# COURSE WORK FOR Ph. D.
## PAPER-II
## ADVANCES IN TEXTILE ENGINEERING

Lecture - 4 Hrs/Week
Theory - 100 Marks
Total - 100 Marks

**UNIT 1 a) 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.

**b) FIBRE MANUFACTURING**

Principles of melt spinning - general features, melt spinning variables and post spinning operations. Principles of solution spinning – aspects of dry and wet spinning, post spinning operations

Manufacturing process of PET, nylon 6 and 66, Acrylic, PP and Viscose

**UNIT 2 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.

**UNIT 3 a) YARN MANUFACTURING**

Blow room: Role of air current, Opening intensity, Effect of trash, cotton factor and machine factor on performance of blow room, factors responsible in designing and design changes in blow room machine.

Carding: Carding theories, fiber behavior through carding machine, factor responsible in designing card wires, transfer efficiency and factor responsible

Draw frame: Doubling and drafting principle, Drafting force, Design and performance of auto-leveler

Comber and preparatory: Factors responsible for good lap preparation, Noil theory, Design parameters considered during designing in nipper , top comb, half lap.

Speed frame and ring frame: Design and development in flyer, Spinning geometry, defects and remedies in yarn.

**b) FABRIC MANUFACTURING**

Development trends in winding, warping and sizing process and machines, tension control and automation. Developments in shuttle less looms, developments in circular and other multiphase weaving, electronic let off and take-up ,electronic shedding devices, energy saving, waste control, process control in all weaving processes, cost elements and cost control, fabric geometry aspects, project planning and management information system, use of electronics and information technology in fabric manufacturing.

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

**UNIT 4 a) 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.

Colour Fastness: Colour fastness to various agencies like washing, light, perspiration, sublimation and hot pressing

Evaluation of Functional Finishes: Evaluation of functional finishes like Antimicrobial finish, Flame Retardant Finish, Water Repellent Finish, Soil Release Finish, Resin Finish, UV – Protection Finish and Antistatic Finish.

**b) GARMENT MANUFACUTRING**

Computerized pattern making, digitizing, calculation of marker efficiency, marker duplication, computer aided marker making, fabric spreading, advances in cutting machines, computerized fabric cutting, advances in garment manufacturing machines, Special sewing machines like three thread overlock with a microprocessor, Sewing problems, slipped stitches, stay gered stitches, unsalaneed stitching pocker etc., Garment Finishing and Inspection

**REFERENCE BOOKS:-**

1. Handbook of textile fibres, Vol I and II, - Gorden 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 Nonwovens – Kroma
12. Basic Principles of Textile Coloration by Arthur D Broadbent Published by Society of Dyers and Colourists
13. Cellulosic Dyeing edited by J.Shore
14. Blend Dyeing edited by J.Shore
15. Textile Printing edited by Leslie W C Miles
16. Textile Finishing by Derek Heywood

17. Handbook of Textile processing machinery by R.S. Bhagwat
18. Garment Technology for fashion designers by Gerry Cooklin
19. Introduction to clothing Manufacturing by Gerry Cooklin

## LIST OF ELECTIVE SUBJECTS FOR PAPER-III

| Elective No. | Elective Subjects |
|---|---|
| 1 | High Performance Fibres |
| 2. | Technical Textiles |
| 3. | Textile For Protection |
| 4. | Textile for Sports Application |
| 5. | Textile in Automobile Engineering |
| 6. | Intelligent Textiles & Clothing |
| 7. | Physical Methods of Analysis & Eco-Testing |
| 8. | Nanotechnology in Textiles |
| 9. | Project Preparation, Appraisal & Implementation |
| 10. | Management of Textile Production |

## COURSE WORK FOR Ph. D.
## PAPER-III
## ELECTIVE-1 - HIGH PERFORMANCE FIBRES

Teaching Scheme
Lect. 3 hrs./week
Practical/Tutorial 1 hr. /week

Examination Scheme
Theory Paper : 80 Marks,
Term work: 20 marks

**UNIT 1 :** High performance fibres **-**Introduction to High Performance Fibres.

Aramids: - Manufacturing, properties of fibres, and applications.

Gel spun high performance polyethylene fibres:-Manufacture, fibre characteristics and applications,

**UNIT 2 :** Carbon Fibres: Introduction, PAN and pitch based carbon fibres, physical properties and applications. semi carbon fibres,

Fully aromatic polyester fibres.

**UNIT 3 :** Glass Fibres: fibre manufacture, properties and Applications

Ceramic Fibres: Introduction, silicon carbide based fibres, Alumina based fibres. Single crystal oxide fibres.

