

SEMESTER – III

21TT71 PROJECT WORK – I vide Automotive Engineering 21AE71

SEMESTER – IV

21TT81 PROJECT WORK – II Vide Automotive Engineering 21AE81

PROFESSIONAL ELECTIVE THEORY COURSES (Four to be opted)

21TT11 CHARACTERIZATION OF TEXTILE POLYMERS

3 0 0 3

MOLECULAR CHARACTERIZATION: Molecular weight averages, Determination of molecular weight: primary methods – end group analysis, osmometry, light scattering. Secondary methods – viscometry, gel permeation chromatography. (11)

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. (11)

MICROSCOPY AND SPECTROSCOPIC CHARACTERIZATION: Microscopy analysis – Scanning electron microscopy, Transmission electron microscopy, Atomic Force Microscopy and Scanning Tunneling Microscope. Spectroscopy analysis – Infrared, NMR, UV-visible and Raman Spectroscopy techniques. (12)

ORIENTATION, CRYSTALLINITY CHARACTERIZATION AND OTHER METHODS: Birefringence, dielectric anisotropy, dichroism. Crystallinity characterization techniques – X-ray diffraction, density gradient measurement, Small angle x-ray scattering. Other methods: Fibre fineness, friction, crimp, spin finish content, viscosity, dye uniformity, bulkiness measurements. (11)

Total L:45

REFERENCES:

1. Mishra S P, "Fibre Structure", Wood head Publishing Limited, India, 2016.
2. Gupta V B and Kothari V K, "Manufactured Fibre Technology", Chapman & Hall Pub., England, 1997.
3. Mukhopadhyay S K, "Advances in Fibre Science", The Textile Institute, Manchester, 1992.
4. Billmeyer F W, "Textbook of Polymer Science", Wiley Inter Science, New York, 2002.
5. Billmeyer F W, "Textbook of Polymer Science", Wiley Inter Science, New York, 2002.

21TT12 NANOTECHNOLOGY IN TEXTILES

3 0 0 3

NANOFIBRE PRODUCTION: Emergence of Nanotechnology, Bottom-up and top-down approaches. 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, Applications of electrospun nanofibres. (12)

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, Graphene based fabrics and their applications. (11)

NANOPARTICLES: Preparation, characterization, and application of silver nanoparticles, Fe nanoparticles ZnO, TiO₂, MgO, SiO₂ & Al₂O₃ 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, Applications of nanoparticles in textiles. (12)

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. (10)

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.
5. Chavan R B and Radhakrishnan J, "Environmental Issues - Technology Options for Textile Industry", IIT Delhi Publication, 1998.

21TT13 HIGH PERFORMANCE AND SPECIALITY FIBRES

3 0 0 3

HIGH STRENGTH AND HIGH MODULUS FIBRES: Synthesis, Manufacture, Properties and Applications of Aramids, Aromatic Polyester, UHMWPE, PBO and other aromatic heterocyclic rigid rod polymers PBT, PIPD and Carbon Fibres. (11)

CHEMICAL AND THERMAL RESISTANT FIBRES: Synthesis, Manufacture, Properties and Applications of Glass Fibres, Ceramic Fibres, Aramid, Aramid, PBI, PEEK, PPS, PEI, Chlorinated and Fluorinated Fibres, PVDC, PTFE, PVF, PVDF and FEP. Reference to the other grade fibres. (12)

PHYSICALLY MODIFIED FIBRES: Synthesis, Manufacture, Properties and Applications of Hollow Fibres, Bicomponent Fibres, Multi Cross-Sectional Fibres, Micro and Nanofibres. (11)

FUNCTIONAL FIBRES: Optical Fibres, Elastomeric Fibres, Super Absorbent Fibres, Conductive Fibres, Luminescent Fibres and Biodegradable Fibres. (11)

Total L : 45

REFERENCES:

1. Hearle JWS, "High Performance Fibers", Textile Institute, CRC Press, London 2001.
2. Books on Google Play, Structure and Properties of High-Performance Fibers, Woodhead Publishing, UK, 2016.
3. Robert R Mather, Roger H Wardman The Chemistry of Textile Fibres, Second Edition, Royal Society of Chemistry, UK, 2015.
4. Mukhopadhyay S K, "High Performance fibres", Textile Progress Vol.25, Textile Institute, UK, 1993.
5. Menachan Lewis & Jack Preston, "High Technology Fibres", Part A,B, C& D, Mercebe Dekkar Inc, New York 1993.
6. Nakajima T, "Advanced fiber spinning Technology", Woodhead Publishing, UK, 1996.

