

SHIVAJI UNIVERSITY, KOLHAPUR

Doctor of Philosophy [Ph. D.]

Ph.D. Coursework

TEXTILE ENGINEERING

Course Structure

(To be implemented from Academic Year 2022-23 Onwards)

Course Structure

TEXTILE ENGINEERING

Total number of papers:

S. No.	Subject	Marks
1	Research Methodology, Quantitative Techniques and Computer Application.	100
2	Advances in Textile Engineering	100
3	Elective Subjects (Based on Specialization). The student has to select one elective from the followings. 1. Surface Treatment of Textiles or 2. Fibre Reinforced Composite or 3. Theory of Clothing Comfort or 4. Mechanics of Textile Machines	100
	Total	300

For each Paper there will be 60 hours of work load (Lectures -40 hours, Discussion/Seminars - 10 hours and Library work -10 hours).

Scheme of Examination:

Paper I:- Research Methodology, Quantitative Techniques and Computer Application.

This is a common subject for the Faculty of Engineering and its scheme of examination is also common.

Paper II & III:-

Paper No	Paper Title	Theory Marks	Internal Marks	Total Marks
Paper II	Advances in Textile Engineering	80	20	100
Paper III	Elective Subjects (Based on Specialization).	80	20	100
			Total	300

For Paper II the internal evaluation will include 2 Seminars of 10 Marks each

For Paper III the internal evaluation will be as follows:

- a) Seminars (Submission and Presentation)- 10 marks
- b) Review of Literature: Submission and Presentation- 10 marks

Syllabus:

PAPER-II
ADVANCES IN TEXTILE ENGINEERING

TEXTILE FIBRES:

Natural fibres – cellulosic fibres, protein fibres, regenerated cellulosic and protein fibres, and their physical and chemical properties. Synthetic fibres: apparel grade and industrial grade fibres and their physical and chemical properties.

THEORY OF TEXTILE STRUCTURES:

Fibre structure-morphology of fibres, mechanical properties of fibres-creep, stress relaxation, dynamic test, Boltzmann superposition principle, elastic recovery, Thermal properties of fibres-specific heat capacity, thermal conductivity, mechanics of heat setting, decomposition and degradation, Frictional properties of fibres-factors affecting friction, mechanism of friction.

Yarn structure-Migration - geometrical approach and tension variation as mechanism of migration, Extension behavior of continuous filament yarn - theoretical approach, actual behavior, breakage of staple yarn – modified approach.

Fabric structure - Peirce paper on fabric geometry, bending, buckling, compression behavior of fabric, Structure of knitted fabric, transfer properties of fabric-Moisture, air, water, heat transmission, hand of fabric-KAWABATA, FAST systems.

YARN AND FABRIC MANUFACTURING

Development trends in yarn and fabric manufacturing technologies, Non woven – web formation details, orientation of fibres and its effect, web forming machines, doubling, bonding methods bonding material, properties of nonwovens and quality assessment, applications

CHEMICAL PROCESSING OF TEXTILES

Recent advancements in Dyes and Chemicals; Eco –friendly Processing of Textiles; Modern Processing of Textiles, Conservation of utilities in Textile Processing, Recent Advancements in Chemical Processing Machinery, Applications of Bio-Technology, Plasma Technology and Nanotechnology in Textiles.

REFERENCE BOOKS: -

1. Handbook of textile fibres, Vol I and II, - Gordon and Cook
2. HandBook of fibre chemistry – Menachem Lewin
3. Manufactured fibre technology – V B Gupta and V K Kothari
4. Physical properties of textile fibres-Morton W.E. And Hearle J.W.S.
5. Textile Fibres yarns and fabrics-Kaswell E.R.
6. Textile yarns –Martindale and Goswami.
7. The Textile Institute Publication - Manual of Textile Technology – Short Staple Spinning Series by W. Klein.
8. Yarn Production Theoretical Aspects - P. Grosberg & C.Iype.
9. Handbook of Weaving – Sabit Adnur
10. Modern Preparation and Weaving Machinery – A Ormerod
11. Handbook of Textile processing machinery by R.S. Bhagwat
12. Garment Technology for fashion designers by Gerry Cooklin
13. Introduction to clothing Manufacturing by Gerry Cooklin

PAPER-III

Elective Subject

SURFACE TREATMENT OF TEXTILES

COATING CHEMISTRY:

Advantages & Disadvantages of conventional finishing, Concept of Coating & Lamination, Merits & Demerits of Coating & Lamination, Production, Structure & Properties of Rubbers like- Natural Rubber, Styrene- Butadiene rubber, Isoprene-Isobutylene Rubber, Butyl Rubber, EPM & EPDM, Polychloroprene Rubber, Nitrile Butadiene Rubber & Silicone Rubber, Polymeric materials like Polyvinyl Chloride, Polyurethane, Acrylic Polymers, Foams For Laminates, Radiation-Cured Coating, Adhesion.