**UNIT 4 :** Chemical resistant fibres and thermally resistant fibres: Chlorinated fibres: PVDC,Fluorinated Fibres: PTFE, PVF, PVDF & FEP,Poly (entheretherketones): PEEK,Poly (phenylene sulphide): PPS,Poly (enther imide) : PEI,:poly benzimidazole, PBI Polybenzoxazoles, PBO.

**Note: Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS**

1. High Performance Fibres by J. W. S. Hearle
2. Carbon Fibres by Donnet & Bansal
3. Hand book of Fibres Science & Technology : High Technology Fibres edited by Manachem Lewin & Jack Preston
4. New Fibres by Hongu and Phillips.
5. Kevlar Aramid Fibres by yang.

## COURSE WORK FOR Ph. D.
## PAPER-III

## ELECTIVE-2 - TECHNICAL TEXTILES

| Teaching Scheme | Examination Scheme |
|---|---|
| Lect. 3 hrs./week | Theory Paper : 80 Marks, |
| Practical/Tutorial 1 hr. /week | Term work: 20 marks |

**UNIT 1 :**Overview of Technical Textiles: Classification, products, market overview and growth projections of technical textiles.

Automotive Textiles: Application of textiles in automobiles. Requirement s of pneumatic tyres, airbags and belts. Their production and properties of textiles used in these applications.

**UNIT 2 :**Architectural and Construction Textiles: Introduction, Fabrics for Architecture and Construction ,Applications of Coated Fabrics in Building Structures, Awnings and Canopies, Textiles as Roofing Materials, Storage Vessels, Fibre Reinforced Concrete and Cements, Textiles for Acoustic and heat Insulation

**UNIT 3 :**Protective Textiles: Requirements of textiles used against fire, chemicals, ballistic, wind, rain. Interactions between protection and thermal comfort

Textiles in sports: Physiological comfort of sportswear .Types of textiles used in the manufacturing of sports textiles.Functional requirements of these textiles.

Military and Defense Textiles:Introduction ,Protective Clothing and Individual Equipment,Textile Used in Defense Systems and Weapons.

**UNIT 4 :**General Industrial Textiles:Textiles in Agriculture,Textile in Electronics,Banners and Flags,Textile Reinforced Products,Transport Bags and Sheets,Fabrics to Control Oil Spills,Canvas Covers and Tarpaulins,Ropes and Nets,Home and Office Furnishings,Miscellaneous Applications

Functional requirements and types of textiles used for paper making, medical agricultural, packaging and footwear.

**Note : Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS**

1. The Textile Institute Advances in Fibre Science by S. K. Mukhopadhya
2. Textile Fibres: Developments & Innovations Vol. 2 by V. K. Kothari

3. S.Adanur “Wellington Sears Handbook of Industrial textiles”, Technomic Publishing Co., Inc Lancaster, Pennylvania ISBN: 1-56676-340-1, 1995.
4. Mukhopadhyay, S.K. and partridge J.F,’ Automotive Textiles’, Text.Prog, Vol. 29, No.1/2, 1998, ISBN: 1870372212.
5. Horrocks, A.R and Anand S, ‘Technical Textiles’, Text.Inst. 1999, ISBN: 1855733854.

## COURSE WORK FOR Ph. D.
## PAPER-III
## ELECTIVE-3– TEXTILES FOR PROTECTION

Teaching Scheme
Lect. 3 hrs./week
Practical/Tutorial 1 hr. /week

Examination Scheme
Theory Paper : 80 Marks,
Term work: 20 marks

**UNIT 1: Overview of protective clothing:** Overview and various standards for protective clothing, Market prospects, Classification, Materials and technologies, Future of personal protection, Requirements, International standards, Certification, Future trends.

**Factors affecting the design and use of protective clothing:** Introduction, Factors influencing the design development process, Clothing systems and functionality, Reconciling fashion and function, Future trends, Recommended steps in the selection of textiles for protective clothing, Relevant standards, specifications or guidelines, Protection performance of materials, Biological protection performance, Flame and thermal protection performance, Mechanical protection performance, Selection of materials based on other major factors,

**UNIT 2: Protection against hazard:** Introduction, Types of hazards, Mechanical hazards, Pressure hazards, Environmental and fire hazards, Chemical and biological hazards, Electrical and radiation hazards

**Intelligent textiles and surface treatments for textiles:** Smart textiles, Applications of smart textiles for protective purposes, Sensor function, Data processing, Actuators, Energy, Communication, Thermal protection, Electric actuation, Types of surface treatments, Early treatments for protective textiles, Progression to modern treatments, Choice of treatments in relation to fibre and fabric types, Treatment process fundamentals, Treatment application systems, Brief overview of finishes for protection.

