

## I SEMESTER

### 15TT01 QUANTITATIVE TECHNIQUES IN TEXTILE ENGINEERING

3 0 0 3

**FIBRES:** Length, dispersion, fineness, density. Tensile strength, initial modulus, works of rupture. Man-made fibres: Flow rate, draw ratio, denier calculation, degree of crystallinity. (7)

**YARNS:** Yarn conversion systems. Opening intensity, transfer co-efficient in card, actual and mechanical draft, noil % in forward and backward feed, bobbin and flyer lead calculations, spinning triangle, balloon formation and yarn tension, forces in ring and traveler, Index of irregularity. (8)

**YARN PREPARATION:** Winding rate, wind and traverse ratio, gain, yarn tension, calculations in warping, size pick up, stretch. Weft preparation- pirn shape, volume of yarn, chase length and angle. (7)

**WOVEN FABRICS:** Timing diagram. Calculations on production, shed geometry, shuttle velocity, picking power, beat-up force, take-up and let-off, reed count. Crimp, cover, areal density. (8)

**KNITTED FABRICS:** Production calculation, stitch density, tightness factor, areal density, dimensional constants. Forces acting on knitting needles. (7)

**CHEMICAL PROCESSING:** Determination of Oils, fats, waxes and resins in fibre samples, quantitative analysis of fibre mixtures, Desizing and scouring efficiency, whiteness index. Calculation of concentrations based on owm, gpl. (8)

Total L: 45

#### REFERENCES:

1. Booth J E, "Textile Mathematics", The Textile Institute, Manchester, 1975.
2. Booth J E, "Textile Mathematics", The Textile Institute, Manchester, 1975.
3. Booth J E, "Textile Mathematics", The Textile Institute, Manchester, 1977.
4. Andree Wynne, "The Motivate Series", Macmillan Education Ltd, London, 1997.
5. Bernard P Corbman, "Textiles Fiber to Fabrics", McGraw Hill Book Company, Singapore, 1983.
6. Norma Hollen and Sane Saddler, "Textiles", The Macmillan Company / Collier – Macmillan Limited, London, 1968

### 15TT02 POLYMER AND FIBER PHYSICS

3 0 0 3

**POLYMER AND FIBRE STRUCTURE:** Polymer rheological characteristics, Newtonian and Non-newtonian flow, Visco-elastic nature. Parameters of fine and morphological structures. (8)

**POLYMER AND FIBRE STRUCTURE STUDY TECHNIQUES:** Optical and electron microscope, optical, X-ray and electron diffraction, IR spectroscopy and Nuclear Magnetic resonance - Interpretation and analysis of test results. (7)

**STUDY OF FIBRE:** Properties in relation to physical and chemical structures - cotton, rayons, wool, silk, acetates, polyester, polyamides, polyolefins, poly acrilonitriles, carbon fibres. (7)

**MECHANICAL AND FRICTIONAL PROPERTIES:** Tensile properties, the effects of variability, Elastic recovery, Time Effects, Forces in various directions, Theories of mechanical properties. General theory and its applications to fibres. (8)

**MOISTURE PROPERTIES:** Theoretical explanation of moisture and related properties - conditioning - swelling - Heats of sorption. (7)

**ELECTRICAL AND THERMAL PROPERTIES:** Electrical resistance of fibres, measurements, factor influencing the dielectric properties of fibres. Optical properties. Structural changes in fibres on thermal treatment - Mechanism of heat setting - temporary and permanent heat setting of polyester, polyamide and PAN Fibres. Structure and properties of High Performance fibres. (8)

Total L: 45

#### REFERENCES:

1. Morton W E and Hearle J W S, "Physical Properties of Textile Fibres", Woodhead Publishing Limited, England, 2008.
2. Carty P, "Fibre Properties", Textile Institute, UK, 1992
3. Mukhopadhyay S K, "High Performance Fibres", Textile Institute, UK, 1994.
4. Warner S B M, "Fiber Science", Prentice Hall, US, 995.
5. Greaves P H and Saville B P, "Microscopy of Textile Fibres", BIOS Scientific Publishers, England, 1995.
6. Ugbolue S C O, "Structure and Property Relationships in Textile Fibres", The Textile Institute, Manchester, 1990.

## 15TT03 THEORY OF YARN AND FABRIC MANUFACTURE

3 0 2 4

**PREPARATORY PROCESSES FOR YARN MANUFACTURE:** Principles of fibre opening, cleaning, mixing, blending and leveling. Principles of fibre individualization, short fibre removal and sliver formation. Principles of doubling and drafting, Concept of short fibre removal in comber. Principle of bobbin winding. (9)

**YARN MANUFACTURING PROCESS:** Ring spinning – Requirement to create real twist in a strand, twisting and cop building, factors influencing optimum twist level, influence of spinning triangle and balloon formation on yarn quality. Other spinning systems –twisting principles in rotor, air-jet, air-vortex and friction spinning. (9)

**PREPARATORY PROCESSES FOR FABRIC MANUFACTURE:** Cop unwinding characteristics, Principles of wound package formation – winding, pirn winding, warping and sizing. Preparatory processes for knitting and nonwoven manufacture. (9)

**WOVEN FABRIC MANUFACTURING PROCESS:** Concept of shedding, picking, and beat-up. Warp tension and cloth control – effect of temples on cloth formation, weaving resistance, bumping condition, disturbed weaving conditions. Optimization of loom settings for different weave structure. (9)

**THEORY OF KNITS AND NONWOVEN MANUFACTURE:** Concept of loop formation, Needle selection techniques in weft knitting, Patterning for multi track machines, Yarn tension and knitting forces, Pattern wheels and chain links in warp knitting. Theories of nonwoven formation – Mechanical, Chemical and Thermal bonding. (9)

### LABORATORY COMPONENT:

1. Comparative study of actual and mechanical drafts in the spinning preparatory machine.
2. Study on the influence of ring frame process parameters on floating fibres and spinning triangle.
3. Study on cop unwinding characteristics at various stages of cop in cone winder.
4. Study of loom settings for producing different weave structures
5. Study of knitting machine settings for producing different knit structures
6. Production of needle punched nonwoven fabrics with different GSM

Total L: 45 + P: 30 = 75

### REFERENCES:

1. Carl A Lawrence, "Fundamentals of Spun Yarn Technology", CRC Press, New York, 2003.
2. Grosberg P and Iype C, "Yarn Production – Theoretical Aspects", The Textile Institute, Manchester, 1999.
3. Marks R and Robinson A T C, "Principles of Weaving", The Textile Institute, Manchester, 1976.
4. Allan Ormerod and Sondhelm W S, "Weaving - Technology & Operation", The Textile Institute, Manchester, 1998.
5. Raz S, "Warp Knitting Technology", Verlag Melland Textilberchte, GMBH, Heidelberg, 1987.
6. Spencer D J, "Knitting Technology", Pergamon Press, UK, 1998.
7. Wilhelm Albrecht, "Nonwoven Fabrics", Wiley - VCH Verlag Gmbh and Company, US, 2003.

## 15TT04 COLOURATION AND FINISHING TECHNOLOGY

4 0 0 4

**MECHANISM OF PREPARATORY PROCESSES:** Desizing, Scouring, Bleaching, Mercerization, Heat setting. Degradation of fibres associated with chemical pre-treatment processes. Combined pretreatment processing of textiles. (10)

**DYEING TECHNIQUES:** Exhaust and Padding Principle. Low liquor applications. Use of microwave, ultrasonic waves, Apparel dyeing. (10)

**DYEING THEORY:** Chemical Constitution of Colourants, Resonance, Theory of Molecular Orbitals, Free electron model, Dye-Fibre Bonds, Influence of fibre structure on dye uptake, Thermodynamic Considerations, Heat of Dyeing, Adsorption Isotherms, Kinetics of Dye Adsorptions. Functions and properties of dyeing auxiliaries. (10)

**PRINTING:** The production and properties of printing pastes, Principles of direct, resist, discharge printings. Transfer, digital and ink-jet printing. After-treatment processes. (10)

**FINISHING :** Mechanism of Softening, Easy-care and durable press finishes of cellulose, water repellent, soil-release, flame-retardant, anti-static, anti-pilling, insect resist and mite protection finishes. (10)

**EFFLUENT TREATMENT:** Introduction. Flow chart of effluent treatment processes. Primary, Secondary and Tertiary treatments. Evaporation and Reverse osmosis. Colour removal in waste water. Recovery and reuse of water. Advances in Effluent Treatment. Introduction to concept of eco-friendly textile, Norms for effluent discharge. (10)

Total L: 60

### REFERENCES:

1. Karmakar S R, "Chemical Technology in the Pretreatment Processes of Textiles", Elsevier Science, Netherlands, 1999.
2. Trotman E R, "Dyeing and Chemical Technology of Textile Fibres", Charles Griffin & Company Limited, London, 1984.

3. Arthur D Broadbent, "Basic Principles of Textile Coloration", Society of Dyers and Colourists, Bradford, 2001.
4. Leslie W C Miles, "Textile Printing", Society of Dyers and Colourists, Hobbs The Printers, Hampshire, UK, 2003.
5. John Shore, "Colorants and Auxiliaries", Society of Dyers and Colourists, Bradford, 1990.
6. Schindler W D and Hauser P J, "Chemical Finishing of Textiles", Woodhead Publishing Limited, Cambridge, 2004.
7. "Eco friendly Textiles: Challenges to the Textile Industry", Textiles Committee, Mumbai, 1996.

### 15TT05 QUALITY ANALYSIS OF TEXTILES & CLOTHING

**3 0 0 3**

**INTRODUCTION:** Accuracy, Precision, Calibration of instruments, quality standards. (4)

**YARN QUALITY:** Mass variation – Mass variation of textile strands in time and frequency domains, Classification and analysis of yarn faults created by mass variations, Variance – Length curve, Effect of specimen length and total length in mass variation measurements. Spectrogram – Analysis of spectrogram, type of faults and their representation in spectrogram. (10)

**FABRIC QUALITY:** Quality parameters and their control in grey and processed woven and knitted fabrics – Troubleshooting. Fabric hand: Definition and concept of fabric hand. Subjective evaluation of fabric hand. Fabric hand attributes and quality descriptors. Role of fiber, yarn and fabric parameters on handle characteristics. Analysis of low stress mechanical properties on specific applications. Kawabata and FAST fabric evaluation systems. (11)

**GARMENT QUALITY:** Quality parameters and their control in spreading, pattern making and cutting. Process control in sewing- Stitching defects and control, Causes and solutions for seam pucker, sewing damage due to thermal and mechanical problems. Quality control aspects of fusing and pressing operations, storage and packaging. Final product testing- AQL. Accessories evaluation techniques (10)

**MICROSCOPICAL EXAMINATION:** Principles of Microscopy – examination methods, preparation of negative imprints with the size of microscope slides – detection of various defects, thermal and thermo mechanical damage to synthetics, chemical damage, streaks and bars, microbial damage to fibres. (10)

**Total L: 45**

**REFERENCES:**

1. Furter R, "Evenness Testing in Yarn Production: Part -I & Part-II", The Textile Institute, Cambridge, England, 1982.
2. Kothari V K, "Progress in Textiles: Science & Technology, Vol. 1, Testing and Quality Management", IAFL Publications, 1999.
3. Majumdar A, Das A, Alagirusamy R and Kothari V K, "Process Control in Textile Manufacturing", Wood Head Publishers, Cambridge, England, 2012
5. Karl Mahall, "Quality Assessment of Textiles – Damage Detection by Microscopy", Springer-Verlag, New York, 2003.
6. Raheel M, "Modern Textile Characterization Methods", Marcel Dekker Inc, 1996.

### 15TT51 FABRIC PROPERTY DEVELOPMENT AND CHARACTERIZATION LAB

**0 0 4 2**

Specific textile structures (Woven/Non-woven) will be developed and value added finishing will be applied for various characteristic property requirements for wide range of applications. This lab will also provide a practical understanding of textile /non woven manufacture process, industrial textile product development and various Instruments used for thermal/chemical/mechanical characterization of textile structures.

**Total P: 60**

### 15TT61 INDUSTRIAL VISIT & TECHNICAL SEMINAR

**0 0 4 2**

| S.No | Name of Activity       | Area                          | Number of Hours |
|------|------------------------|-------------------------------|-----------------|
| 01   | Industrial Visit       | Warp knitting                 | 5               |
| 02   | Industrial Visit       | Nonwoven & Industrial Textile | 5               |
| 03   | Technical Presentation | Presentation by students      | 9               |
| 04   | Guest Lecture          | Textile Costing               | 3               |
| 05   | Guest Lecture          | Industrial Textile            | 3               |
| 06   | Industrial Visit       | Cotton research               | 5               |
| 07   | Industrial Visit       | Textile Quality Control       | 5               |
| 08   | Industrial Visit       | CETP                          | 5               |
| 09   | Industrial Visit       | Nano Technology               | 5               |

The student will make at least two technical presentations on current topics related to the specialization. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation together with the observation in industry visits. A quiz covering the above will be held at the end of the semester.