COATING TECHNIQUES:

Knife Coating- Different types of Knives, Knife coating with pre-metering and post-metering, Roll Coating- Mayer rod coating, Direct-roll coating, Kiss roll coating, Gravure coating, Reverse roll coating, Dip Coating, Transfer Coating, Rotary screen Printing, Calendering- Zimmer coating, Hot-Melt Coating, Scatter Coating, Foam Coating, Lamination by Adhesives, Flame Lamination, Hot melt Lamination Merits & Demerits of each coating methods. Test methods for coated, laminated materials

NANO TECHNOLOGY:

Concept of nano-scale and historical background of nanotechnology, Fundamental concepts of nanotechnology - Bottom-up approaches, Top- down approaches, Functional approaches.

Synthesis and Properties of Nanoparticles: Synthesis of Fullerenes and various forms of carbon. Synthesis of nano metal particles by various chemical, physical and biological methods. Properties of nano particles like organic and inorganic materials in various chemical forms. **Characterization of Nanoparticles:** Principles of various techniques

NANO TEXTILES:

Development of functional textile using nano material: Conductive textiles, Antimicrobial textiles, Self-cleaning textiles, Moisture absorbing textiles, Improved hydrophilicity, colourability and wear resistance, UV- blocking textiles, Controlled release of active agents.

PLASMA TECHNOLOGY:

Introduction, gases used, plasmas generation, plasma chemistry and plasma surface collisions. Low pressure, Atmospheric pressure and DBD plasma generation, its equipment for textile processing

TEXTILE APPLICATIONS OF PLASMA TECHNOLOGY

Action of plasma on various textile substrates. Plasma treatment of Textiles for water and soil repellency, Interfacial engineering of functional textiles for biomedical applications, plasma modification of wool, plasma modification of natural cellulosic fibres, plasma treatments of fibres and textiles. Characterization of Plasma Treated Textiles, principles of various techniques.

REFERENCE BOOKS

1. Principles of Nanotechnology by Phani Kumar
2. Nanofibres & Nanotechnology in Textiles by P.J. Brown & K. Stevens
3. Plasma Technology for Textiles by Roshan Shishoo, CRC Publication
4. Plasma Surface Modification and Plasma Polymerization – Norihiro Inagaki: CRC Press
5. Coated Textiles Principles and Applications by Dr. A. K. Sen
6. The Nanoscope, Encyclopedia of Nano Science & nanotechnology Vol.-I to VI, Dr.
7. Parag Diwan & Ashish Bharadwaj
8. Analytical Electrochemistry in Textiles by P. Westbroek, G. Priniotakis & P. Kiekens

PAPER-III

Elective Subject

FIBRE REINFORCED COMPOSITES

General Introduction - Meaning and types of composite materials, design of composite materials, the concept of load transfer.

Fibers and Matrices

Reinforcements - carbon fibers, glass fibers, organic fibers, silicon carbide, Strength of reinforcements: thermal stability, compressive strength, fiber fracture and flexibility, A statistical treatment of fiber strength.

Matrices - polymer matrices, metal matrices, ceramic matrices.

Fiber architecture - Volume fraction and weight fraction, fiber packing arrangements, clustering of fibers and particles.

Long fibers - laminates, woven, braided and knitted fabric arrays, characterization of fiber orientations in a plane.

Short fibers - fiber orientation distributions in three dimensions, fiber length distributions.

Fabrication: Liquid resin impregnation routes, pressurized consolidation of resin pre-pregs, injection mouldings of thermoplastics, hot press mouldings of thermoplastics, powder blending and consolidation, physical vapour deposition diffusion bonding of foils, Layered ceramic composites, reactive processing, carbon/carbon composites, powder based routes.

The interface region: Bonding mechanisms: absorption and wetting, inter diffusion and chemical reaction, electrostatic attraction, mechanical keying, residual stresses. Bond strength: Measurements of bond strength: single fiber pull out strength, single fiber push out and push down strength. Control of bond strength: coupling agents and environmental effects, toughness reducing coatings, interfacial chemical reaction and diffusion barrier coatings.

Strength of composites: Failure mode of long fibers like axial tensile failure, transverse tensile failure, shear failure, failure in compression. Failure of laminae under off-axis loads. Strength of laminates like tensile cracking, interlaminar stresses and edge effects. Basic concepts of fracture mechanics, interfacial fracture and crack deflection. Contributions to work of fracture like Matrix deformation, fiber fracture, interfacial debonding and frictional sliding. Subcritical crack growth like fatigue and stress corrosion cracking.

Thermal behavior of composites: Thermal stresses and strains, thermal expansivities, thermal cycling of unidirectional composites, thermal cycling of laminates, basics of matrix and fiber in relation to creep, axial creep of long fiber composites, transverse creep and discontinuously reinforced composites. Thermal conduction mechanism like heat transfer, conductivity of composites and interfacial thermal resistance.