**UNIT 3 : Interactions between protection and thermal comfort** :Introduction, Definition of comfort, Test methods for heat and moisture transfer, Measurement of thermal comfort with practice-related tests, Interactions between heat and mass transfer, Moisture storage and influences on protection, Thermal manikins, Measuring the insulation of protective clothing systems, Measuring the evaporative resistance of protective clothing systems, Ensemble data, Moving manikins, Manikin tests vs fabric tests, Using manikins under transient conditions.

**UNIT 4 : General protection requirements and applications:** Civilian protection and protection of industrial workers from chemicals, Textiles for UV protection,

Textiles for protection against cold, Thermal (heat and fire) protection, Microorganism protection, Textiles for respiratory protection. Electrostatic protection, Ballistic protection, Military protection, Fire fighters protective clothing, Protection against knives and other weapons, Flight suits for military aviators, Protection for workers in the oil and gas industry, Motorcyclists

**Note : Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS :-**


1. Handbook of Fibre Science & Technology Vol-III Part –B.
2. New Fibres Second Edition by T. Hongu & Phillips.
3. Advanced Fibres Spinning Technology by T. Nakajima.
4. High Performance Fibres by J.W.S. Hearle.
5. Advances in Fibre Science by Dr. S.K. Mukhopadhyay.
6. Kevlar Aramid Fibres by H.Yang.
7. Textiles for Proptection by R.A. Scott.
8. Fire Retardant Materials by A.R. Horoocks & D. Price.
9. Wellington Sears Handbook of Industrial Textiles by Sabit Adanur.
10. Intelligent Textiles & Clothing by H.R. Mattila.


## COURSE WORK FOR Ph. D.
## PAPER-III
## ELECTIVE-4– TEXTILES FOR SPORTS APPLICATION

Teaching Scheme
Lect. 3 hrs./week
Practical/Tutorial 1 hr. /week

Examination Scheme
Theory Paper : 80 Marks,
Term work: 20 marks

**UNIT1: Key Trends in Sportswear Design**

Introduction, Market overview, Future market trends, the evolution of performance underwear; the rise of all-in-one suits; seamless garments; three-dimensional modeling; stitch less seams; the influence of advances made in laminating, The evolution of layering: the reorganization of the three-layer system; the soft shell; air: a key raw material, External influences: interactions between fashion and sportswear; wearable technology, Future trends: streamlining or stealth design.

**Material Requirements for the Design Performance of Sportswear:**

Introduction: the link between textile technology and the demands of the end-user, Identifying the needs of the end-user: developments in sport specific clothing from post war to the present day: the layering system; from walking to mountaineering; point of sale promotional material; synthetic fibres and fabrics; commercialization of sport; technical sportswear for women; trend; style; fashion; fibre branding; garment development. The design development process: the application of technical textiles in performance sportswear; functional needs of the end-user; the needs of the body; the demands of the sport, Form and style considerations, the demands of the culture; the demands of style and fashion, Emerging trends: commercial reality; smart clothes and wearable technology biomimicry; environmental-issues.

**UNIT 2 : Functional Sport Footwear**

Introduction, Functional design of sport footwear, Functional fit of sport footwear: biomechanics of the foot; fitting areas of the shoe: flexing point; heel; toe and arch; heel-to-joint and shock absorbency; shape of the last; fastening systems; shoe size systems, Functional materials and components in sport footwear: properties of materials and components; materials for sport footwear of upper sole, Future trends in functional footwear, High-functional textiles: hydrophobic surface; dirt and oil repellence; hydrophilic finishing; UV-protection; flame retardance, antistatic finishing; antimicrobial finishing; reduction of shrinkage; softening; coating and membranes

**Coated And Laminated Textiles In Sportswear:**

Introduction, Sports products from coated and laminated fabrics: protective sportswear and comfort; other sports products

**UNIT 3 : Sportswear and Comfort:** Physiological comfort of sportswear:
Introduction, Aspects of wear comfort, Measurement of physiological comfort, wear comfort as a measurable quantity; wearer trials; skin model; skin sensorial test apparatus; wear comfort vote applications

**Elastic Textiles:**
Manufacturing of Elastic textiles for sports wear

**UNIT 4 : Protection against impact using clothing and personal equipment:**
Introduction, Analysis of injury sustained during sporting activities
Impact protection provided through protective clothing/equipment: general principles; effectiveness of impact protection in selected sporting codes
Effects of protective clothing/equipment on human performance; guidelines; codes of practice