**Total P: 60**

## II SEMESTER

### 15TT06 STATISTICS AND QUALITY CONTROL FOR TEXTILE INDUSTRY

**4 0 0 4**

**STANDARD PROBABILITY DISTRIBUTIONS:** Mean and variance of Probability distribution, Geometric distribution, Binomial distribution, Poisson distribution, Normal approximation to Binomial and Poisson. (10)

**STANDARD SIGNIFICANCE TESTS:** Hypothesis, significance level, interpretation of significance test, single and double tail tests. Errors and choice of sample size. Test for single mean, two means – test for single variance, two variances and single proportion. Rejection of outliers. (10)

**ANALYSIS OF VARIANCE:** ANOVA for different models, test of significance – comparison with a control, global comparisons. Rank test. (10)

**DESIGN OF EXPERIMENTS:** Introduction. Random variation in experiments – randomization,  $2^n$  full-factorial designs – Yate's algorithm, fractional replication. Optimization techniques using composite designs. (10)

**LINEAR REGRESSION:** Introduction. Method of least squares – linear regression equation – correlation coefficient. Regression through origin – multiple regression. Confidence limits. (10)

**CONTROL CHARTS:** General principle of control charts – action and warning limits – interpretation of control charts. Control charts for defectives, defects, averages, ranges. Cusum charts. Process capability analysis. (10)

**Total L: 60**

#### REFERENCES:

1. Leaf G A V, "Practical Statistics for the Textile Industry", The Textile Institute, Manchester, 1984.
2. Leaf G A V, "Practical Statistics for the Textile Industry", The Textile Institute, Manchester, 1987.
3. J. R. Nagla, "Statistics for Textile Engineers", Woodhead Publishing India Pvt. Ltd., 2014
4. Meloun M and Militky J, "Statistical Data Analysis: A Practical Guide", Woodhead Publishing Ltd. UK, 2011.
5. Hayavadana J, "Statistics for Textile and Apparel Management", Woodhead Publishing Ltd., UK, 2012.
6. Montgomery D C, "Design and Analysis of Experiments", John Wiley & Sons, New York, 1997.
7. Ronald D moen, Thomas W Nolan and Lloyd P Provost, "Quality Improvement Through Planned Experimentation", McGraw Hill, 1998.

### 15TT07 INDUSTRIAL TEXTILES

**3 0 0 3**

**INTRODUCTION TO INDUSTRIAL TEXTILES:** Definition, classification, market overview and growth projections of industrial textiles. (3)

**INDUSTRIAL TEXTILES: FILTER FABRICS:** Filter fabric requirements, Types-dry and wet filtration. Filtration mechanism. Fibers, yarn and fabric structures used for filtration. Design of Filter fabrics. Manufacture of woven, knitted and nonwoven filters. Finishing treatments. Developments in filter fabrics-Melt blown and electrospun fabric filters. Evaluation & standards. (9)

**OTHER INDUSTRIAL TEXTILE PRODUCTS:** Cords, ropes, belts and their types, method of production, characteristics and applications. Manufacture and properties of textiles used in scrub pads, waddings, battery separators, computer ribbons and coated abrasives. (9)

**TRANSPORTATION TEXTILES:** Automotive textiles: Requirement and design for pneumatic tyres, airbags, belts, carpets, sound absorption pads and car interiors. Methods of production and properties of textiles used in these applications. **Other Transportation Applications:** Properties of textiles used in rail and aircrafts (9)

**TEXTILES IN CIVIL ENGINEERING:** Geotextiles: Functions and application areas of geotextiles. Fibres and fabric selection criteria for geotextile applications. Manufacture of woven and nonwoven geotextiles. Evaluation of geotextiles. **Other Civil Engineering Applications:** Properties of textiles used in civil construction, architectural and ocean engineering application (9)

**TEXTILES IN AGRICULTURE:** Requirement and properties of textiles used in crop covers, bird netting, shade fabrics, soil mats, sacks and silos. **Textiles in Packaging:** Requirement and properties of textiles used in food packaging, bags and luggage. (6)

**Total L: 45**

## REFERENCES:

1. Sabit Adanur and Wellington Sears, "Handbook of Industrial Textiles", Technomic Publishing Co., USA, 1995.
2. Horrocks A R and Anand S C, "Handbook of Technical Textiles", Woodhead Publishers and Textile Institute, England, 2000.
3. Shishoo R, "Textile Advances in the Automotive Industry", Woodhead Publishers, Cambridge, England, 2008.
4. Alagirusamy R and Das A, "Technical Textile Yarns", Woodhead Publishers, Cambridge, England, 2010.
5. Deopura B L, Alagirusamy R, Joshi M and Gupta B, "Polyesters and polyamides", Woodhead Publishers, England, 2008.

## 15TT08 PRINCIPLES OF COLOUR MEASUREMENT

2 0 2 3

**COLOUR PERCEPTION:** Introduction. Theories and Principles. Properties of light and colour. The human colour vision system - Chromatic perception, Defective colour vision, Colour constancy. Colour Specification Systems- Additive and subtractive colour mixing- The CIE system of colour specification. (5)

**COLOUR MEASUREMENT OF TEXTILES:** Introduction. Colour measuring instrument-Spectrophotometer- inter instrument agreement and traceability. Colour into numbers: Reflectance measurement – Spectral reflectance measurement – Relationship between colour and spectral reflectance value. The CIE standard light sources, observer and the unreal primaries, On-line colour measurement. Colour of wet and dry fabrics. (5)

**MEASUREMENT OF CIE COLOUR PARAMETERS:** Computation of CIE tristimulus values – Chromaticity coordinates. CIE  $L^*$ ,  $a^*$ ,  $b^*$ ,  $u^*$ ,  $v^*$ ,  $C^*$  and  $h$  values. Measurement of whiteness index of bleached fabric. Measurement of fluorescence of OBA treated fabric. Measurement of yellowness index of silk fabrics. Metamerism-types of metamerism, influence of metamerism in colour measurement. (5)

**COLOUR MATCHING AND COLOUR DIFFERENCES:** Definition, Manual colour matching. Instrumental Colour matching. Kubelka – Munk theory, spectral match, Metameric match, tristimulus match. Colour differences - Perceptibility and acceptability, methods of assessment, colour difference formula. Assessment of colour fastness of dyed goods. (5)

**COLORANT FORMULATION FOR DYEING:** Introduction. Colorant recipe formulation – computer colour matching (CCM) technique, Application of CCM system to Textile processing. Advantages and Limitations. Improvement of the formulation accuracy. (5)

**MEASUREMENT OF CONCENTRATION OF DYE LIQUOR:** Introduction. Beer-Lambert's law. Measurement of Absorbency value of dye liquor using spectrophotometer – preparation of dye liquor and standard solution. Development of calibration graph. Calculation of dye concentration. Applications. (5)

### PRACTICALS:

1. Determination of colour parameters (%R, K/S, Tristimulus values) of dyed fabric
2. Determination of  $L^*$ ,  $a^*$ ,  $b^*$ ,  $C^*$ ,  $h$  of dyed fabric
3. Determination of Whiteness and Yellowness indices of textile fabric
4. Determination of colour difference of dyed sample with standard fabric
5. Establishment of calibration curve and identification of strength of dye solution using spectrophotometer
6. Reproduction of colour on the given fabric with help of spectrophotometer

Total L:30 + P: 30 = 60

### REFERENCES:

1. Gulrajani M L, "Colour Measurement: Principles, Advances and Industrial Applications", Woodhead Publishing Ltd, UK, 2010.
2. Xin J, "Total Colour Management in Textiles", Woodhead Publishing Limited, UK, 2006.
3. McDonald R, "Colour Physics for Industry", Woodhead Publishing Limited, UK, 1997.
4. Shah H S, and Gandhi R S, "Instrumental Colour Measurements and Computer Aided Colour Matching for Textiles", Mahajan Publications, Ahmedabad, 1990.
5. Mc Laren K, "The Colour Science of Dyes and Pigments", Adam –Hilger, Bristol, U.K, 1983.
6. Peters A T and Freeman H S, "Physio –Chemical Principles of Colour Chemistry", Blackie, 1995

## 15TT09 CLOTHING COMFORT

3 0 0 3

**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. (7)

**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. (8)

**TACTILE COMFORT:** Tactile comfort sensations. Fabric characteristics and tactile attributes. Fabric parameters influencing tactile sensation. (7)

**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. (8)

**AESTHETIC COMFORT:** Psychological aspects of aesthetic comfort. Analysis of clothing aesthetics. Aesthetic concepts of clothing. (7)

**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. (8)

**Total L: 45**

**REFERENCES:**

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.

## 15TT10 FUNCTIONAL TEXTILES

**3 0 0 3**

**INTRODUCTION TO FUNCTIONAL TEXTILES:** Classification of functional textiles. Requirements from functional textiles- Physiological, biomechanical, ergonomic and psychological. Steps involved in clothing design. Role of fiber, yarn and fabric parameters on functional attributes (5)

**PROTECTIVE TEXTILES:** Market prospects. Classification of protective textiles. Materials and technologies for manufacturing protective textiles. Requirement and design system for Protective textiles- Fire protection, Cold weather protection, Thermal protection, Chemical protection. (8)

Requirement and Design system for Ballistic protection, Radiation protection and Biological protection. Surface treatments for protective textiles. (7)

**MEDICAL TEXTILES:** Medical textiles market. Classification of medical textiles. Sutures- Classification based on origin, physical configuration and absorbability, properties of sutures, Evaluation and standards. Wound dressings-Functional requirements, materials used, wound healing mechanism and factors affecting wound healing, Evaluation and standards. (9)

**HEALTHCARE AND HYGIENE PRODUCTS:**Functional requirements, materials used, design procedure, Evaluation and standards. Antimicrobial finishing of medical textiles-Need for antimicrobial finishing, antimicrobial agents and their working mechanism, Antimicrobial test methods. (8)

**SPORTS TEXTILES:** Sports wear market. Key trends in sportswear design. Material requirements for the design of performance sportswear. Developments in active sports wear- New fibers, coated and laminated textiles. Evaluation and standards. (8)

**Total L: 45**

**REFERENCES:**

1. Deepti Gupta, "Special Issue on Functional Clothing", Indian Journal of Fibre and Textile Research, India, 2011.
2. Richard A Scott, "Textiles for Protection Textiles Institute", CRC Press & Wood Head Publishing, England, 2005.
3. Horrocks A R and Anand S C, "Handbook of Technical Textiles", Woodhead Publishers and Textile Institute, England, 2000.
4. Deopura B L, Alagirusamy R, Joshi M and Gupta B, "Polyesters and Polyamides", Woodhead Publishers, England, 2008.
5. Shishoo R, "Textiles in Sport", Woodhead Publishers, Cambridge, England, 2005.

## 15TT52 INDUSTRIAL TEXTILES PRODUCT DEVELOPMENT AND QUALITY EVALUATION LAB

**0 0 2 1**

**LIST OF EXPERIMENTS:**

1. Development of needle punched nonwoven fabrics for specific applications
2. Development of chemical and thermal bonded nonwoven fabrics
3. Evaluation and characterization of developed fabrics for particular applications
4. Development of automotive needle punched carpets and sound absorption measurement
5. Development and evaluation of braided cords/ropes

**Total P: 30**

### III SEMESTER

#### 15TT53 STATISTICAL ANALYSIS AND OPTIMIZATION LAB

0 0 2 1

1. Standard probability distributions
2. Standard significance tests
3. One-way / two-way ANOVA
4. Optimization techniques
5. Simple linear regression and multiple regression
6. Reliability analysis with Weibull distribution function

Total P: 30

#### 15TT71 PROJECT WORK – I

0 0 6 3

Identification of a real life problem in thrust areas  
Developing a mathematical model for solving the above problem  
Finalization of system requirements and specification  
Proposing different solutions for the problem based on literature survey  
Future trends in providing alternate solutions  
Consolidated report preparation of the above

Total P: 90

### IV SEMESTER

#### 15TT72 PROJECT WORK – II

0 0 28 14

The project involves the following:

- **Preparing a project - brief proposal including**
  - Problem Identification
  - A statement of system / process specifications proposed to be developed (Block Diagram / Concept tree)
  - List of possible solutions including alternatives and constraints
  - Cost benefit analysis
  - Time Line of activities
- **A report highlighting the design finalization [based on functional requirements & standards (if any) ]**
- **A presentation including the following:**
  - Implementation Phase (Hardware / Software / both)
  - Testing & Validation of the developed system
  - Learning in the Project
- **Consolidated report preparation**

Total P: 420

## ELECTIVE THEORY COURSES

### 15TT21 CHARACTERIZATION OF TEXTILE POLYMERS

3 0 2 4

**MOLECULAR CHARACTERIZATION:** Molecular weight averages, Determination of molecular weight: primary methods – end group analysis, osmometry, light scattering. Secondary methods – viscometry, gel permeation chromatography. (8)

**THERMAL CHARACTERIZATION:** Characterization of glass transition, crystallization, melting and decomposition temperatures. Thermoanalytical techniques: Differential scanning calorimeter, Differential thermal analysis, Thermogravimetry, Thermo-mechanical analysis, Dynamic mechanical tests. (10)

**MORPHOLOGY CHARACTERIZATION:** Microscopy analysis – Scanning electron microscopy, Transmission electron microscopy, Atomic Force Microscopy and Scanning Tunneling Microscope. Spectroscopy analysis – Infrared, NMR, UV-visible, mass and Raman Spectroscopy techniques. (10)

Orientation techniques – optical birefringence, dialectic anisotropy, dichroism. Crystallization techniques – X-ray diffraction, density gradient measurement, Small angle x-ray scattering. (9)

**PHYSICAL CHARACTERIZATION:** Fibre fineness, friction, crimp, spin finish content, viscosity, dye uniformity, bulkiness measurements. (8)

#### LABORATORY COMPONENT:

1. Comparative analysis and study of molecular weight averages
2. Analysis of thermograms of DSC, TGA and DTA
3. Fibre surface and morphological structure analysis under varying resolutions of SEM, TEM and AFM
4. Structure analysis and identification of chemistry of fibres and polymers through spectrogram analysis
5. Fine structure interpretation of fibres through X-ray spectrogram and DSC analysis
6. Study of principle of measurement of fibre fineness, crimp and spin finish

Total L: 45 + P: 30 = 75

#### REFERENCES:

1. Gupta V B and Kothari V K, "Manufactured Fibre Technology", Chapman & Hall Pub., England, 1997.
2. Mukhopadhyay S K, "Advances in Fibre Science", The Textile Institute, Manchester, 1992.
3. Raheel M, "Modern Textile Characterization Methods", Marcel Dekker Inc, New York, 1996.
4. Billmeyer F W, "Textbook of Polymer Science", Wiley Inter Science, New York, 2002.