Applications: minesweeper hull, sheet processing rolls, helicopter rotor blade, and golf driving club, racing bicycle, diesel engine piston, microelectronics housing, aircraft brakes and gas turbine combustor can.

REFERENCE BOOKS

- 1 Introduction to Composite Materials, Clyne and Hull
- 2 Fabre reinforced composites by P. K. Mallick
- 3 Composite materials: Engineering & science by F. L. Mathew & R. D. Rawlings.
- 4 Micro structural Characterization of fibre reinforced composites by John Summer scales
- 5 3-D Textile reinforcements in composite materials by Prof. A. Miravete
- 6 Mechanics of Textile & Laminated composites by A. E. Bogdanovich & C. M. Pastore.

PAPER-III

Elective Subject

THEORY OF CLOTHING COMFORT

HUMAN PHYSIOLOGY AND ROLE OF CLOTHING:

Definition of Comfort. Human physiological aspect of comfort. Perception of Comfort. Various aspects of clothing comfort. Comfort variables. Comfort properties of fibres, yarns and fabric structures.

THERMAL COMFORT:

Thermal balance of human body. Mechanism of heat transfer through clothing. Parameters influencing heat transfer. Mathematical modeling of heat transfer through clothing. Moisture transmission: Liquid water transfer- wicking, water absorption and principles of moisture vapour transfer. Dynamic heat and mass transmission characteristics of clothing. Factors influencing heat and mass transfer through fabrics.

TACTILE COMFORT:

Tactile comfort sensations. Fabric characteristics and tactile attributes. Fabric parameters influencing tactile sensation.

CLOTHING FIT AND COMFORT:

Body dimensions and pattern. Tight-fit and loose-fit clothing. Clothing fit and pressure. Factors related to clothing fit. Clothing fit and body movement.

AESTHETIC COMFORT:

Psychological aspects of aesthetic comfort. Analysis of clothing aesthetics. Aesthetic concepts of clothing.

IMPROVING COMFORT IN CLOTHING:

Different approaches for improving thermal comfort of clothing. Improving moisture transport and developments in moisture management. Improving textile surface properties for tactile sensation. Materials and design strategies for improved fit and movement.

REFERENCE BOOKS

- 1 Guowen Song, “Improving Comfort in Clothing”, Woodhead Publishing Limited, Cambridge, 2011
- 2 Apurba Das and Alagirusamy R, “Science in Clothing Comfort”, Wood head Publishing India Limited, New Delhi, 2010
- 3 Li Y, “The Science of Clothing Comfort”, Textile Progress, Vol.31, No.1/2, The Textile Institute, Manchester, 2001
- 4 Fan J and Hunter L, “Engineering Apparel Fabrics and Garments”, Woodhead Publishing Limited, Cambridge, 2009

PAPER-III

Elective Subject

MECHANICS OF TEXTILE MACHINES

Fundamentals of mechanics - Equations of forces, motion and energy; energy stored in rotating masses, simple harmonic motion its application to sley motion & heald shaft movement.

Design of machine elements – forces acting on components, stress strain curve, factor of safety, design steps, combined stresses, design of drafting rollers & shaft.

Friction & Lubrication – Machine degradation, factors & impact, meaning of lubrication, types of lubricants, selection criteria, lubricant monitoring.

Vibration monitoring – types of machine vibrations, impact of vibration, natural frequency of vibration, important vibration characteristics, vibration monitoring programme, materials & methods to control vibrations.

Mechanics in yarn manufacturing processes – elimination of trash & dust, carding theories, transfer of fibres, doubling & drafting, drafting force, design of cone drums, tension variation in roving, spinning geometry, balloon tension, cop winding, friction & open end spinning

Mechanics in fabric manufacturing processes - Study of mechanisms in winding, Build of various packages. Screw traversing mechanism. Design of grooved drums for various packages. Design changes in Beam warping drive for high speed. Sectional warping drum design. Mechanism of squeezing, sow box design. Review of design changes of shedding mechanism. Picking mechanism theories for different shuttle less weaving techniques.

REFERENCE BOOKS

- 1 Textile Mathematics, Vol-I, II and III By J.E. Booth, The Textile Institute Publication.
- 2 Control Methodology in Textile Engineering and Economics By John W.s. Hearle, Journal of the Textile Inst. Vol.83, No.3, 1992, The Textile Institute Publication

- 3 Textile Mechanics Vol.I, II By K. Slater, The Textile Institute Publication.
- 4 Mechanics of Spinning Machines By R.S. Rengasamy, NCUTE Publication
- 5 An Introduction to Textile Mechanisms By P. Grosberg, The General Publishing Company.
- 6 Theory of Machines by Sharma Agarwal
- 7 Mechanics of Textile Machinery By W.A.Hanton, The Textile Institute, Publication.
- 8 Principles of Weaving By R.Marks & Robbinson