**Water Resistance and Water Vapour Transfer:**
Introduction, Water resistance, Water vapor transfer: performance and protection under steady state conditions; performance and protection under windy conditions; performance and protection under rainy conditions; performance and protection under wind driven rainy conditions, The condensation problem in waterproof breathable fabrics for sportswear

**Textile Use in Sports Shoes:**
Introduction: Current use of textiles in sport shoes: uppers; textiles in the sole

**Note : Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS:-**

1) Wellington Sears Handbook of Industrial Textiles by Sabit Adanur.
2) High Performance Fibres J.W.S. Hearle.
3) Advances in Fibre Science by S.K. Mukhopadhyay
4) New Fibres by T. Hongu & G.O. Phillips.

5) Handbook of Technical Textiles by A.R. Hoorocks & S.C. Anand.
6) New Millennium Fibres by G.O. Phillips & T. Hongu.
7) Smart Textiles for Medicine & healthcare b L.Van Langenhove.
8) Synthetic Fibres, Nylon, Polyester, Acraylic & Polydefin by J.E. McIntyre.
9) Composite Materials: Engineering & Science by F.L. Matthews & R.D. Rawlings.
10) Textiles for Protection by R.A. Scott.
11) Coated Textiles by A.K. Sen
12) Materials in Sports Equipments by Subic.

## COURSE WORK FOR Ph. D.

## PAPER-III

## ELECTIVE-5– TEXTILES IN AUTOMOBILE ENGINEERING

| Teaching Scheme | Examination Scheme |
|---|---|
| Lect. 3 hrs./week | Theory Paper : 80 Marks, |
| Practical/Tutorial 1 hr. /week | Term work: 20 marks |

**UNIT 1 :** Introductory survey : General survey, Material survey – fibres, Material survey – plastics, Material survey – natural and synthetic rubbers, Requirements from suppliers, Interior design

Fabric structures and production methods for Automobile textiles: Introduction, fibres and yarn types , Fabric structures – wovens Fabric structures – warp knitted Fabric structures – weft knitted Fabric structures – flat-bed knitting Fabric structures – non-wovens ,

**UNIT 2 :** Yarn and fabric processing: Introduction, dyeing and finishing, Printing, Coating and lamination,

Quality assurance and testing for Automotive textiles: Quality assurance, Test method details,

**UNIT 3:** Product engineering – interior trim

Introduction, Seats, Headliners, Door casings, Parcel shelves, other interior trim, complete modular interiors

Other textile applications

Introduction , Seat belts 228, Airbags, Carpets, Cabin air filters, Battery separators, Bonnet (hood) liners Wheel arch liners, Hood material for convertibles, Tyres, Hoses and belts – general considerations,

**UNIT 4 :** Automotive textiles and the environment

Introduction, The greenhouse effect and global warming, Environmental legislation, the effects of pollutants, Manufacturing concerns, Sustainable development,

Textiles in other forms of transportation

Introduction, Composite materials, Flame retardancy, Fabric coating, Textiles in other road vehicles, Railway applications, Marine applications, Textiles in aircraft.

**Note : Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS:-**

1. Wellington Sears Handbook of Industrial Textiles by Sabit Adanur.
2. Hand book of Technical Textiles by A. R. Horrocks.
3. Textiles in automotive engineering by W. Fung.
4. Composite materials: Engineering & Science by F. L. Matthews & R. D. Rawlings.
5. Fire retardant materials by A. R. Horrocks & D. Price.
6. Textile advances in the automotive Industry by R. Shishoo.
7. Knitting Technology by Spencer.
8. Composite forming technologies by A. C. Long.
9. Textiles in automotive engineering by W. Fung.
10. Automotive textiles by Textile progress Vol. 29 by S. K. Mukhopadhyay.

## COURSE WORK FOR Ph. D.
## PAPER-III
## ELECTIVE-6 – INTELLIGENT TEXTILES AND CLOTHING

Teaching Scheme
Lect. 3 hrs./week
Practical/Tutorial 1 hr. /week

Examination Scheme
Theory Paper : 80 Marks,
Term work: 20 marks

**UNIT 1 : General Introduction**:

Definition, classification, intelligent systems and general applications.