### 15TT22 NANOTECHNOLOGY IN TEXTILES

3 0 0 3

**INTRODUCTION:** Emergence of Nanotechnology, Bottom-up and top-down approaches. (7)

**NANOFIBRE PRODUCTION:** Principle of electrospinning. Electrospinning of nanofibres – conditions, structure formation, properties, effect of process parameters upon fibre formation. Methods to produce continuous filaments. Electrospinning of polyamides and polyesters. (10)

**CARBON NANOTUBES (CNT):** Definition, Synthesis, Characterization and properties of CNT. Application of CNT in polymer and textiles. Effect of process conditions upon CNT structure and properties. (10)

**NANOPARTICLES:** Preparation, characterization, and application of silver nanoparticles, Fe nanoparticles ZnO, TiO<sub>2</sub>, MgO, SiO<sub>2</sub> & Al<sub>2</sub>O<sub>3</sub> with PP or PE coating, Indium-tin oxide Nanoparticles, Ceramic Nano-Particles, Carbon black Nanoparticles, Clay nanoparticles, Cellulose Nanowhiskers and Nanoparticles. Self- assembled nanolayer films, Nano structuring of polymers with cyclo dextrins (10)

**ECOLOGICAL ASPECTS:** Ecological considerations of nanoparticles and nanofibres. Human health hazards, hazard to environment, aquatics and to useful microbes responsible for biodegradation. Global regulation concerning nanoparticles and products. (8)

Total L: 45

#### REFERENCES:

1. Brown P J and Stevens K, "Nanofibres and Nanotechnology in Textiles", Woodhead Pub. Ltd., Cambridge, 2007.
2. Yury Gogotsi, "Nanotubes and Nanofibres", CRC Taylor & Francis, Boca Raton, 2006.
3. Guazhong Cao, "Nanostructure and Nanomaterials", Imperial College Press, USA, 2006.
4. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simons and Burkhard Raguse, "Nanotechnology- Basic Science and Emerging Technologies", Overseas Press, New Delhi, 2005.



## 15TT23 HIGH PERFORMANCE AND SPECIALITY FIBRES

3 0 0 3

**INTRODUCTION:** Growth Patterns - Major attributes and advantages – Product development areas. ARAMID AND AROMATIC POLYESTERS: Fibres formation – Fibre & structure properties and performance – Application. (6)

**CARBON AND GRAPHITE:** Classification and Types – manufacturing processes from Polyacrylonitrile, Rayon and pitch based fibres-properties. (7)

**GLASS FIBRES:** Types and Composition – Manufactures Processes – Fibre structures – Properties – Applications. Optical Fibres: Light Propagation - Fibre manufacture – Application (7)

**CERAMIC FIBRES:** Classification and fibre formation, composition and structure – properties and application. Elastomeric Fibres: Manufacturing Processes – Fiber Properties- Application and future trends. (8)

**POLYETHYLENE FIBRES:** Manufacturing Processes – Fibre Properties – Application and future trends. Metallic Compound Fibres: Aluminium oxide fibres and Lead Fibers – Preparation and processes – Fibre structure – properties – Application (8)

**SPECIALITY FIBRES:** Highly aesthetic fibres – evolution – specialized non circular cross section - blending – mixed and conjugate spinning- super fine fibres. Spinning of ultrafine fibres. Spinning of continuous filament type- direct spinning, conjugate spinning with alternately arranged polymers. Random type spinning-melt blowing, and flash spinning. (9)

Total L: 45

### REFERENCES:

1. Hearle J W S, "High Performance Fibres", Woodhead Publishing, Cambridge, England, 2001.
2. Nakajima T, "Advanced fiber spinning Technology", Woodhead Publishing, UK, 1996.
3. Mukhopadhyay S K, "High Performance Fibres", Textile Progress Vol.25, Textile Institute, England, 1993.
4. Menachan Lewis and Jack Preston, "High Technology Fibres", Part D, Mercel Dekkar Inc, New York, 1996.
5. Menachan Lewis and Jack Preston, "High Technology Fibres", Part B, Mercel Dekkar Inc, New York, 1993.
6. Menachan Lewis and Jack Preston, "High Technology Fibres", Part A, Mercel Dekkar Inc, New York, 1988.

## 15TT24 ALTERNATIVE SPINNING SYSTEMS

3 0 0 3

**DEVELOPMENTS IN RING SPINNING:** Condensed yarn spinning – Principles, Advantages, Disadvantages. Developments in drive system and automations in ring frame. SIRO spinning - method of production. structure, properties and end uses of SIRO yarn produced under cotton spinning system. Multi rove spinning - structure, properties and end uses. Solo spinning systems. (8)

**OPEN - END SPINNING:** Rotor Spinning - task, principles of operation. Requirements of the raw material. Opening unit, sliver in feed, opening roller, rotor, yarn formation, yarn withdrawal and winding. Friction spinning: principle of operation, requirements of the raw material, classification, technical data, yarn characteristics. Vortex spinning: Principle of airvortex spinning, electro static spinning. Yarn structure, properties and end uses. (12)

**FALSE TWIST SPINNING:** Principle of air-jet spinning, Requirements of the raw material, distribution of twist in the running fibre strand, drafting arrangement, twist jets, technical data, yarn characteristics. (4)

**CORE YARN SPINNING:** Methods of yarn production, Production of core spun yarns in ring, rotor, friction and air jet spinning. Applications. (6)

**OTHER SPINNING SYSTEMS:** Wrap spinning- Production of yarn by hollow spindle spinning .Yarn structure, properties and end uses. Self twist spinning – repco spinning machine, yarn structure, properties and end uses. Adhesive bond spinning -.Production of twistless yarns. Yarn structure, properties and end uses. (8)

**COMPARISON:** Comparison amongst various spinning systems- Count range, Production speed, Yarn structure and properties. (7)

Total L: 45

### REFERENCES:

1. Lawrence C, "Advances in Yarn Spinning Technology", Woodhead Publishing Limited, UK, 2010
2. Mahendra Gowda R V, " New Spinning Systems", NCUTE Publication, IIT Delhi, 2006.
3. Lawrence C, "Fundamentals of Spun Yarn Technology", CRC Press, New York, 2003
4. Klein.W, "RIETER Manual of Spinning – Vol.5: New Spinning Systems", The Textile Institute", UK, 2011.

## 15TT25 PROCESS AND QUALITY CONTROL IN SPINNING AND WEAVING

3 0 2 4

**RAW MATERIAL QUALITY:** Introduction - Definition and scope of process and quality control in textiles- norms and standards. Mixing- fibre selection, mixing quality and cost. Bale management techniques - Contamination removal techniques. Significance of modern developments on mixing quality. Application of statistical techniques in quality control. (6)

**WASTE AND NEPS IN BLOW ROOM, CARDING AND COMBING:** Yarn realization – Types of waste, control of invisible loss. Blowroom - Control of waste, Nep generation and Fibre rupture. Carding - control of waste, Nep removal efficiency and fibre rupture in carding, Online monitoring and control of neps on modern cards. Comber - control of comber waste and nep removal, optimisation of comber noils. Influence of machine and process parameters on waste removal. Significance of modern developments on waste control and nep removal efficiency. (8)

**YARN QUALITY:** Count variation - Assessment of within and between bobbin count variations, control of count variations in preparatory machines. Strength variation – assessment and causes, process variability, causes, control of variability. Unevenness and imperfections-measurement and assessment, analysis and interpretation of diagram, spectrogram and V- L curve. Yarn faults and package faults- classification, assessment, causes and remedies. Control of Yarn hairiness. (9)

**PRODUCTIVITY ANALYSIS:** Factors affecting the productivity in ring spinning. Productivity indices. Methods for maximizing production in spinning machinery – Factors affecting spinning tension in ring spinning - Control of yarn end breakage rate in ring spinning - Factors affecting yarn end breakage rates in ring spinning - Control of fly generation and twist variations in ring spinning New concepts. End breaks in spinning – causes and remedial measures, Snap study. Effect of Machinery maintenance and Humidity on production. (6)

**WEAVING PREPARATORY:** Winding-quality of knots and splices, process parameters, control of productivity. Pirm winding-improving build of the pirm, process parameters, control of productivity. Warping- process parameters, control of end breakages, warp beam quality and productivity. Sizing – process parameters, Control of size pick-up, stretch, moisture and quality of beams. Control of productivity and size loss. (8)

**LOOM SHED:** Drawing-In and Warp Tyeing - Control of extra ends on the weaver's beam, selection & care of reeds. Loom shed – Controlling loom productivity, efficiency and fabric quality - Online process control, quality control and monitoring in weaving - Cost control in weaving process parameters, Hard waste control - Control of hard waste in ring frame, winding, warping, sizing, drawing-in, pirm winding and loom shed. Analysis and Control measures for woven and knitted fabric defects. (8)

### LABORATORY COMPONENT:

1. Linear Programming technique for optimum mixing cost
2. Analysis of V-L curves and diagrams
3. Yarn fault analysis and classifications
4. Study on productivity indices in spinning and weaving
5. Analysis of woven and knitted fabric defects

Total L: 45 + P: 30 = 75

### REFERENCES:

1. Majumdar A, Das A, Alagirusamy R, and Kothari V K, "Process Control in Textile Manufacturing", Woodhead Publishing, Cambridge, UK, 2012.
2. Garde A R and Subramanian T A, "Process Control in Spinning", ATIRA, Ahmedabad, 1989.
3. Paliwal M C and Kimothy P D, "Process Control in Weaving", ATIRA, Ahmedabad, 1983.
4. Booth J E, "Principles of Textile Testing", CBS Publishers and Distributors, New Delhi, 1996.
5. Furter R, "Evenness Testing in Yarn Production: Part I and Part II", The Textile Institute, Manchester, 1982.
6. Barella A and Manich A M, "Yarn Hairiness : A Further update", Textile Progress, Vol. 31 No.4, 2000.

## 15TT26 THEORY OF YARN AND FABRIC STRUCTURES

3 0 0 3

**INTRODUCTION:** Basic concepts of yarn and fabric structure. (5)

**YARN STRUCTURE:** Types of yarn, the idealized helical yarn structure, yarn count and twist factors, twist contraction and retraction, packing of fibres in yarn, effect of fibre properties on the diameter and density of yarn, measurement of yarn diameter, density and specific volume, empirical formulas for the determination of yarn diameter. (10)

**MIGRATION & PROPERTIES:** The arrangement of fibres in a unitary yarn, fibre obliquity and slippage. Fibre migration, characterization of migration behaviour, techniques of determining the position of fibre in a yarn, effect of various parameters on migration behavior, forms of yarn twisting, analysis of tensile behavior of continuous filament yarns. (10)

**WOVEN STRUCTURE:** Elements of fabric geometry. cloth setting, cloth setting theories, study of Peirce's model and introduction to the later modifications, jamming of threads, cover and crimp interchange in woven fabrics with respect to simple geometry. (10)

**MODELLING OF FABRIC PROPERTIES:** Mathematical models and their applications in the study of tensile, bending, shear, compression and buckling of woven fabrics. Fabric Geometry – Peirce and Kemp Models. (10)

**Total L: 45**

**REFERENCES:**

1. Hearle J W S, Grosberg P and Backer S, "Structural Mechanics of Fibres, Yarns, Fabrics", Wiley Interscience, New York, 1999.
2. Goswami B C, Martindale J G and Scardino, "Textile Yarns, Technology and Application", Wiley Interscience, New York, 1995.
3. Hu J, "Structure and Mechanics of Woven Fabrics", Hong Kong Polytechnic University, Woodhead Publishing Ltd, UK, 2004.
4. Seyam A M, "Structural Design of Woven Fabrics", Textile Progress Vol.31, No: 3. Woodhead Publishing, UK, 2002.
5. Hearle J W S, Grosberg P and Backer S, "Structural Mechanics of Fibres Yarn and Fabrics", Wiley Interscience, New York 1999.
6. Indian Journal of Fibre and Textile Research, "Special issue on Recent Advance in Fabric Forming", Publications and Information Directorate (NISCOM) CSIR, Vol. 19, No.3, 1994.