21TT14 ALTERNATE SPINNING SYSTEMS

3 0 0 3

DEVELOPMENTS IN RING SPINNING: Condensed yarn spinning – Principles, Advantages, Disadvantages. Developments in drafting system, spindle, ring and traveller, 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. Solo spinning systems. (9)

OPEN - END SPINNING: Principle of open-end spinning. Rotor Spinning –mechanism of yarn formation, principles of operation. Requirements of the raw material. Design aspects of components and their influence on production and yarn quality - opening unit, rotor, transport tube, navel. Back doubling and production calculations. Yarn characteristics. Friction spinning: principle of operation, requirements of the raw material, classification, technological limitations, yarn characteristics. (13)

AIR-JET & AIR-VORTEX 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. Vortex spinning: Principle of airvortex spinning, Yarn structure, properties and end-uses. Comparison amongst various spinning systems- Count range, Production speed, Yarn structure and properties. (12)

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. Core yarn: Methods of yarn production. Production of core spun yarns in ring, rotor, friction and air jet spinning. Application of core spun yarns. (11)

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.4,5&6", Rieter Machine Works, Winterthur, 2014.
5. Grosberg P and Iype C, "Yarn Production – Theoretical Aspects", The Textile Institute, Manchester, 1999.

21TT15 PROCESS AND QUALITY CONTROL IN SPINNING AND WEAVING

3 0 0 3

CONTROL OF QUALITY IN FIBRE OPENING AND SPINNING PREPARTORY PROCESSES: Raw material selection and control: Cotton fibre selection and bale management techniques. Control of waste in blow room, card and comber. Influence of machine and process parameters on waste removal. Assessment of intensity of opening and cleaning. Control of Nep generation and fibre rupture in blow room. Improving the nep removal in carding and combing machines. (12)

YARN QUALITY: Control of count and its variation - within and between bobbin count variations. Strength variation – causes and control of strength variability in yarn. Principle of autolevellers and their influence on yarn count variation and evenness. Unevenness and imperfections – types of variation and imperfection control measures. Analysis and interpretation of diagram,

spectrogram and V- L curve. Control of yarn hairiness – influence of raw material, preparatory process and ring frame process parameters on yarn hairiness. (11)

WEAVING PREPARATORY AND LOOM SHED: Winding – assessment of quality of knots and splices, process parameters and its influence on quality and productivity. Pirn winding-improving build of the pirn. Warping- improving warp beam quality. Sizing – control of size pick-up, stretch, moisture and quality of beams. Loom shed – Improving loom efficiency and performance, relation between loom allocation and loom efficiency. (11)

PRODUCTIVITY ANALYSIS: Productivity indices. Control of end breaks in ring spinning, weaving preparatory and loom shed – influencing factors, Snap study. Role of machinery maintenance and humidity control on production efficiency; Yarn faults and package faults- classification, assessment, causes and remedies. HARD WASTE CONTROL- control of hard waste in winding, warping, sizing, drawing-in, pirn winding and loom shed. Analysis and control measures for woven and knitted fabric defects. (11)

Total L: 45

REFERENCES:

1. Thilagavathi, G & Karthik, T, "Process control and yarn quality in spinning", Woodhead Publishing India, New Delhi, 2015.
2. Paliwal M C and Kimothy P D, "Process Control in Weaving", ATIRA, Ahmedabad, 1983.
3. Garde A R and Subramanian T A, "Process Control in Spinning A TIRA., Ahmedabad, 1989.
4. Majumdar, Das, Alagirusamy, Kothari, "Process control in textile manufacturing", Woodhead Publishing, UK, 2012
5. Senthilkumar, R. "Process management in spinning", CRC press, Taylor & Francis Group, U.S, 2014.

21TT16 THEORY OF YARN AND FABRIC STRUCTURES

3 0 0 3

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. (12)

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. Analysis of tensile behavior of spun yarns. (11)

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. (11)

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. (11)

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.