**Phase change materials:** Heat balance and thermo-physiological comfort, Phase change technology, PCM in textiles, Future prospects of PCM in textiles and clothing

**Shape memory polymer:** Introduction to shape memory polymer, Shape memory alloys, Shape memory ceramics, Magnetic shape memory materials, Shape memory polymers and gels, Future prospects of shape memory materials

**UNIT 2 :Temperature sensitive shape memory polymers :** A concept of smart materials, Shape memory polymer and smart materials, Some examples of shape memory polymer for textile applications, Potential use of shape memory polymer in smart textile, General field of application, Challenges and opportunities

**UNIT 3 :Study of shape memory polymer films for breathable textiles:** Breathability and clothing comfort, Breathable fabrics, Water vapor permeability (WVP) through shape memory polyurethane

**Introduction to conductive materials:**Electric conductivity,Metal conductors'lonic conductors,Inherently conducting polymers,Application technologies for conducting fibre materials

**UNIT 4 : Textile micro system technology:**Textile micro system technology,Textiles are inherent microstructures,Goal of the application of compliant textile structures

First attempt: textile electronic circuit technology based on copper wires in a lattice structure with interconnections and interruptionsGalvanic modification of yarns

Light effects based on textiles with electrically conductive microstructure

Textile-based compliant mechanisms in micro-engineering and mechatronics

**Note : Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS**

1. Smart fibres, fabrics and clothing edited by Xiaoming Tao, Wood head publishing Ltd., Englang.
2. Intelligent Textile and clothing edited by H. R. Mattila, Wood head Publishing, England.
3. Clothing bisensory Engineering edited by Y. L. and A. S. W Wang, Wood head publishing ltd. England.
4. Analytical electro chemistry in textiles P. Westbrock, G. Priniotakis and P.Kienkens, wood head publishing Ltd, England

## COURSE WORK FOR Ph. D.
## PAPER-III
## ELECTIVE-7– PHYSICAL METHODS OF ANALYSIS & ECO TESTING

Teaching Scheme
Lect. 3 hrs./week
Practical/Tutorial 1 hr. /week

Examination Scheme
Theory Paper : 80 Marks,
Term work: 20 marks

**UNIT 1 :Electron Microscopy**

Basic theory of electron microscopy.

imaging system, image-translating system of electron microscope. Principle, working procedure and application of scanning Electron Microscope and Transmission electron microscope.

**UNIT 2 : Spectroscopy**

Infrared spectroscopy. Introduction, experimental techniques, Infrared spectra of natural and synthetic fibres. Identification of finishing agents using IR. FTIR spectroscopy.

X-ray diffraction and Fluorescence. Principle, working procedure of X-ray diffraction technique. X-ray diffraction of natural and synthetic fibres. X-ray Fluorescence and its application to textile related materials.

NMR and Mass Spectroscopy: Principle, working procedure and application of NMR and Mass Spectroscope.

**UNIT 3 : Chromatographic Methods**

Theoretical considerations of chromatography. Gas chromatography – Instrumentation, qualitative analysis, quantitative analysis, theory and applications. High Pressure Liquid Chromatography – Instrumentation and applications.

**Eco-Testing**

Concept of Banned Dyes, Chemicals and Auxiliaries. Testing and analysis of banned dyes, chemicals and auxiliaries used in Textiles.

**UNIT 4 : Methods for Analyzing damage in Textile Materials**

Concept of Mechanical and Chemical damage. Methods for analyzing damage in natural and synthetic fibrous materials.

**Note : Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS :-**

1. Instrumental Methods of Analysis 7th Edition by H.H. Willard; L.L. Merritt, John A Dean, Frank A Settle, Jr. CBS Publishers & Distribution Delhi.
2. Instrumental Methods of Chemical Analysis 5th Edition by Galen W. Ewing.
3. 100 and More Basic NMR Experiments – A Practical course by S. Baraun, H.Kalinowski, S. Berger. Weinhein – New Yark, Basel Cambridge – Tokyo.
4. Elementary Organic Spectroscopy – Principles and Chemical Applications by Y.R. Sharma.
5. Spectroscopy of Organic Compounds by P.S. Kalsi
6. Basic Concepts of Analytical Chemistry, 2nd Edition by S.M. Khopkar
7. The Analytical Chemistry of Synthetic dyes Edited by K. Venkataraman. Wiley – Interscience Pub. John Wiley & Sons New York.
8. Hand Book of Textile Testing Part 1 to 4, Bureau of Indian Standards.
9. Instrumental Analysis of Cotton Cellulose & Modified Cotton Cellulose – Robert T.O' Connor.
10. Textile Laboratory Manual – W – Garner Vol.I & II.
11. Physical Methods of Investigating Textiles – ED R. Meredith J.W.S. Hearle.
12. Textile Laboratory Manual – Walter Garner.
13. Handbook of Environmental Health & Safety – Principles & Practices – Herman Koren, Michael Bisesi Vol.- I & II.
14. Textile Testing & Its Role in Textile Business with Special Reference to Eco-Friendly Textiles & Eco-Testing – Dr.G.S. Nadiger & S. Subramanian.
15. Handbook of Methods of Tests for Cotton Fibres, Yarns & Fibres – Dr.V. Sundaram & Dr. R.L.N. Iyengar.
16. Vibrational Spectroscopy Theory & Applications – D.N. Sathyanarayana.
17. Analytical Methods for a Textile Laboratory – J.W. Weaver.
18. Mass Spectroscopy – E. Constantin & A. Schanell.
19. Profiles in Analysis of Chemicals – Dr.N.F. Desai.
20. Introduction to Electron Microscopy – Saul Wischnitzer.
21. X-ray Diffraction Methods in Polymer Science – Alexander Leray E.
22. X-ray Diffraction – Cullity B.D.