### 15TT27 SPECIALTY TEXTILES

**3 0 2 4**

**NARROW WIDTH FABRICS:** Narrow fabric and their types, Preparatory processes for narrow fabric production, method of production, characteristics and application (8)

**BRAIDED STRUCTURES:** Types of braids. Production techniques. Properties and applications. (5)

**HYBRID YARNS FOR THERMOPLASTIC COMPOSITES:** Types of hybrid yarns. Manufacture of thermoplastic composites with hybrid yarns. Compaction and consolidation of hybrid yarns. Hybrid yarn structure – composite property relations. Potential application areas of thermoplastic composites. Trends in thermoplastic composite applications (12)

**INDUSTRIAL SEWING THREADS:** Structure of industrial thread. Thread finishing. Threads for very high temperature applications. Applications of various sewing threads in technical applications. (8)

**CARPETS:** Material characteristics. Types of carpets. Production techniques. Properties and applications (6)

**OTHER FABRIC FORMATION SYSTEMS:** 3-D weaving and structures, Terry weaving and Spacer fabrics. (6)

**LABORATORY COMPONENT:**

7. Study of narrow width looms and fabric development
8. Study of braiding machine and development of braided structures
9. Study of sewing thread performance through finishes
10. Collection and study of carpet structures
11. Study of terry loom and pile fabric development

**Total L: 45 + P: 30 = 75**

**REFERENCES:**

1. Turner J P, "The Production and Properties of Narrow Fabrics", Textile Progress , Vol.8 No.4, The Textile Institute, Manchester, 2002.
2. Sabit Adanur, "Wellington Sears Handbook of Industrial Textiles", Technomic publishing company Inc., USA, 1995.
3. Jarmila Svedova , "Industrial Textiles", Elsevier Science Publishing Co in, New York, 1990.
4. Alexander N G, "Desighing Interior Environment", Mass court Brace Covanorich Inc., Newyork, 1996.
5. Crew A H and Arahamsen H, "Carpets: Back to Front", Textile Progress, Vol.19 No.3, The Textile Institute, Manchester, 1987.

### 15TT28 NONWOVENS

**3 0 0 3**

**INTRODUCTION:** Classification of nonwovens – Nonwoven manufacturing processes. Development of the nonwovens industry. Raw material. Binders. (5)

**WEB FORMATION:** Dry lay process, Wet-lay process - Raw materials and fibre preparation - Process variables – properties. Web drafter. Quality control in web preparation. Extrusion lay process – Types – Process variables – Properties. (8)

**WEB BONDING:** Needling – Principle – Needle characteristics – Process variables – Needled fabric properties. Loop formation processes – types – process variables – nonwoven fabric properties. Hydroentanglement process – principle – process variables – hydroentangled nonwoven fabric properties. Thermal bonding – Hot air bonding – calender bonding – Ultrasound bonding. Chemical bonding – Saturation bonding, Print bonding, Foam bonding and Spray bonding. Spun bonding, melt blown processes.

(8)

**FINISHING OF NONWOVENS:** Mechanical finishing – shrinking, compacting and creping, calendaring, pressing, perforating, slitting, breaking, raising, shearing, singeing, sewing. Chemical finishing – washing, dyeing, printing, finishing, softening, special effects, coating, laminating and flocking. (8)

**TESTING AND APPLICATIONS OF NONWOVENS:** Testing of nonwoven fabrics. Nonwovens for hygiene applications – use of nonwovens in medicine – safety nonwovens for cleaning and household products, home textiles – apparels and technical applications. Re-utilization of nonwovens. (8)

**NONWOVEN PRODUCT DEVELOPMENT:** Concepts and definitions – Nonwoven product development for garments, decorative fabrics, home textiles and technical textiles. Techno economics. Modeling of nonwoven fabrics- pore size distribution – tensile strength- bending rigidity-permeability-filtration properties. (8)

**Total L: 45**

**REFERENCES:**

1. Wilhelm Albrecht, "Nonwoven Fabrics", Wiley – VCH, Verlag GmbH and Company, 2003.
2. Krcma R, "Manual of Nonwovens", Textile Trade Press, 1993.
3. Russel.S, "Handbook of Nonwovens", Textile Institute Publication, UK, 2004.
4. Irsak O, "Nonwoven Textiles", Textile Institute, UK, 1999.
5. Mrstina V and Feigl F, "Needle Punching Technology", Elsevier Science Publishers, India, 1990.

## 15TT29 SURFACE MODIFICATION OF TEXTILES

**3 0 0 3**

**INTRODUCTION:** Importance of surface modification of textiles materials. Physical, Chemical and Bio Methods. Potential applications. (6)

**PLASMA SCIENCE AND TECHNOLOGY:** Definition, generation, characterization, classification of plasma with special reference to cold plasma. Low pressure plasma versus atmospheric plasma. Microdischarge versus glow discharge. Corona, DBD, O AUGP. (7)

**HIGH ENERGY RADIATIONS:** Electromagnetic spectrum. Wavelength and photon energy of Electron beam, gamma rays, X-rays, VUV light and UV light. Equipments based on light source, laser and electron beam. (7)

**SURFACE MODIFICATION OF TEXTILES BY PHYSICAL METHODS:** Interaction of plasma and light with substrate and mechanisms of modifications. Plasma treatment for enhancement of hydrophilicity, hydrophobicity, shrink proofing of wool, enhancement in dyeing characteristics and for enhancement in pretreatments. Plasma induced polymerization. Plasma metallisation, plasma cleaning, UV & VUV irradiations, electron beam for irradiations for similar applications and for ablation. (10)

**ENZYME TREATMENT:** Mechanism of specific interaction of enzymes with substrates. Surface modification of natural and synthetic fibres with enzymes - mechanism, characterization and challenges. (7)

**CHARACTERISATION:** Characterization of modified and unmodified textile substrates using FTIR, ATR-FTIR, XPS, SEM, AFM, TEM. Surface characterization challenges. (8)

**Total L: 45**

**REFERENCES:**

1. Christopher M Pastore and Paul Kieken, "Surface characteristics of Fibers and Textiles," Marcel Dekker, Inc., New York, 2001.
2. Perkins W S, "Textile Coloration and Finishing", Carolina Academic Press, London, 1996.
3. Shishoo R, "Plasma Technologies for Textiles", Woodhead Publishing Ltd., Cambridge, 2007.
4. Xiaoming Tao, "Smart fibers, Fabrics and Clothing", Woodhead Publishing Ltd., Cambridge, 2007.

## 15TT30 GREEN PROCESSING OF TEXTILES

**3 0 0 3**

**ECO STANDARDS AND ECO-LABELS:** Regulations concerning azo dyes- banned amines, Pesticides, Heavy metals, Formaldehyde and Pentachlorophenol in textiles. Global eco standards and eco-labels. Ecomark scheme of India. Criteria for an eco-label based on the life cycle. **Eco-Management:** Concept of eco-management, eco-audit, certification and labeling of eco-friendly textiles. (10)

**ECO-TESTING OF TEXTILES:** Testing of banned chemicals such as free formaldehyde, pesticides, pentachlorophenol, heavy metals, azo dyes containing aromatic amines & benzidine and halogen carriers. Principle of Instruments used – Chromatography (HPLC, GC) and Mass Spectrometry and Atomic Absorption/Emission Spectrometry. (9)

**APPROACH TO ECO-FRIENDLY PROCESSING:** Concept of Sustainable Textiles, Fibre origin, Approach and Alternative methods/chemicals in Pretreatments, Eco-friendly dyes and dyeing & printing, Eco-Friendly Finishing – formaldehyde free finishing, Halogen free FR finish, Comfort and Hygiene Finishing using natural agents. (9)

**ADVANCED PROCESSING TECHNIQUES:** Principle and advantages of dry processing. Plasma treatment – principle, plasma as a source of reducing the effluent and energy consumption, as a source of enhancing the dyeing properties, as a source of finishing of textiles in eco-friendly manner. Super critical carbon dioxide processing of textiles, Surface modification by VUV irradiation – VUV lamp, Laser modification, Dielectric Barrier Discharge, and Corona. Electrochemical reduction - Ultrasonic dyeing. Concept of low level application of chemicals. (10)

**ENZYMATIC PROCESSING OF TEXTILES:** Enzyme treatments: Enzymes in preparatory processes - desizing, scouring, bleaching – Amylase, pectinase, protease, catalase, lipase etc. Enzymes used as discharging agents in printing – Laccase, Enzymes used in finishing – Bio finishing by cellulase. Enzymes for surface modification of natural and synthetic fibres. (7)

**Total L: 45**

**REFERENCES:**

1. "Eco -Textiles, Special Report", The Bombay Textile Research Association, Mumbai, 1996.
2. "Eco-Friendly Textiles: Challenges to the Textile Industry", Textiles Committee, Mumbai, 1996.
3. Chavan R B and Radhakrishnan J, "Environmental Issues - Technology Options for Textile Industry", IIT Delhi Publication, 1998.
4. Asokan R, "Eco-Friendly Textile Wet Processing", NCUTE Publications, New Delhi, 2001.
5. Shishoo R, "Plasma Technologies for Textiles", Woodhead publishing limited, UK, 2007.
6. Cavaco-Paulo A and Gübitz G M, "Textile Processing with Enzymes", Woodhead Publishing Ltd., UK, 2003.
7. MirafTAB M and Horrocks A R, "Eco Textiles", The Textile Institute, Woodhead Publishing Ltd., Cambridge, 2007.

## 15TT31 THEORY OF COLORATION

**3 0 0 3**

**PHYSICAL CHEMISTRY ESSENTIAL TO DYEING THEORY:** Laws of Thermodynamics. Thermochemistry – Thermodynamics of solutions. Properties of solutions. Theories of ionisation. Law of independent ionic migration. Acidity and alkalinity of aqueous solutions. Surface chemistry. Adsorption at dye bath–fibre interfaces. Kinetics of chemical reactions. (9)

**DYE – FIBRE BONDS:** Classification of fibres and dyes. Surface energy and Interfacial effect. Intermolecular forces – Hydrophobic interaction. Identification of dye –fibre forces – Dyeing mechanisms. Specific dye –fibre bonds. **Influence of Fibre Structure on Dye Uptake:** Fibre structure. Classification of dyeing systems. Heat treatment. (9)

**THERMODYNAMICS OF DYE SORPTION:** Activity of a dye – Substantivity, Aggregation of dyes. Heat of dyeing. Dyeing at Equilibrium. Donnan Membrane effect. **Diffusion and Rates of Dyeing:** Fick's laws of diffusion - diffusion in anisotropic media, diffusion in the steady state, diffusion in non-steady state, boundary layers in diffusion, diffusion in finite baths. Practical dyeing systems. (9)

**RESPONSE OF FIBRES TO DYEING PROCESSES:** Dyeing phenomena and the molecular organisation of the fibre. Relationship between temperature and physical properties of man-made fibres . WLF equation. Solubility parameter concept and dyeing, swelling of fibres and plasticisation. Practical dyeing systems. Carrier dyeing. Dry heat fixation. (9)

**REACTIVE DYE - FIBRE SYSTEMS:** Dye-fibre reactions- Reactive dyes – Structure and classification of reactive dyes, mechanism of reaction with textile fibres and water. Efficiency of reactive dyeing. Reactive sites in textile fibres. Methods for identification of dye-reactive sites. (9)

**Total L: 45**

**REFERENCES:**

1. Bird C L and Boston W S, "The Theory of Colouration of Textiles", Dyers Company Publications Trust, U.K, 1975.
2. Johnson A, "The Theory of Colouration of Textiles", SDC, Bradford, 1990.
3. Trotman E R, "Dyeing and Chemical Technology of Textile Fibres", Charles Griffin & Company Limited, London, 1984.
4. Arthur D. Broadbent, "Basic Principles of Textile Coloration", Society of Dyers and Colourists, Bradford, 2001.

## 15TT32 FUNCTIONAL FINISHES

**3 0 2 4**

**INTRODUCTION :** Chemical and mechanical finishing. The challenge and charm of Chemical finishing. Chemical Finishing Processes. Importance of chemical finishing. Application of chemical finishes. (6)

**SOFTENING FINISHES:** Introduction. Mechanisms of the softening effect. Types of Softeners. Compatibility and combinability of softeners. Evaluation and testing methods. Troubleshooting for softening finishes. (7)

**HAND BUILDING FINISHES:** Introduction. The hand building effect. Textiles with hand building finishes. Hand builder chemistry. Evaluation methods. Trouble shooting for hand building finishes. (6)

**NON-SLIP AND ELASTOMERIC FINISHES:** Introduction. Mechanisms of non-slip finishes. Chemistry of non-slip finishes. Application methods and combinability. Evaluation, Trouble shooting for non-slip finishes. Mechanism of elastomeric effect. Evaluation. Trouble shooting for elastomeric finishes. (9)

**PROTECTIVE FINISHES:** Introduction. Mechanism of UV protection. Chemistry of UV Protection finishes. Evaluation. Trouble shooting for UV protection finishes, EMI Shielding. Antimicrobial finish. Mechanisms of antimicrobial finishes. Evaluation. Trouble shooting for antimicrobial finishes. (10)

**NOVEL FINISHES:** Introduction. Anti-odour and fragrance finishes. Mosquito repellent finish. Conductive finishing. Microencapsulation technique for finishing of Textiles, Nanofinishing. Enzyme finishing. (7)

**LABORATORY COMPONENT:**

1. Study of calendaring machine and calendaring of fabrics
2. Study of sanforizing machine and shrink proofing of fabrics
3. Softening and stiffening of fabrics
4. Selected protective finishing of textiles
5. Selected novel finishing of textiles

**Total L: 45 + P: 30 = 75**

**REFERENCES:**

1. Schindler W D and Hauser P J, "Chemical Finishing of Textiles", The Textile Institute, Woodhead Publishing Ltd., Cambridge, 2004.
2. Charles T, "Chemistry & Technology of Fabric Preparation & Finishing", North Carolina State University, 1992.
3. Perkins W S, "Textile Colouration and Finishing", Carolina Academic Press, U.K, 1996.
4. Menachem L and Stephen B S, "Handbook of Fibre Science and Technology", Volume II, Part B, Marcel Dekker Inc., New York, 1983.

