examination of the regular students will be conducted by the concerned college/Institute.
Each student will be required to score a minimum 40% marks separately in theory and practical/Field visit. The marks in this qualifying paper will not be included in determining the percentage of marks obtained for the award of a degree. However, these marks will be shown in the detailed marks certificate of the students.

**26PCC-TC-218H Synthesis of Dyes and Pigments**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26PCC-TC-218H | | | | |
| **Category** | Professional Core Course (Honors) | | | | |
| **Course title** | Synthesis of Dyes and Pigments | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 3 | 0 | 0 | 3 | |
| **Classwork** | 25 Marks | | | | |
| **Examination** | 50 Marks | | | | |
| **Total** | 75 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**COURSE OBJECTIVES:**

- To explain the various dyes and pigments of different colour and their chemical constitution.
- To illustrate the fundamentals of organic reactions involved in the synthesis of dyes, pigments and their intermediates.
- To apply the knowledge of qualitative and quantitative analysis of dyes, pigments and their intermediates.
- To understand the various factors affecting the dyeing process.

**COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

**CO1:** Define and explain the theory of colour and colour laws, types of dyes and pigments of different colour and their chemical constitution.

**CO2:** Understand the fundamentals of organic reactions involved in the synthesis of dyes, pigments and their intermediates.

**CO3:** Apply the knowledge of qualitative and quantitative analysis of dyes, pigments and its intermediates.

**CO4:** Analyze the chemistry involved in the synthesis and application of dyes and pigments. Also, analyze the factors affecting the dyeing process.

**CO - PO – PSO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 3 | 1 | - |
| CO2 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | 1 | 3 | 1 | 1 |
| CO3 | 2 | 3 | 1 | 3 | 2 | - | - | - | - | - | 1 | 2 | 3 | 1 |
| CO4 | 2 | 3 | 2 | 3 | 1 | - | 1 | - | - | - | 1 | 3 | 3 | 2 |
| Wt. Avg. | 2.5 | 2.3 | 1.3 | 2.3 | 1.5 | - | 1.0 | - | - | - | 1.0 | 2.8 | 2.0 | 1.3 |
| | | | | | | | | | Overall Mapping of Subject | | | | | 1.80 |

**Note:**
Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total selecting at least one from each unit.

**UNIT-I**

**Colour and Chemical Constitution:** Properties of electromagnetic radiation, its interactions with matter, Visible spectrum, and viewing of colour. Additive and subtractive theories of colour; Relationship between colour and chemical constitution – Witt's Theory, Relationship between colour and chemical constitution, valence bond and molecular orbital theory, Concept of Fluorescence and Phosphorescence. (6)

**Dyes and Pigments:** Concept of dye and pigment, Classification of dyes according to the method of application and chemical structure, Dye-fibre interactions, Relationship between chemical structure and substantivity, as well as fastness properties. Concept of colour index and its significance. Nomenclature of dyestuffs. Concept of fluorescent dyes, thermochromic dyes, photochromic dyes, Organometallic dyes and pigments. (6)

**UNIT-II**

**Fundamentals of Organic Reactions:** Introduction, functional group interconversion, nucleophilic substitution reaction via benzyne intermediate, electrophilic substitution reaction of monosubstituted benzene and disubstituted benzene, activation and deactivation effect, orientation effect of substituents. (10)

**UNIT-III**

**Synthesis of dyes, pigments and intermediates**: Polynuclear Dye intermediates: preparation and properties of naphthalene, anthracene and their derivatives. Preparation of H-acid, J-acid, G-acid, Naphthionic acid, Gamma acid, Schaffer's acid, N-W acid and Cleve acid. Preparation of dyes based on Azo, Nitro, DPM, TPM and Anthraquinone chromophores. (10)