## COURSE WORK FOR Ph. D.
## PAPER-III

## ELECTIVE-8– NANOTECHNOLOGY IN TEXTILES

Teaching Scheme
Lect. 3 hrs./week
Practical/Tutorial 1 hr. /week

Examination Scheme
Theory Paper : 80 Marks,
Term work: 20 marks

### UNIT 1: NANOFIBER PRODUCTION

**Electrospinning of nanofibers**

- Introduction
- Principles of electrostatic atomization
- Electrospraying and electrospinning by the capillary method
- Electrospraying and Electrospinning by the charge injection method

**Producing nanofibre structures by electrospinning for tissue engineering**

- Introduction
- Fabrication of nanofibrous scaffolds
- Characterization of nanofibrous scaffolds
- Cell-scaffolds interaction

**Continuous yarns from electrospun nanofibers**

- Introduction
- Using electrospun nanofibers: background and terminology
- Controlling fiber orientation
- Producing non-continuous or short yarns
- Producing continuous yarns

**Producing polyamide nanofibers by electrospinning**

- Introduction
- The electrospinning process
- Measuring the mechanical properties of electrospun nanofibers Measuring the effects of different spinning conditions and the use of high molecular weight polymers on the properties of electrospun nanofibers
- Improving the properties of electrospun nanofibers: experimental results

**Controlling the morphologies of electrospun nanofibers**

- Introduction
- The electrospinning process and fibre morphology
- Polymer concentration and fibre diameter
- Fibre bead formation and fibre surface morphology
- Controlling fibre alignment and web morphologies

- Bicomponent cross-sectional nanofibres
- Future trends

**UNIT 2: CARBON NANOTUBES AND NANOCOMPOSITES**

**Synthesis, characterisation and applications of carbon nanotubes: the case of aerospace engineering**

- Introduction
- The development and structure of carbon nanotubes
- Synthesis of carbon nanotubes
- Characterisation techniques
- Purification techniques
- The use of carbon nanotubes in aerospace engineering
- Nanostructured composite materials for aerospace applications
- Nanostructured solid propellents for rockets
- Frequency Selective Surfaces (FSS) for aerospace applications
- Other aerospace applications of carbon nanotubes

**Carbon nanotube and nanofibre reinforced polymer fibres**

- Introduction
- Synthesis and properties of carbon nanotubes
- Developing nanotube/nanofibre polymer composites
- Adding nanotubes and nanofibres to polymer fibres
- Analysing the rheological properties of nanotube/nanofibre polymer composites
- Analysing the microstructure of nanotube/nanofibre polymer composites
- Mechanical, electrical and other properties of nanocomposite fibres

**Structure and properties of carbon nanotube-polymer nanofibers using melt spinning**

- Introduction
- Producing carbon nanotube-polymer nanofibers
- Thermal characterisation
- Fiber morphology
- Mechanical properties of fibers

**Multifunctional polymer nanocomposites for industrial applications**

- Introduction
- The development of functional polymer nanocomposites

- Improving the mechanical properties of polymer nanocomposites
- Improving the fire retardant properties of polymer nanocomposites
- Improving the tribological properties of polymer nanocomposites
- Case-study: development of a nanocomposite sliding seal ring
- Enhancing the functionality of polymer nanocomposites

**Nanofilled polypropylene fibers**

- Introduction
- Polymer layered silicate nanocomposites
- The structure and properties of layered silicate polypropylene (PP) nanocomposites
- Nano-silica filled polypropylene nanocomposites
- Calcium carbonate and other additives