## 15TT33 CHEMICAL PROCESSING OF SYNTHETIC TEXTILES

**3 0 0 3**

**PREPARATORY PROCESS AND MASS COLOURATION:** Various preparatory processes for manmade textile -Heat setting of synthetic fabrics - effects of heat setting on dyeing. Mass colouration of Polyester, Nylon, Acrylic and polypropylene, Advantages & Disadvantages of Mass Colouration; Difference between Mass Colouration and Dyeing. (9)

**DYEING OF PET, NYLON AND ACRYLIC:** Polyester Dyeing: carrier, HTHP and thermosal methods of dyeing. Practical problems and their solutions. Stripping of dyed PET. Dyeing of nylon. Dyeing with acid dyes- High temperature dyeing. Low temperature dyeing of Nylon 66 – Dyeing with disperses dyes. Barriness of dyeing. Dyeing of Acrylic Fibres: – Dyeing with cationic dyes–stripping of cationic dyes, dyeing with disperse dyes, dyeing of acrylic blends, differentially dyeable acrylic fibres. (10)

**DYEING OF BLENDS:** Dyeing of Polyester Blends: Various shop floor practices of dyeing of polyester/cellulosic blended fabrics. Practical problems and their solutions. Various shop floor practices of dyeing of polyester/wool blended fabrics. Practical problems and their solutions. Dyeing of polyester with cationic dyes. Dyeing of Micro polyester fabric. Dyeing of polyamide cellulosic blends – polyamide/wool blends, polyamide/ polyester blends-Stripping of Nylon dyed material. Practical problems and remedies in Nylon Dyeing. Dyeing of unmodified and modified polypropylene. (12)

**PRINTING:** Printing of synthetic and blended fabrics with different dye classes - Direct, resist and discharge styles of printing - Transfer printing of polyester and blends. (8)

**FINISHING:** Different functional and easy care finishes on synthetics and blends like anti-static, soil-release, soil-resistant, flame-retardant. (6)

**Total L: 45**

**REFERENCES:**

1. Vaidya A A, and Datye K V, "Chemical processing of Synthetic Fibres and Blends", John Wiley and Sons, New Delhi, 1999.
2. Shore J, "Blend Dyeing", Society of Dyers Colourists, London, 1998.
3. Mittal R M and Trivedi S S, "Chemical Processing of Polyester and Blends", ATIRA, Ahmadabad, 1998.
4. Duckworth C, "Engineering in Textile Colouration", Dyers Company Publications Trust, UK, 1983.
5. Gulrajani M L, "Polyester Dyeing", Indian Institute of Technology Delhi, New Delhi, 1995.

## 15TT34 PRINTING TECHNOLOGY

**3 0 0 3**

**STYLES AND METHODS OF PRINTING:** Direct, Resist, Discharge styles of printing. Screen printing, Roller printing, and Rotary printing. Effect of process parameters upon print quality. (9)

**TRANSFER PRINTING:** Introduction, Sublimation transfer, Melt and film release transfer, Wet transfer printing. (8)

**CARPET AND FABRIC PRINTING:** Historical development of carpet printing, Carpet printing, Printing of carpet tiles, Treatments before and after printing, Physical factors affecting the quality of printed carpets, Selection of dyes and chemicals for printing nylon carpets, Printing of carpets tufted from fibres other than nylon. (9)

**DIGITAL PRINTING:** Introduction. Printer-Inkjet printing technology. Drop formation and impaction and industrial production printers. Printer software – Digital encoding and formation of printed images and digital colour management. Digital printing colouration – substrate preparation for ink-jet printing, pigmented ink formulation. Formulation of aqueous inkjet ink. Effect of pretreatment on print quality and its measurement, and inkjet printing of cationized cotton with reactive inks. (10)

**SPECIAL PRINTING TECHNIQUES:** Developments in Photo printing and Blast printing with Indigo. Developments in Xerox printing and Laser printing for fancy effects. Yarn printing (space dyeing) (9)

**Total L: 45**

**REFERENCES:**

1. Miles L W C, "Textile Printing", Society of Dyers and Colourists, Hobbs The Printers, Hampshire, UK, 2003.
2. Miles L W C, Textile Printing, Dyers company Publishing Trust, UK, 1981.
3. Shenai V A, "Technology of Printing", Sevak Publishers, Mumbai, 1990.
4. Shore J, "Colorants & Auxiliaries", Vol. I & II, Society of Dyers and Colourists, UK, 1990.
5. Ujiie, "Digital Printing of Textiles", CRC, Wood Head Publishing Ltd, UK, 2006.
6. Tyler D, "Textile Digital Printing Technologies", Textile Institute Publication UK, Vol.37 No.4, 2005.

## 15TT35 TEXTILE EFFLUENT TREATMENTS

**3 0 0 3**

**EFFLUENT PARAMETERS AND TREATMENTS:** pH, TDS, TSS, COD, BOD, Color, Banned Chemicals. Sources of effluents from textiles. Flow chart. Preliminary Treatment - Screening, Shredding, Grit Removal, Preaeration, Chemical Addition. Primary Treatments - Aeration, Neutralisation. Secondary Treatments: coagulation, flocculation, use of filter beds for biodegradation, activated sludge process (aerobic biodegradation). (9)

**TERTIARY TREATMENTS:** Adsorption - Activated carbon, Ion-exchange resins, Inorganic, Biomass. Oxidation - Radiation (UV, Gamma, Electron Beam), Electrochemical, Chemical (H<sub>2</sub>O<sub>2</sub>, Chlorine, Fenton's reagent), Thermal, Corona discharge. Separation - Ultrafiltration, Nanofiltration, Reverse osmosis, Microfiltration. (9)

**BIOTECHNOLOGICAL TREATMENT OF TEXTILE DYE EFFLUENT:** Biotechnology and dye effluent treatment, Microbial processes - General aspects, Aerobic treatment - Activated sludge, Fungi, Anaerobic treatment; Enzymic processes -General aspects, Oxidative enzyme remediation, Reductive enzymes. (9)

**OZONE AND ADVANCED OXIDATION:** Effect of ozonation on TOC, BOD and COD. Decolorisation mechanisms with ozone and ozone-based Advanced Oxidation Process, Decolorisation by ozonation. Reuse of spent dyebath. **Advanced Oxidation:** Electron beam/O<sub>3</sub>, UV/O<sub>3</sub>, UV/H<sub>2</sub>O<sub>2</sub>, H<sub>2</sub>O<sub>2</sub>/O<sub>3</sub>, Photo catalytic, Catalytic ozonation, UV/O<sub>3</sub>/H<sub>2</sub>O<sub>2</sub>. (9)

**WATER AND ENERGY:** Water consumption in textile industry, Impurities in water. **Energy conservation:** Efficient generation of energy and minimum consumption, Mechanical removal of water before drying, Increased efficiency of drying and heat-setting, Reduced liquor to material ratio, Efficient heat recovery, Heat recovery from process effluents. **Water conservation:** Minimising liquor to material ratio, Minimising wash liquor, Re-using rinsing bath water, Direct steam injection. (9)

**Total L: 45**

**REFERENCES:**

1. Christie R M, "Environmental aspects in Textile Dyeing", Woodhead Publishing Ltd., UK, 2007.
2. Karmakar S R, "Chemical Technology in the Pre-treatment Processes of Textiles", Elsevier, New York, 1999.
3. Cavaco-Paulo and Gübitz G M, "Textile Processing with Enzymes", Woodhead Publishing Ltd., UK, 2003.
4. Peter J Hauser, "Advances in Treating Textile Effluent", InTech Publisher, Croatia, 2011.
5. Babu B V, "Effluent Treatment: Basics & A Case Study", Chemical Engineering Department, Birla Institute of Technology and Science (BITS), PILANI, Rajasthan, India, 2000.

## 15TT36 FASHION DESIGN

**3 0 2 4**

**INTRODUCTION:** Basics of Fashion, Motif, Design, Style and aesthetics (5)

**DESIGN:** Structural and Decorative Design, requirement of structural and decorative design, design development  
**ELEMENTS OF DESIGN:** Introduction on basic Elements of design ---Line, Size, Shape, Texture, Colour and light - effects of elements in the apparel through fullness. (10)

**PRINCIPLES OF DESIGN:** Introduction to principles of designs - Balance, Proportion, Emphasis, Rhythm, Harmony. Radiation and gradation of principles in fashion apparel. Illusion effects, principles on functionality and aesthetics (7)

**COLOUR:** Colour Theories-- primary, secondary, tertiary, intermediate colors - color scheme dimensions of colors - warm and cool colors, Tint and Shades, Psychology of Colors, Application of Colors to different components and In Different Seasons, Colour Combinations, color contrast and color harmony. (7)

**FASHION:** Terminology, Components of Fashion, The Environment of Fashion, The Movement of Fashion, fashion trends  
**Fashion Forecasting** --Forecasting on Fabric, Colour, Silhouette, texture, Style, Street Fashion, Accessories. (8)

**FIGURE AND DESIGN ANALYSIS:** Fashion art and theories of fashion for Men, Women, Children, Figure analysis **Accessory Design:** Neck Tie, Hats, Over Coats, Hosiery and Shoes, Ornaments. (8)

**LABORATORY COMPONENT:**

1. Free hand drawing of lines and strokes.
2. Drawing Heads and faces –Hairstyles –arms, hands, legs and feet.
3. Illustration of human anatomy- Understanding the basics of different head theories
4. Head theories -Illustration of 8 head and of 10 head theory
5. Development of Inspiration and mood board
6. Development of Colour board
7. Understanding the development of Design using the developed mood, colour and inspiration board

**Total L: 45 + P: 30 = 75**

**REFERENCES:**

1. Brockman H L, "The Theory of Fashion Design", John Wiley and Sons Inc., New York, 2000.
2. Marian L Davis, "Visual Design in Dress", Prentice Hall, New Jersey, 1996.
3. Suzanne G Marshall and Hazel O Jackson, "Individuality in Clothing Selection and Personal Appearance", Prentice Hall, 2000.
4. Laver J, "Costume and Fashion", Thames and Hutson, London 1995.
5. Bush G, "Psychology of Clothing", Macmillan Pub., Australia, 1990.
6. Stecker P, "The Fashion Design Manual", Macmillan Pub., Australia, 1997.

**15TT37 TEXTILE MARKETING AND MERCHANDISING**

**3 0 0 3**

**INTRODUCTION:** Marketing concepts. Marketing system. Marketing environment ,and marketing organization. (6)

**CUSTOMER MANAGEMENT:** Defining customer value and satisfaction. Delivering customer value and satisfaction. Attracting and retaining customers. Customer Profitability, company profitability and Total Quality Management. (8)

**MARKET DEMAND:** Modern Marketing Information System. Marketing Intelligence System. Marketing Research System, Marketing Decision Support System. Forecasting and Demand Measurement. Product Life Cycle : Introduction Types, Marketing strategies for different stages of PLC. New Product Development: Introduction. Stages. (11)

**PRODUCT AND BRANDING STRATEGIES:** Product and Product Mix. Product - Line decisions. Brand decisions. Packaging and Labeling .Retailing, Wholesaling And Market Logistics : Retailing Types, Marketing decisions and trends. Wholesaling Types, marketing decisions and trends. Market logistics – Objectives and decisions. (10)

**MERCHANDISING:** Dimensions of product change. Nature and timing of merchandising responsibilities – line planning, line development and line presentation. Sourcing: Role of sourcing in an apparel industry. Materials sourcing processes - selection of fabrics, predicting aesthetics and performance and evaluation of fabric quality. (10)

**Total L: 45**

**REFERENCES:**

1. Philip Kotler and Kevin Keller, "Marketing Management", Prentice Hall Inc., New Delhi, 2011.
2. Ruth E Glock and Grace I Kunz, "Apparel Manufacturing – Sewn Product Analysis", Prentice Hall, New Jersey, 2004.
3. Philip Kolter, Kevin Lane Keller, Abraham Koshy and Mithileshwar Jha, "Marketing Management – A South Asian Perspective", Pearson Education India, New Delhi, 2011.
4. Easey M, "Fashion Marketing", Blackwell Science, Oxford, 2009.