21TT17 SPECIALITY TEXTILES

3 0 0 3

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, applications. (11)

TECHNICAL YARNS AND INDUSTRIAL SEWING THREADS: Structure, thread finishing, applications for very high temperature and technical applications. (10)

NARROW WIDTH FABRICS: Narrow fabric and their types, preparatory processes for narrow fabric production, method of production, characteristics and application. **Braided structures:** Types of braids, production techniques, properties and applications. (12)

CARPETS: Material characteristics. Types of carpets. production techniques, properties and applications. **Other fabric structures :** 3D weaving and structures, pile structures, raising fabrics and spacer fabrics. (12)

Total L: 45

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, "Designing 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.
6. Whewell C S, Selim A and Wood H, "The Raising of Textile Fabrics" Journal of the Textile Institute Proceedings, UK, 2009.

21TT18 NONWOVENS

3 0 0 3

RAW MATERIAL AND WEB FORMATION : Classification of nonwovens. Development of the nonwoven industry. Raw materials. Binders. Nonwoven manufacturing processes- fibre preparation, dry lay process, wet-lay process, process variables, properties. Extrusion lay process – types, process variables, properties. Web drafter. (12)

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 –calendar bonding , hot air bonding and ultrasound bonding. Chemical bonding – saturation bonding, foam bonding, spray bonding and print bonding. Spun bonding, melt blown processes. (11)

FINISHING AND PRODUCT DEVELOPMENT: 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. Nonwoven product development for garments, decorative fabrics, home textiles and technical textiles. (10)

NONWOVEN PRODUCT DEVELOPMENT AND APPLICATIONS: 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. Nonwoven product development for garments, decorative fabrics, home textiles and technical textiles. Modeling of nonwoven fabrics- pore size distribution, tensile strength, bending rigidity, permeability and filtration properties. (12)

Total L:45

REFERENCES:

1. Wilhelm Albrecht, "Nonwoven Fabrics", Wiley – VCH, VerlagGmbh and Company, 2003.
2. Russel.S, "Handbook of Nonwovens", Textile Institute Publication, UK, 2004.
3. George Kellie, "Advances in Technical Nonwovens ", Woodhead Publishing Series in Textiles , 2016.
4. R Chapman , "Applications of Nonwovens in Technical Textiles", Woodhead Publishing Series in Textiles , 2010.

21TT19 SURFACE MODIFICATION OF TEXTILES

3 0 0 3

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, OAugP. (12)

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. (10)

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. (12)

ENZYME TREATMENT: Mechanism of specific interaction of enzymes with substrates. Surface modification of natural and synthetic fibres with enzymes - mechanism, characterization and challenges. (11)

Total L: 45

REFERENCES:

1. Q Wei, Surface Modification of Textiles, Woodhead Publisng Ltd., Combridge, 2009.
2. Christopher M Pastore and Paul Kieken, "Surface characteristics of Fibers and Textiles," Marcel Dekker, Inc., New York, 2001.
3. Perkins W S, "Textile Coloration and Finishing", Carolina Academic Press, London, 1996.
4. Shishoo R, "Plasma Technologies for Textiles", Woodhead Publisng Ltd., Cambridge, 2007.
5. Xiaoming Tao, "Smart fibers, Fabrics and Clothing", Woodhead Publisng Ltd., Combridge, 2007.

21TT20 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. (11)

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. (11)

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, Recycling, Better Cotton Initiative (BCI). (11)

ADVANCED PROCESSING TECHNIQUES: Principle and advantages of dry processing. Plasma treatment, Super critical carbon dioxide processing, Surface modification by VUV irradiation – VUV lamp, Laser modification, Concept of low level application of chemicals. Enzyme treatments: Enzymes in preparatory processes, Enzymes in printing, finishing – and surface modification. (12)

Total L: 45

REFERENCES:

1. "Eco -Textiles, Special Report", The Bombay Textile Research Association, Mumbai, 1996.
2. Chavan R B and Radhakrishnan J, "Environmental Issues - Technology Options for Textile Industry", IIT Delhi Publication, 1998.
3. Shishoo R, "Plasma Technologies for Textiles", Woodhead publishing limited, UK, 2007.
4. Cavaco-Paulo A and Gübitz G M, "Textile Processing with Enzymes", Woodhead Publishing Ltd., UK, 2003.
5. Mirafab M and Horrocks A R, "Eco Textiles", The Textile Institute, Woodhead Publishing Ltd., Cambridge, 2007.
6. Q Wei, Surface Modification of Textiles, Woodhead Publishing Ltd., Cambridge, 2009.