**UNIT 3: IMPROVING POLYMER FUNCTIONALITY**

**Nanostructuring polymers with cyclodextrins**

- Introduction
- Formation and characterisation of polymer-cyclodextrin-inclusion compounds
- Properties of polymer-cyclodextrin-inclusion compounds
- Homo and block copolymers coalesced from their cyclodextrin-inclusion compounds
- Constrained polymerisation in monomer cyclodextrin-inclusion compounds
- Coalescence of common polymer-cyclodextrin-inclusion compounds to achieve fine polymer blends
- Temporal and thermal stabilities of polymers nanostructured with cyclodextrins
- Cyclodextrin-modified polymers
- Polymers with covalently-bonded cyclodextrins

**Dyeable polypropylene (PP) via nanotechnology**

- Introduction
- Dyeing techniques for unmodified polypropylene
- Modifying polypropylene for improved dyeability using copolymerisation and other techniques
- Polyblending and other techniques for improving polypropylene dyeability
- Dyeing polypropylene nanocomposites

- Using x-ray diffraction analysis and other techniques to assess dyed polypropylene nanocomposites

**Polyolefin/clay nanocomposites**

- Introduction
- Organomodification of clays
- Polyolefin/clay nanocomposites
- Polypropylene/clay nanocomposites
- Polyethylene/clay nanocomposites
- The range of polyolefin/clay nanocomposites

**Multi-wall carbon nanotube-nylon 6 nanocomposites from polymerization**

- Introduction
- Nanocomposite synthesis and production
- Characterisation techniques
- Properties of multi-wall carbon nanotube-nylon 6 nanocomposite fibers

**UNIT 4: NANOCOATINGS AND SURFACE MODIFICATION TECHNIQUES**

**Nanotechnologies for coating and structuring of textiles**

- Introduction
- Production of nanofiber nonwovens using electrostatic spinning
- Anti-adhesive nanocoating of fibres and textiles
- Water and oil-repellent coatings by plasma treatment
- Self-cleaning superhydrophobic surfaces

**Electrostatic self-assembled nanolayer films for cotton fibers**

- Introduction
- Principles of electrostatic self-assembly (ESA) for creating nanolayer films
- Advantages and disadvantages of electrostatic self-assembly
- Substrates used for ESA
- Polyelectrolytes used for ESA
- Analysing self-assembled nanolayer films on cotton

**Nanofabrication of thin polymer films**

- Introduction
- Macromolecular platform for nanofabrication
- ‘Grafting from’ technique for synthesis of polymer films
- ‘Grafting to’ technique for synthesis of polymer films
- Synthesis of smart switchable coatings

- Synthesis of ultrahydrophobic materials

**Hybrid polymer nanolayers for surface modification of fibers**

- Introduction: smart textiles via thin hybrid films
- Mechanisms of responsive behavior in thin polymer films
- Polymer–polymer hybrid layers
- Polymer–particles hybrid layers
- Hierarchical assembly of active nanostructured hybrid films

**Structure-property relationships of polypropylene nanocomposite fibres**

- Introduction
- Materials, processing and characterisation techniques
- Structure and morphology
- Phase homogeneity and spinline stability
- Optical birefringence and infra-red activation
- Crystallisation behaviour and mechanical performance
- Exfoliation by extensional flow deformation

**Note : Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS :-**

1) Nanofibres & Nanotechnology in Textiles by P.J. Brown & K. Stevens.
2) New Millennium Fibres by G.O. Phillips & M.Takigami.
3) Analytical Electrochemistry in Textiels by P. Westbroek, G. Priniotakis & P. Kiekens.
4) Smart Textiles for Medicine & Healthcare by L. Van Langenhove.
5) The Nanoscope, Encyclopedia of Nano Science & nanotechnology Vol.-I to VI, Dr. Parag Diwan & Ashish Bharadwaj.
6) Nanotechnology in Fibres matures : A New Perspective, Textile Progress, The Textile Institute by Rajesh D. Anandiwala.

## COURSE WORK FOR Ph. D.
## PAPER-III
## ELECTIVE-9– PROJECT PREPARATION, APPRAISAL & IMPLEMENTATION

| Teaching Scheme | Examination Scheme |
|---|---|
| Lect. 3 hrs./week | Theory Paper : 80 Marks, |
| Practical/Tutorial 1 hr. /week | Term work: 20 marks |

**UNIT 1** : Overview – Capital expenditure, Phase of capital budgeting, Project development cycle, Objectives of investment, decision-making, Risk & return.

Identification of investment opportunities – Governmental regulatory framework – Generation & screening of project ideas – Project identifications for an existing company.

Market & demand analysis – Information required for market & demand analysis – demand forecasting methods – market planning.