**15TT38 HOME TEXTILES**

**3 0 0 3**

**INTRODUCTION TO TEXTILE FURNISHINGS:** Definition - Different types of furnishings materials - Woven and non-woven - factors affecting selection of home furnishings. (6)



**HOME DECORATION:** Draperies – Choice of fabrics – Calculating the amount of material needed – Different types of doors and windows – Their applications - Curtains – Types of curtains. Method of finishing draperies – Tucks or pleats. Uses of drapery rods, hooks, tape rings and pins. (9)

**FLOOR COVERINGS:** Hard floor and wall coverings, resilient floor coverings, soft floor coverings, rugs, cushion and pads - Use and care. Living Room Furnishings: Sofa covers – Wall hangers - Cushion – Cushion covers – Upholsteries – Bolster and bolster covers. (8)

**BED LINENS:** Definitions – Different types of bed linen – Sheets – Blankets – Blanket covers – Comforts – Comfort covers – Bed spreads – Mattress and mattress covers – Pads – Pillows and pillow covers – Their uses and care. (7)

**KITCHEN AND DINING TEXTILES:** Definitions – Types of kitchen linens – Dish cloth – Hand towels - Fridge cover – Fridge handle cover – Mixie cover – Grinder cover – Their use and care. Cleaning materials – wipes and mobs. **Dining** - Placemats – Table cloth – Hand towels – Selection – Use and care. (8)

**BATH LINEN:** Towels – types, selection use and care, Mats and Rugs – types and its uses. **TESTING** : Fastness - Wash, Light , Rub. Tearing-Strength-Pilling, Abrasion, Tensile. (7)

**Total L: 45**

**REFERENCES:**

1. Alexander N G, "Designing Interior Environment", Mass Court Brace Covanorich Inc., New York, 1996.
2. Charles Randall and Sharon Templeton, "Dream Windows", Randall International, California 2003.
3. Wendy Baker, "Curtain and Fabric selector", Collins and Brown, London, 2000.
4. Cheryl Mendelson, "Home Comforts: The Art and Science of Keeping House", Published by Scribner, New York, 2005.

### 15TT39 TEXTILE COMPOSITES

**3 0 0 3**

**COMPOSITES BASICS:** Composites-Classification, Constituents- reinforcement, matrix, interface, Critical fibre length, Rule of mixtures.application of composites (4)

**CONSTITUENT MATERIALS:** Types and Properties of reinforcements, Matrix Materials. Interface - mechanisms and theories. Prepregs: Introduction - Manufacturing techniques - property requirements, Compaction. **Textile Preforms**– weaving, knitting and braiding. Multi-axial multiply non-crimp fabrics. (10)

**COMPOSITES MANUFACTURING:** Hand layup,Vacuum Bag moulding, Compression moulding, filament winding , vacuum forming, Resin transfer moulding, Pultrusion, Injection moulding, selection criterion. Manufacturing with thermosets and thermoplastics. (9)

**CHARACTERISTICS OF COMPOSITES:** Micromechanical Analysis – Volume and Mass fraction, Density and Void content, Evaluation of elastic moduli, Tensile, shear, compression, flexural, torsion, toughness, Interlaminar fracture Failure and Fracture mode in fibre composites. Inplane shear characteristics of textile reinforcements. (10)

**POLYMER-BASED AND POLYMER-FILLED NANOCOMPOSITES:** Nanoscale Fillers – Nanofiber, Nanotube Fillers, Carbon Nanotubes. Inorganic /inorganic FillerPolymer Interfaces. Processing of Polymer Nanocomposites, Properties of nanoComposites. (6)

**MODELLING:**The Need For Modeling, Flow through porous media, Liquid injection molding simulation. Modeling of Nanocomposites: Current Conceptual Frameworks, Multiscale Modeling, Multiphysics Aspects, Validation. (6)

**Total L: 45**

**REFERENCES:**

1. Peters S T, "Handbook of composites", Chapman & Hall, London, 1998,
2. Long A C, "Design and Manufacture of Textile Composites", Woodhead publishing Ltd, London, 2005.
3. Jang-Kyo Kim and Yiu-Wing Mai, "Engineered Interfaces in Fiber Reinforced Composites", Elsevier India, 1998,
4. Liyong Tong Adrian P Mouritz and Michael K Bannister, "3D Fibre Reinforced Polymer Composites", Elsevier Science Ltd, India, 2002,
5. Autar K Kaw, "Mechanics of Composite Materials", CRC Press LLC, New york 1997.
6. Rakesh K Gupta, Elliot Kennel and Kwang-Jea Kim, "Polymer Nanocomposites Handbook", CRC Press Taylor & Francis, New York, 2010.

### 15TT40 FILTERS AND FILTRATION TEXTILES

**3 0 0 3**

**BASIC PRINCIPLES:** Filtration and Separation, Contaminants, Surface and Depth Filtration. Filter Ratings and Filter Test, Dust collection – Theory and Principles, Practical implications, cleaning mechanisms Fabric design and selection considerations. **Filter**

**Media:** Introduction, Absorbent, Adsorbent and Biological Filter Media, Paper and Fabrics, Woven Wire and Screens, Constructed Filter Cartridges, Membranes, Packed Beds. Types of Filters. (9)

**TEXTILE FILTERS & FINISHING TREATMENTS:** Fabric construction (woven fabrics, needlefelts, knitted fabrics), Heat Setting, Singeing, Raising, Calendaring, Chemical Treatments, Special Surface Treatments. (6)

**LIQUID AND OIL FILTRATION:** Water filters, Waste Water Treatments, Surface Treatment Chemicals. Oil and Hydraulic Systems: Engine filters, Oil-water separators, Oil cleaning and Hydraulic Systems. Gas filtration. Introduction, Engine Filters, Oil-water Separators, Oil Cleaning, Hydraulic Systems. (8)

**TEXTILE FILTER IN SOLID-LIQUID SEPARATION** – Introduction, Fabric Design/Selection Consideration, Filtration Equipment Considerations. Yarn types and fabric constructions - Monofilaments, Multifilaments, Fibrillated tape ('split film') yarns, staple-fibre yarns, Yarn combinations. Fabric constructions and properties - Plain weave, Twill weaves, Satin weaves, Duplex and semiduplex weaves, Link fabrics, Needlefelts. (8)

**GAS FILTRATION:** Introduction, Indoor Air Quality, Fume and Vapour Emissions, Dust Collectors, Machine Air Intake Filters, Vehicle Cabin Filters, Compressed Air Filtration, Pneumatic Systems, Sterile Air and Gas Filters, Respiratory Air Filters. (7)

**FABRIC TEST PROCEDURES:** General quality control test, Performance related test, **Filter Selection:** Filter Selection, Reference Standards. (7)

**Total L: 45**

**REFERENCES:**

1. Horrocks A R and Anand S C, "Handbook of Technical Textiles", Woodhead publication and Textile Institute, England, 2000.
2. Ken Sutherland, "Filters and Filtration Handbook", Butterworth-Heinemann, Elsevier, Burlington, 2008.

## 15TT41 BIOMECHANICAL ENGINEERING OF FUNCTIONAL TEXTILES

**3 0 0 3**

**TEXTILE BIOMECHANICAL ENGINEERING:** Background, Biomechanical engineering design, Functional and fashion products, Fundamental frameworks in clothing, biomechanical engineering, Clothing biomechanical engineering design system: an example. (9)

**THEORETICAL BACKGROUND:** Fiber mechanics, Yarn mechanics, Fabric mechanics, Clothing mechanics, The human body, Mechanics of the human skin and underlying, Contact mechanics in wearing garments, Clothing comfort and compression therapy, Pressure comfort measurements. (9)

**MATERIAL PROPERTIES:** Fibers, Yarns, Fabrics, Human skin and underlying soft tissue - Biomechanical testing of human skin, Frictional properties of human skin. (9)

**APPLICATIONS IN PRODUCT DEVELOPMENT:** Biomechanical engineering of jeans, Sports bra, Compression stockings, Socks, Biomechanical engineering of footwear and aerobic sportswear. (9)

**ERGONOMICS:** Introduction, Ergonomic for clothing industry, Ergonomics for designing and engineering of functional clothing, Ergonomics and Comfort in Functional, Protective and Sport Clothing, Ergonomic challenges in conventional and advanced apparel manufacturing, Computer-aided clothing ergonomic design for thermal comfort. (9)

**Total L: 45**

**REFERENCES:**

1. Li Y and Dai X Q, "Biomechanical Engineering of Textiles and Clothing", Woodhead Publishers, The Textile Institute, England, 2006.
2. Jennifer Gunning, "Ergonomic Handbook for the Clothing Industry", Union of Needletrades, Industrial and Textile Employees, UK, 2001
3. Li Y, "The Science of Clothing Comfort", Textile Progress, 31(1/2), 2001 p. 1-138, 2002
4. Li Y and Zhang X, "Mechanical Sensory Engineering Design of Textile and Apparel Products", Journal of the Textile Institute, 93(2), p. 56-75.
5. Nakahashi, M, "Effect of Clothing Pressure on Front and Back of Lower Leg on Compressive Feeling", in Journal of the Japan Research Association for Textile End-Uses, p. 661-668, 1999.

## 15TT42 COATED TEXTILES

**3 0 0 3**

**POLYMERIC MATERIALS FOR COATING:** Natural Latex & Synthetic Rubbers, Synthetic Polymers: Polyurethanes, Poly (Vinyl Chloride), Polyacrylate Elastomers, Silicone Elastomers, Poly (Tetrafluoroethylene), Polyethylene, Chlorinated and Chlorosulphonated Polyethylenes, Foams for Laminates. **TEXTILE SUBSTRATE FOR COATED FABRICS:** Fibers, Yarn, Woven & Knitted Fabrics, Non-wovens, Fabric Preparation for Coating. (9)

**COATING METHODS:** Knife coating, Roll coating, Dip coating, Transfer coating, Gravure Coating, Rotary screen printing, Calendaring, Hot melt coating, Foam coating, Lamination by adhesives, Welding. (6)

**BREATHABLE LIQUID PROOF AND VAPOUR PERMEABLE COATED FABRICS:** Breathable textiles, Methods of making breathable textiles, Physiological Aspects, Types of Waterproof/Vapour, Permeable Fabrics, Microporous Coatings and Films, (Poromerics), Hydrophilic Coatings, Smart temperature responsive breathable coatings. (6)

**NONAPPAREL COATING:** Synthetic Leather, Architectural Textiles, Fluid Containers, Tarpaulins, Automotive Applications, Carpet Backing, Flocking, Fusible Interlinings. (9)

**COATING WITH FUNCTIONAL MATERIALS:** Thermochromic fabrics, Temperature adaptable fabrics, Fabrics for chemical protection, Camouflage nets, High visibility garments, Intumescent coating, Metal and conducting polymer coated fabrics, Coating with hydrogel and shape memory polymers. (9)

**TESTING OF COATED TEXTILES:** Tensile strength, Elongation, Adhesion, Tear Resistance, Weathering behavior, Microbiological degradation, Yellowing, Testing Standards. (6)

**Total L: 45**

**REFERENCES:**

1. Walter Fung, "Coated and Laminated Textiles", Woodhead Publishing Ltd, UK, 2002.
2. Carr C M, "Chemistry of the Textile Industry", Blackie Academic & Professional, UK, 1995.
3. Smith W C, "Smart textile Coatings and Laminates", Woodhead Publishing Ltd, UK, 2010.
4. Brown P J and Stevens K, "Nanofibers and Nanotechnology in Textiles", Woodhead Publishing Ltd, UK, 2007.
5. Ashish Kumar Sen, "Coated Textiles: Principles and Applications", CRC Press, New York 2008.

## 15TT43 FINANCIAL MANAGEMENT

**2 2 0 3**

**GOALS AND FUNCTIONS OF FINANCE:** Textile costing-Elements of costing-Material cost, labour cost and expenses. Methods of costing cost system, costing of yarn, cloth and garment. (6+6)

**INVESTMENT APPRAISAL:** Payback period method, Accounting rate of return-Introduction to discounting and cash flows estimation, DCF methods-IRR,NPV, PI. Discounted payback methods-concept , causes and methods of depreciation. (6+6)

**COST OF CAPITAL:** Equity, debt, convertible debentures, preference share capital, capital structure, dividend policy, short, intermediate and long term financing. (6+6)

**WORKING CAPITAL MANAGEMENT:** Management of liquidity and current assets, estimation of working capital requirements for spinning mill, composite textile mill and garment unit, management of cash and marketable securities. (6+6)

**TOOLS OF FINANCIAL ANALYSIS AND CONTROL:** Trading, profit and loss account, balance sheet, financial ratio analysis, fund flow analysis and financial forecasting. Analysis of operating and financial leverage-Illustrations for spinning, weaving , garment and composite industry. (6+6)

**Total L: 60**

**REFERENCES:**

1. Varma H K, "Costing in Textile Industry", Dhanpat Rai publications, New Delhi,1965.
2. Maheswari S N, "Fundamentals of Cost Accounting", Sultan Chand & Sons, New Delhi 2011.
3. Pandey I M, "Financial management", Vikas Publishing House PVT Ltd, New Delhi, 1999.
4. Thukaram Rao M E, "Cost and management accounting", New Age International, Bangalore, Karnataka, 2004.
5. Hrishikes Bhattacharya, "Working capital management-Strategies and Techniques", Prentice Hall of India Pvt Ltd, New Delhi, 2001.