**UNIT-IV**

**Analysis of Dyes and Pigments:** Purification by crystallization, Element detection by Lassaigne's Test - Test for Nitrogen, Sulphur, Halogens from dyes. Qualitative and quantitative analysis of dye intermediates. Fundamentals of U.V-visible spectroscopy and FTIR spectroscopy for analysis of dyes and pigments. Introduction to methods of dye degradations. (6)

**Elements of Dyeing:** Concept of substantivity and affinity of dyes, Concept of percentage shade, liquor ratio, exhaustion, and expression. Solubility and dissolution of dyes, aggregates of dyes, dyeing assistants like water softeners, exhausting agents, levelling and retarding agents. Effect of temperature on dyeing. Compatibility of dyes in combination shades. (6)

**Suggested Textbooks:**


1. Spectroscopy of Organic Compounds by P. S. Kalasi.
2. Instrumental Methods of Chemical Analysis by G. Chatwal and S. Anand
3. A textbook of practical organic chemistry by A. I. Vogel.
4. Synthetic organic chemistry by G. R. Chatwal
5. Synthetic dyes by K. Venkatraman
6. Chemical processing of textile – preparatory and dyeing C V Kaushik, A I Josico, NCUTE
7. Principles of dye chemistry by Paul Vittum
8. Synthetics Dyes by K. M. Shah

9. Dyeing and chemical technology of textile fibres by E. R. Trotman
10. The dyeing of cellulose fibres by Clifford Preston.
11. Chemical technology of fibrous material by F. Sadov
12. Basic Principles of Textile Colouration by Arthur D Broadbent, SDC
13. Chemical processing of synthetic fibres by Dr K. V. Datye and A. A. Vaidya

**26LC-PCC-TC-218H Synthesis of Dyes and Pigments Lab**

| | | | | | |
|---|---|---|---|---|---|
| **Course code** | 26LC-PCC-TC-218H | | | | |
| **Category** | Professional Core Lab Course (Honors) | | | | |
| **Course title** | Synthesis of Dyes and Pigments Lab | | | | |
| **Scheme and Credits** | L | T | P | Credits | Semester-IV |
| | 0 | 0 | 2 | 1 | |
| **Classwork** | 05 Marks | | | | |
| **Examination** | 20 Marks | | | | |
| **Total** | 25 Marks | | | | |
| **Duration of Exam** | 03 Hours | | | | |

**Course Outcomes:**

The students will be able to:

- Perform qualitative analysis of organic compounds and dye intermediates to identify functional groups and elements using standard chemical tests.
- Synthesize selected dyes and dye intermediates and carry out extraction of natural dyes using aqueous, solvent, and ultrasonic-assisted methods.
- Analyze and interpret UV–Visible and FTIR spectra to determine λmax, percentage transmittance, and functional groups of dyes and dye intermediates.
- Apply chromatographic and spectroscopic techniques to separate, identify, and evaluate plant pigments and textile dyes, and relate results to textile chemistry applications.

**LIST OF EXPERIMENTS**

1. Qualitative analysis of functional groups presents in a given organic compound.
2. Organic qualitative analysis of dye intermediates.
3. Preparation of phenyl azo β naphthol.
4. Synthesis of phthalic anhydride from phthalic acid.
5. Extraction and evaluation of natural dyes by aqueous method.
6. Extraction and evaluation of natural dyes by solvent method.
7. Extraction and evaluation of natural dyes by ultrasonic assisted method.
8. Analysis of IR spectra of various dye intermediates.
9. To separate and identify different plant pigments present in green leaves using paper chromatography.
10. To determine the absorption peak ($\lambda_{max}$) of a dyed sample and dye intermediates using UV–visible spectrophotometer.
11. To determine the (%) transmittance of a dye intermediate using a UV–Visible spectrophotometer.
12. FTIR analysis of dye intermediates to identify functional groups.

**Suggested Books:**


1. Spectroscopy of Organic Compounds by P. S. Kalasi.
2. Instrumental Methods of Chemical Analysis by G. Chatwal and S. Anand
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