**UNIT 2 :** Technical Analysis – Material inputs & utilities – Manufacturing process / technology – Plant capacity – location & site – structures & civil works – Machineries & equipments – Project charts & layouts – Work schedule – Need for tendering alternatives.

Financial Analysis – Cost of Project – Means of finance – Estimation of Sales & Production – Cost of production – Working capital requirement & financing – Profitability projections – Break even point – Project cost flow statements – Projected balance sheet – Multi – year projection.

**UNIT 3 :**Time value of money – Future value of single amount, Future value of an annuity –Present value of single amount – Present value of an annuity.

Cost of Capital – Basic concepts – Cost of debt – cost of preference capital – cost of Equity Capital – Weighted average cost of capital – Marginal cost of capital-Cost of capital for a new company.

Appraisal criteria – Urgency, Pay back period – Accounting, Debt service coverage ratio, Rate of Return, Net present value – Internal rate of return – Annual capital charge – Investment appraisal in practice.

**UNIT 4 :** Analysis of Risk – Types & measurement of project risk – Analytical derivation or simple estimation – Sensitivity Analysis – Scenario analysis – Selection of a project-Risk analysis in practice.

Project implementation – Forms of project organization – Project planning – project control – Human aspects of project management – Pre-requisites for successful project implementation.
Review – Initial review, performance evaluation.

**Note : Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS :-**

1) Textile Project Management by A. Ormerod, The Textile Institute Publication.
2) Goal Directed Project Management by E.S. Andersen, K.V. Grude & Tor Hang, Coopers & Cybranl Publication.
3) Project, Planning Analysis, Selection Implementation & Review by Prasanna Chandra, Tata McGraw Hill Publishing Co. Ltd.,
4) Industrial Organisation & Engg. Economics T.R. Banga & S.C. Sharma, Khanna Publishers, Delhi.

## COURSE WORK FOR Ph. D.
## PAPER-III
## ELECTIVE-10– MANAGEMENT OF TEXTILE PRODUCTION

| Teaching Scheme | Examination Scheme |
|---|---|
| Lect. 3 hrs./week | Theory Paper : 80 Marks, |
| Practical/Tutorial 1 hr. /week | Term work: 20 marks |

**UNIT 1 : Indian Textile Industry:** Structure, production and exports. Textile Policy. Sickness of Textile Industry- Analysis and options. Essentials of production management, production systems, classification.

**Material Management:** Role of material management techniques, purchase management, acceptance sampling and inspection, vendor rating system, inventory management.

**UNIT 2 :Production, Planning and Control:** Types of production systems and problems of planning and control, product section design, process planning, forecasting, planning

of batch, mass and job shop system. Machine balancing. Layout and material handling. Machine assignment and allocation of jobs. Maintenance management: maintenance concepts, maintenance strategies, maintenance planning. Productivity and improvement techniques. Quality management: Introduction to TPM/TQM, concepts of value and quality assurance, total quality control, quality circles, ISO 9000. Marketing management: fundamental of industrial marketing, industrial buyer behaviour model.

**UNT 3 : Marketing:** systems selling, role of service, marketing planning and marketing strategies, market research.

**UNIT 4 : Enterprise resource planning:** Role of information in managerial decision making,

information needs for various levels of management, decision makers, management information system, resource monitoring and control. Product mix. Case studies.

**Note : Term work marks for presentation of review on published research papers from national / international journals on the concerned specialized areas.**

**REFERENCE BOOKS**

1) Essential of Management – by Harold Koontz & Heinz, Weihrich – Tata McGraw- Hill Publishing Company Ltd., New Delhi.
2) Advanced Cost & Management Accounting by P.K. Sikdar – Viva Books Pvt. Ltd., New Delhi.
3) Industrial Engineering & Management by O.P. Khanna & A. Sarup, Dhanapat Rai Publications (P) Ltd., Delhi.
4) Dynamics of Entrepreneurial Development & Management by Vasant Desai – Himalaya Publishing House – Delhi.
5) How to Read a Balance Sheet – An ILO Programmed Book – Oxford & IBH Publishing Co. Pvt. Ltd., Delhi.
6) Enterpreneurial Development by S.S. Khanta , S. chand & Company Ltd., Delhi – 110 055.
7) Fundamentals of Marketing by W.J. Stanton, M.J. Etzel B.J. Walker – McGraw-Hill, Inc – New York, St. Laouis etc.
8) Industrial Organisation & Engineering Economics by S.C. Sharma & T.R. Banga – Khanna Publishers – 2-B, Nath Market, Nai Sorak, Delhi – 110 006.
9) Marketing Management By Philip Kotler – Prentice – Hall of India Pvt. Ltd., New Delhi – 110 001.