## 15TT44 INDUSTRIAL ENGINEERING

**2 2 0 3**

**INTRODUCTION:** Concept of Industrial Engineering – Scope of Industrial Engineering in Textile Industry – Industrial Engineering Techniques – Role of Industrial Engineer. Production, productivity. Productivity analysis and causes for low productivity – Spinning – weaving – Processing – Garment Industry. (6+6)

**WORK STUDY:** Method study and Work Measurement – Importance, Procedure ,method of conducting study. Principles of motion economy. Motion study Therbling, SIMO chart, Left hand & right hand chart, flow diagram,flow chart,string diagram,process flow,multiple activity chart. Work Measurement-Techniques of work measurement, Time study-time study equipments, steps in

conducting time study, scale of rating, basic time, allowances and standard time. PTMS,MTM .Case studies in textile and apparel industries. (7+6)

**STANDARD MINUTE VALUE:** Definition – calculation of SMV. Difference between SMV and SAM. Operation breakdown – Work in progress – Pitch time – Calculations of SAM value for various textile industry types. Softwares for SAM calculation. Assessment of work force requirement. Line balancing. (5+6)

**LEAN MANUFACTURING:** Definition – Concept – Kanban system – Implementation method. **Six Sigma:** Definition – concept – Quality Policy – Quality circle – Levels – Implementation. 5S Concept. Kaizen : Concept – Procedure – Implementation. (5+6)

**LAYOUT:** Planning – types of layout - Selection of layout. **Work environment:** Lighting. Ventilation. Climatic Condition – Temperature Control and Humidity Control. Noise Control, Safety, Ergonomics. Services- Stores, Health, Feeding and Convenience related services. **Material Handling:** Descriptions and characteristics of material handling equipments. Specialized material handling equipments related to Textile and Apparel industries. (5+6)

**Total : 60**

#### REFERENCES:

1. Jacob Solinger, "Apparel Manufacturing Hand Book - Analysis, Principles and Practice", Boblin Media Corp, Columbia, 1991.
2. ILO and Geneva, "Introduction to Work Study", Universal Publishing Corporation, Mumbai,2006.
3. Dudeja V D,"Management of Textile Industry", Textile Trade Press, Ahmedabad,1981.
4. International Labour Organisation, "Work study in the Textile Industry", ILO Geneva,1972.
5. Khanna O P, "Industrial Engineering & Management", Dhanpat Rai & sons, Delhi, 2004.
6. Rajesh Bheda, "Managing Productivity of Apparel industry", CBS Publishers and Distributors, New Delhi 2002.

### 15TT45 PROJECT FORMULATION AND APPRAISAL

**3 0 0 3**

**PROJECT CYCLE:** Phases of project cycle identification, preparation evaluation, documentation & Supervision. Various functions in project cycle - Technical, commercial, financial, economic, managerial. (10)

**PROJECT FORMULATION AND APPRAISAL:** Appraisal concept, Need for appraisal, Methodology, Various aspects - market, management, technical, financial and economic, Key financial indicators in appraisal, Investment decision from appraisal report, Post-project appraisal. (10)

**EVALUATION OF TECHNOLOGICAL CONTENT OF TEXTILE PROJECTS:** The choice of Technology and their assessment, operating constraint, appropriateness of technology, factors influencing selection, various aspects of technology transfer. Project Utilities and Environmental. (12)

**COSTING:** Cost Concepts: Direct/indirect, Fixed/ variable, Total cost. Inventory costing: FIFO, LIFO, Weighted average methods. System of costing : Job, order, batch, process, unit & operating cost joint & byproduct. Cost Standards in Textiles : Cost structure in textile industry, Cost of raw material/labour/utilities. Cost Control: Standard costs, variance analysis, determination of cost per kg of yarn, per kg (metre) of fabric, measures for cost reduction, selling price decision for yarn/ fabric. Profit planning : Cost volume - profit analysis, Break Even point. Budgeting, Definition, purpose, types. (13)

**Total L: 45**

#### REFERENCES:

1. Albert Lester, "Project Management-Planning and Control", Elsevier Publication, UK,2012.
2. Prasanna Chandra, "Projects preparation ,appraisal, budgeting and implementation", Tata Mc Graw hill publishing, New Delhi,1993.
3. Ormerod A, "Textile Project Management", The Textile Institute, Manchester, 1992.
4. Varma H K, "Costing in Textile Industry", Prentice Hall Inc., 1992.
5. Maheswari S N, "Fundamentals of Cost Accounting", Sultan Chand & Sons, New Delhi 2011.

### 15TT46 ELECTRO - ACTIVE TEXTILES

**3 0 0 3**

**INTRODUCTION:** Electric conductivity, metal conductors, ionic conductors, Inherently conducting polymers. (5)

**CONDUCTIVE YARNS AND FABRICS:** Electro spinning process, process variables, formation of yarns & fabrics. Electro active nano fibres & fabrics, nano composites. (8)

**CONDUCTING TEXTILE PREPARATION TECHNIQUES:** Extrusion, solution coating, In-Situ polymerization. Electrochemical polymerization. Integration of fibre optic sensors and sensing networks. (8)

**TESTING & CHARACTERIZATION:** Electrical and Electromechanical characterization, surface resistance, EMI shielding efficiency, morphological Characterisation, Environmental effects. Electroactive fabrics and wearable man-machine Interfaces. (12)

**TEXTILE SENSORS:** Bio-medical sensors, actuators, wearable bio-feed back systems, motion capture, communication textiles, display of ornamental applications. Textile strain sensors, ECG Electrodes. (12)

**Total L: 45**

**REFERENCES:**

1. Mattila H R, "Intelligent Textiles and Clothing", The Textile Institute, CRC press, New York, & Washington, Woodhead publishing Ltd., England, 2006.
2. Xiaoming T, "Wearable Electronics and Photonics", The Textile Institute, Woodhead publishing Ltd., England, 2005.
3. Langenhove L V, "Smart textiles for medicine and healthcare", Textile Institute & CRC press, Woodhead publishing Ltd., England, 2007.

### 15TT47 RESEARCH METHODOLOGY

**3 0 0 3**

**RESEARCH OBJECTIVES & APPROACHES:** Literature review- data bases and search engines. (6)

**DEFINING RESEARCH PROBLEM:** Research Design- Formulation of Hypothesis (6)

**MEASUREMENT AND SCALING TECHNIQUES:** Data collection & Processing of data for research type studies (6)

**STATISTICAL TEST METHODS:** Testing of Hypothesis - Parametric and Non-parametric methods- Analysis of variance – Multivariate analysis techniques (7)

**OPTIMISATION TECHNIQUES:** Optimisation by steepest ascent – multicriterion Optimisation- variables, constraints and objective functions – desirability function . (7)  
Selection and use of measurement techniques- data acquisition and analysis (6)

**INTERPRETATION OF RESULTS:** Neural Network for data analysis (7)

**Total L: 45**

**REFERENCES:**

1. Kothari C R, "Research Methodology – Methods and Techniques" , New Age International, New Delhi, 2009.
2. Douglas C Montgomery, "Design and analysis of experiments", John Wiley and Sons, India, 2012.
3. Doebelin E O, "Measurement systems - Application and Design", McGraw-Hill, 1986.
4. Douglas C Montgomery and Runger George C, "Applied Statistics & Probability for Engineers", John Wiley and Sons, India, 2007.

### 15TT48 RECYCLING IN TEXTILES

**3 0 0 3**

**INTRODUCTION:** Systems theory. Importance of textile and apparel recycling process. Sorting process. The pyramid model. Textile recycling constituents. Life cycle of textile products. (5)

**RECYCLING ISSUES AND TECHNOLOGY:** Designing of easily recyclable textile products. Systems planning for carpet recycling. Carpet recycling technologies. (7)

**CHEMICAL ASPECTS IN RECYCLING:** Recycling waste water from textile production. Recycling and reuse of textile chemicals. (9)

**REUSE OF POLYMER AND FIBRE WASTE :** Introduction. Utilisation of PET waste. Recovery from Nylon 6 waste. Nylon 66 yarn waste. Polypropylene yarn waste. Acrylic waste. (9)

**RECYCLED TEXTILE PRODUCTS:** Development of products made of reclaimed fibres. Manufacturing nonwovens and other products using recycled fibres containing spandex. Textile products produced from alternative fibres. Recycling of industrial fibres. Recycled products available in the market and their manufacturing methods. (8)

**APPLICATIONS OF RECYCLED TEXTILES:** Recycling of textile used in operating theater. Composite products from post-consumer carpet. Utilization of recycled carpet waste fibres for reinforcement of concrete and soil. (7)

**Total L: 45**

**REFERENCES:**

1. Youjiang Wang, "Recycling in Textiles", Woodhead Publishing Limited, Cambridge 2006.
2. Sabit Adanur, "Wellington Sears Handbook of Industrial Textiles", Technomic Publications Co. Inc., Lancaster, 2006.
3. Miraftab M and Horrocks R, "Eco-Textiles", Woodhead Publishing Limited, Cambridge 2007.
4. Gupta V B and Kothari V K, "Manufactured Fibre Technology", Chapman & Hall, London, 1997.

## 15TT49 CONTROL SYSTEMS AND AUTOMATION IN TEXTILE ENGINEERING

3 0 0 3

**INSTRUMENTATION AND TRANSDUCERS:** Functional Description of Instruments; Types and applications of Instrumentation - Generalized configuration - Tribo electric pick-up, Infrared Transducers - Torque measurement Elastic transducers - sound level meter - vibration measurements.

(7)

**CONTROL SYSTEM COMPONENTS:** Basics of control system – Control system examples - Stepper motors - Hydraulic valves - Pneumatic switches, proximity switches and flapper valves - Hydraulic and Pneumatic automation in textile machines -Simple sequential logic circuit design - Programmable Logic Controllers (PLC), Block diagram – programming methods – programs – applications.

(8)

**INDUSTRIAL AUTOMATION:** Introduction, integration, material handling system, simple systems for motions by electrical and mechanical devices, Mechanical design for automatic feeding assembly and transfer lines.

(7)

**ELECTRONIC TEXTILE INSTRUMENTS:** Electronic principles in evenness tester, classification of faults, digital fibrograph, hairiness meter, Vibroscope - thickness measuring instruments – HVI, Universal tensile testers.

(7)

**CONTROL SYSTEM AND AUTOMATION IN SPINNING MACHINERY:** Machinery material flow and its variation controls – Feeders & Stop motions – Auto levelers – safety switches. Production and quality monitors – Full doff and pre-set length monitors. Data acquisition system for spinning preparatory, ring spinning - rotor spinning

(8)

**CONTROL SYSTEM AND AUTOMATION IN WEAVING MACHINERY:** Yarn clearer controls - knotter /splicer carriage controls - pre-set length/full cone monitors. Warping machine monitors and controls - sizing machine monitors and controls - auto-reaching/drawing-in and knotting machine monitors and controls. Data acquisition system in weaving preparatory and weaving – humidification system.

(8)

**Total L:45**

### REFERENCES:

1. Berkstresser G A, Buchanan D R and Grady P, "Automation in the Textile Industry from Fibres to Apparel", The Textile Institute, UK, 1995.
2. Textiles Go On-line, The Textile Institute, UK, 1996.
3. Vassiliadis S G, "Automation and the Textile Industry", Eurotex, 1996.
4. Ormerod A, "Modern Development in Spinning and Weaving Machinery", Butterworths, 1993.
5. Gordon A Berkstresser III et.al, "Automation and Robotics in the Textile and Apparel Industries", Noyers Publication Park Ridge, 1996.
6. Nalura B C, "Theory and Applications of Automatic Controls", New Age International (P) Ltd Pub, 1998.

## 15TT50 MEDICAL TEXTILES

3 0 0 3

**INTRODUCTION TO MEDICAL TEXTILES:** Definition, classification, market overview and growth projections of medical textiles. Requirements from medical textiles. Application areas of textiles in medical field.

(7)

**WOUND CARE PRODUCTS:** Wounds-Categorization of wounds, wound healing mechanism and factors affecting wound healing. Antimicrobial Wound Dressings. Wound dressings- Functional requirements, Different types of wound dressings, materials used, design aspects and utility. Test methods for wound dressings.

(8)

**BANDAGES:** Different types of bandages and its use. Material characteristics. Textile processes involved in the formation of dressings and bandages.

(7)

**IMPLANTABLE DEVICES:** Sutures-Definition, Classification based on origin, physical configuration and absorbability. Physical, handling and biological characteristics of sutures. Application areas of sutures. Antimicrobial Sutures. Barbed bidirectional sutures. Evaluation and standards. Vascular grafts, artificial ligaments, artificial stents and scaffold for tissue engineering-Functional requirements, materials used and design procedure of these products.

(8)

**HEALTHCARE AND HYGIENE PRODUCTS:** Surgical Gowns - Basic considerations. Thermal properties, breathability and air permeability characteristics. Material characteristics. Fabric type and Design aspects. Recent developments - New fibers and coated textiles. Testing and standards. Face masks - Basic considerations. Filtration mechanism, breathability and air permeability characteristics. Material characteristics. Fabric type and Design aspects. Recent developments -New fibers and coated textiles. Testing and standards.

(8)

**OTHER MEDICAL TEXTILES PRODUCTS:** Surgical drapes, beddings, Wipes and Diapers-Functional requirements, material characteristics and design procedure. Evaluation and standards. (7)

Total L: 45

**TEXT BOOKS:**

1. Bartels V, "Handbook of Medical Textiles", Wood head publishing Ltd, Cambridge, UK, 2011
2. Rajendran S, "Advanced Textiles for Wound Care", Wood head publishing Ltd, Cambridge, UK, 2009.

**REFERENCE:**

1. McCarthy B J, "Textiles for Hygiene and Infection Control" Wood head publishing Ltd, Cambridge UK, 2011.

## 15TT81 ACOUSTIC AND POROUS SOUND ABSORPTION MATERIALS

3 0 0 3

**BASICS OF ACOUSTICS:** Speed of Sound, Wavelength, Frequency, and Wave Number. Acoustic Pressure and Particle Velocity, Acoustic Intensity and Acoustic Energy Density, Spherical Waves, Directivity Factor and Directivity Index. **Acoustic Measurements:** Sound Level Meters, Intensity Level Meters, Octave Band Filters, Acoustic Analyzers, Dosimeter; Measurement of Sound Power, Noise Measurement Procedures, Acoustic Measurement Standards, Commercial Instruments – Alpha Cabin (Rieter) and the Recents (8)

**TRANSMISSION OF SOUND:** The Wave Equation, Wave Equation Solution, Changes in Media, Sound Transmission Through a Wall; Transmission Loss for Walls, Approximate Method for Estimating the TL, Transmission Loss for Composite Walls, Sound Transmission Class, Absorption of Sound, Attenuation Coefficient. (7)

**ROOM ACOUSTICS:** Surface Absorption Coefficient, Steady-State Sound Level in a Room, Reverberation Time; Effect of Energy Absorption in the Air, Noise from an Adjacent Room, Acoustic Enclosures, Acoustic Barriers. (8)

**CONTROL OF INTERFERING NOISE:** Noise Sources and Some Solutions, Sound Transmission Classification (STC), Comparison of Wall Structures, Double Windows; Sound-Insulating Doors - Noise and room resonances, Active noise control. (7)

**ABSORPTION OF SOUND:** Dissipation, Absorption, Reverberation Chamber and Impedance Tube Method, Mounting of Absorbers, Mid/High Frequency Absorption by Porosity, Effects of Thickness, Airspace behind and density of Absorbent; Open-Cell Foams, Drapes as Sound Absorbers, Carpet as Sound Absorber, Sound Absorption by People, Absorption of Sound in Air, Low-Frequency Absorption by Resonance, Diaphragmatic Absorbers, Polycylindrical Absorbers, Poly Construction, Membrane Absorbers, Helmholtz Resonators, Perforated Panel Absorbers, Slat Absorbers, Placement of Materials, Reverberation Time of Helmholtz Resonators, Increasing Reverberation Time, Modules. (8)

**TEXTILES AND POROUS MATERIALS FOR ACOUSTICS:** Natural and Synthetic Fibres and Porous Materials; Material Properties and Biot Parameters – Modulus, Tortuosity, Visco-elasticity, Thermal characteristics, Cyclic properties, stress-strain energy properties; Structure Properties – Porosity, Pores Shape Factor, Air Flow Resistance (AFR), Tortuosity. Forms of Textiles - Nonwoven Structures, Woven and Knitted Structures, Fibrous pads; Design and development of textile structures meeting the acoustic criteria and case studies. (7)

Total L: 45

**REFERENCES:**

1. Randall F. Barron, "Industrial Noise Control and Acoustics", Marcel Dekker, Inc. New York, 2003.
2. F. Alton Everest, Master Handbook of Acoustics, 4<sup>th</sup> edition, McGraw-Hill, New York San Francisco Washington, 2001.
3. Horrocks A R and Anand S C, "Handbook of Technical Textiles", Woodhead publication and Textile Institute, England, 2000.

## 15TT82 SMART MATERIALS FOR INTELLIGENT TEXTILES

3 0 0 3

**STIMULI RESPONSIVE POLYMERIC MATERIALS:** Cross-linked polyol fibrous substrates as multifunctional and multi-use intelligent materials, Stimuli-responsive interpenetrating polymer network hydrogels composed of poly(vinyl alcohol) and poly(acrylic acid), Permeation control through stimuli-responsive polymer membrane, Tailor-made intelligent polymers for biomedical applications. (8)

**SHAPE MEMORY POLYMER:** Chemically Crosslinked Shape Memory Polymers, Physically Crosslinked Shape Memory Polymers, Biodegradable SMP, SMP Composite; Application of SMP - Medical Devices, Clothing, Aerospace Engineering. (7)

**STIMULI RESPONSIVE NON-POLYMERIC MATERIALS:** Phase Change Materials (PCMs) – Organic and Inorganic Type for Heat-storage and thermo-regulative textiles, Chromic Materials – Thermochromic, Photochromic, Electrochromic, Solvatochromic Materials, Nanomaterials – strain thickening fluids (STFs), Self-decontaminating materials for chemical biological protective clothing. (8)

**CONDUCTIVE MATERIALS:** Assembly of Polypyrroles, Properties of Polypyrroles, Synthesis of Polyanilines and their properties, Metallic Wires for Conductive yarns, Conductive Polymers through Additives. Electrically active polymer materials – application of non-ionic polymer gel and elastomers for artificial muscles. (7)

**INTELLIGENT TEXTILES APPLICATIONS:** Camouflage fabrics for military protective clothing, Smart wound-care materials, Textile-based drug release systems, Application of phase change for thermoregulation applications, PCMs and shape memory materials in medical textiles, Smart dyes for medical and other textiles, Intelligent textiles for children, Wearable biofeedback systems, Applications for woven electrical fabrics, Flexible displays on Textiles for Personal Protection. STFs for Impact Applications. (8)

**WEARABLE ELECTRONICS AND SENSOR APPLICATIONS:** Wearable Electronics, Wearable technology for snow clothing Wearable Motherboard, Wearable textiles for rehabilitation of disabled patients using pneumatic systems, Fibre optic sensors, Fiber Bragg grating (FBG) sensors, Textile sensors - healthcare, monitoring pregnancy and patients with heart conditions Conductivity Based Sensors for Protection and Healthcare Optical Chemical Sensors and Personal Protection. (7)

**Total L: 45**

**REFERENCES:**

1. L.Van Langenhove, "Smart Textiles for Medicine and healthcare, Materials, Systems and Applications", Woodhead Publishing Limited, Cambridge, England, 2007.
2. Xiaoming Tao, "Smart fibres, fabrics and clothing", Woodhead Publishing Limited, Cambridge, England, 2007.
3. Gilsoo Cho, "Smart Clothing Technology and Applications", CRC Press Taylor & Francis Group, US, 2010.
4. Mattila H. R., "Intelligent textiles and clothing", CRC Press, Boca Raton Boston New York Washington, DC Woodhead Publishing Limited, Cambridge, England, 2006.
5. Eugene Wilusz, "Military textiles", CRC Press, Boca Raton Boston New York Washington, DC Woodhead Publishing Limited, Cambridge, England, 2008.
6. Sundaresan Jayaraman, Paul Kiekens, Ana Marija Grancaric, "Intelligent Textiles for Personal Protection and Safety", IOS Press, Amsterdam, 2006.
7. Gordon G. Wallace, Geoffrey M. Spinks, Leon A. P. Kane-Maguire, Peter R. Teasdale, "Conductive Electroactive Polymers Intelligent Polymer Systems", CRC Press, Boca Raton Boston New York Washington, DC Woodhead Publishing Limited, Cambridge, England, 2009.

**ONE CREDIT COURSES**

**15TK01 GEOSYNTHETICS**

**1 0 0 1**

**OVERVIEW:** Geosynthetics; Designing with geotextiles: Geotextile properties, test methods and construction and design methods. (4)

**GEOGRIDS:** Geogrid properties and test methods and design; Designing with geonets – Geonet properties and test methods and designing with geonet. (4)

**DESIGNING WITH GEOMEMBRANES:** Geomembrane properties and applications; Designing with geocomposites – Geocomposites in separation, reinforcement, filtration and drainage. (7)

**Total L: 15**

**REFERENCES:**

1. Babu Sivakumar, "Introduction to Soil Reinforcement and Geosynthetics", Univ. Press, Hyderabad, 2004.
2. Koerner, R M, "Designing with Geosynthetics", Pearson Education Inc., New Delhi, 2005.
3. Rao G V, "Geosynthetics", An Introduction, Sai Master Geoenvironmental Services Pvt. Ltd., Hyderabad, 2011.
4. Shukla, "Fundamentals of Geosynthetic Engg.", Imperial College Press, London, 2006.

**15TK02 FIBRE REINFORCED CONCRETE**

**1 0 0 1**

**BASICS OF MATERIALS:** Cement, Sand, Aggregates & Admixtures, Fresh Concrete, Hardening of Concrete, Durability of Concrete & Testing. (4)

**POLYMER & PRE-FORM:** Properties, High Performance Polymers and Fibres, Pre-forms preparations. (3)



**FIBRE REINFORCED CONCRETES (FRC):** Fibre –Matrix Interactions in the freshly mixed state and in the hardened state, Composite behavior under load, Materials, mixture proportioning and manufacture, Properties and applications of FRC. (8)

**Total L: 15**

**REFERENCES:**

1. Shetty M S, "Concrete Technology", S.Chand & Co. Ltd, New Delhi, 2003.
2. Santhakumar A R, "Concrete Technology", Oxford University Press., New Delhi, 2007.
3. Hearle J W S, "High Performance Fibres", Woodhead Publishing, Cambridge, England, 2001.
4. Colin D Johnston, "Fibre Reinforced Cements and Concretos – Advances in Concrete Technology Vol.3", Cordon and Breach Science Publishers, Taylor & Francis, 2010.

### 15TK03 IE TECHNIQUES

**1 0 0 1**

**WORK STUDY:** Definition, purpose, techniques of work study. Procedure of work study. Method study-steps in conducting method study, principles of motion economy. (5)

**MOTION STUDY:** Therbling, SIMO chart, Left hand & right hand chart, flow diagram, flow chart, string diagram, process flow, multiple activity chart. (5)

**WORK MEASUREMENT:** Techniques of work measurement, Time study-time study equipments, steps in conducting time study, scale of rating, basic time, allowances and standard time. PTMS, MTM .Case studies in textile and apparel industries. (5)

**Total L: 15**

**REFERENCES:**

1. Solinger Jacob, "Apparel Manufacturing Handbook-Analysis, Principles and Practice", Bobbin Blenheim Media Corp, South Carolina, USA, 1988.
2. ILO and Geneva, "Introduction to Work Study", Universal Publishing Corporation, Mumbai, 2006.

### 15TK04 TEXTILE AND APPAREL COSTING

**1 0 0 1**

**YARN COSTING:** Determination of Yarn cost – carded, combed. Determination of Yarn realization. Relation between yarn realization and yarn cost. Yarn cost with respect to parameters like count, ply and type of material. Yarn cost with respect to quality parameters and specifications. (5)

**FABRIC COSTING:** Determination of fabric cost per square meter – woven and knit (In grey stage & finished stage). Factors influencing fabric cost – woven and knit. Determination of GSM with respect to count and fabric parameters like ends per inch and picks per inch (for woven), course per inch, wales per inch and loop length (for knits). Relation between GSM and fabric cost. Costing of fabric with respect to weave structure. (5)

**GARMENT COSTING:** Determination of fabric requirement for a single garment. Determination of Garment cost without accessories and with accessories. Costing for different finishes and accessories. Determination of CM and CMT for a garment. Factors influencing garment cost. Cost for packaging and transport – local and international. Total Costing for an order sheet with example. Costing for an order with respect to quantity and style. (5)

**Total L:15**

**REFERENCE:**

1. Varma H K, "Costing in Textile Industry", Dhanpat Rai publications, New Delhi, 1965

### 15TK05 LEAN MANUFACTURING FOR TEXTILE AND APPAREL INDUSTRY

**1 0 0 1**

**INTRODUCTION TO LEAN MANUFACTURING:** Need for Lean manufacturing, Lean manufacturing model, systems and systems thinking, Muda and its types. (3)

**LEAN FOR TEXTILE & APPAREL INDUSTRY:** Visual Management, 5S, total productive maintenance, Small group activity, process flow diagram, establishing TAKT, Case studies. (4)

**JUST IN TIME (JIT):** Definition, Principles of JIT, Continuous Flow, Kanban, Value Stream Mapping, Current State VSM and Future state VSM, Poke – Yake. (4)

**LEAN INVOLVEMENT AND CULTURE:** Practical Kaizen Training, Key factors in Practical Kaizen Training, Lean Culture, Standardization, Standards and abnormality Control, 'Five Why' analysis. (4)

**Total L : 15**

**REFERENCES:**

1. Dennis P Hobbs, "Lean Manufacturing Implementation", Cengage learning India Pvt Ltd, New Delhi, 2004.
2. John Black, "Lean Production Implementing a World Class System", Industrial Press Inc, New York, 2008.
3. Askin G and Goldberg B, "Design and Analysis of Lean Production System", John Wiley & Sons, Singapore, 2003.
4. Bill Carrieva, "Lean Manufacturing That Works", Prentice Hall of India Pvt Ltd, New Delhi, 2007.

**15TK06 BUSINESS ACUMEN**

**1 0 0 1**

|   |     |
|---|-----|
| Understanding strategy formulation                    | (2) |
| Understanding the business to be run                  | (2) |
| Formulating a strategy for the company                | (2) |
| Understanding financial statements                    | (1) |
| Understanding customer perceived value and pricing    | (1) |
| Insights on cross-functional                          | (1) |
| Industry and competitor analysis                      | (1) |
| Strategic alliances and business negotiations         | (1) |
| Understanding strategic thinking and positioning      | (1) |
| Value chain analysis                                  | (1) |
| Comparing decisions and results                       | (1) |
| Case studies relevant to textile and apparel industry | (1) |

**Total L: 15**

**REFERENCE:**

1. Course materials prepared by the department of textile technology.

**ONE CREDIT COURSES**

**For the detailed syllabi of the electives and one credit courses offered by other departments refer to the syllabi of M.E- Automotive Engineering offered by Automobile Engineering Department.**