21TT21 MANAGEMENT OF COLOUR IN TEXTILES

3 0 0 3

COLOUR PERCEPTION AND MEASUREMENT: 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. 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. (11)

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. On-line colour measurement. Colour of wet and dry fabrics. (11)

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. (11)

COLORANT FORMULATION FOR DYEING: Colorant recipe formulation – computer colour matching (CCM) technique, Application of CCM system to Textile processing. Advantages and Limitations. Improvement of the formulation accuracy. Concentration Of Dye Liquor- 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. (12)

Total L : 45

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.

21TT22 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. 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. (12)

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. Influence of Fibre Structure on Dye Uptake- Fibre structure. Classification of dyeing systems. Heat treatment. (11)

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. (11)

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. (11)

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.
5. John Shore, "Colorants and Auxiliaries", Society of Dyers and Colourists, Bradford, 1990.

21TT23 FUNCTIONAL FINISHES

3 0 0 3

FINISHING : Classification, processing methods, challenge, Importance. Applications, concentration relationship, wet pick up: Low wet pick up methods, factors affecting wet pick up. Calculations: wet pick up efficiency, concentration for padding solution, solution flow rate, and feed flow rate. **Softening finishes:** Types of Softeners, mechanisms of the softening effect. Compatibility and combinability of softeners. Evaluation and testing methods. Troubleshooting for softening finishes. (11)

HAND BUILDING FINISHES: Effects of hand building finishing. textiles with hand building finishes. hand builder chemistry, evaluation and trouble shooting for hand building finishes. **Non-slip and elastomeric finishes:** 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 and trouble shooting for elastomeric finishes. (12)

PROTECTIVE FINISHES: Mechanism of UV protection, chemistry of UV protection finishes. EMI Shielding. Antimicrobial finish. mechanisms of antimicrobial finishes, evaluation and trouble shooting. (12)

NOVEL FINISHES: Need for novel finishing. Anti-odour and fragrance finishes. Mosquito repellent finish. Conductive finishing, Microencapsulation technique, Nano finishing. Enzyme finishing. (10)

Total L : 45

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, USA, 1992.
3. Perkins W S, "Textile Colouration and Finishing", Carolina Academic Press, UK, 1996.
4. Menachem L and Stephen B S, "Handbook of Fibre Science and Technology", Volume II, Part B, Marcel Dekker Inc., New York, 1983.
5. Holme L, "New developments in chemical finishing of textiles", Journal of Textile Institute, UK, 2008.

21TT24 CHEMICAL PROCESSING OF SYNTHETIC TEXTILES

3 0 0 3

PREPARATORY PROCESS AND MASS COLOURATION: 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. (11)

DYEING OF PET, NYLON AND ACRYLIC: Polyester Dyeing: carrier, high temperature high pressure and thermosol methods of dyeing, practical problems, solutions, stripping of dyed polyester. Dyeing of nylon, acid dyes, high temperature dyeing, low temperature dyeing of Nylon 66. Dyeing with disperse 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. Dyeing of textured filaments. (11)

DYEING OF BLENDS: Dyeing of polyester blends, shop floor practices of dyeing of polyester/cellulosic blended fabrics. Practical problems, solutions. Shop floor practices, dyeing of polyester/wool blended fabrics, practical problems, 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, 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. **Finishing:** Different functional and easy care finishes on synthetics and blends like anti-static, soil-release, soil-resistant, flame-retardant. (11)

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.

21TT25 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. (11)

CARPET AND FABRIC PRINTING: Historical development of carpet printing, carpet printing, printing of carpet tiles, before and after treatments, 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. (11)

DIGITAL PRINTING: 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. (12)

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) **Transfer printing:** Sublimation transfer, melt and film release transfer, wet transfer printing. (11)

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. Ujjie, "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.

21TT26 TEXTILE EFFLUENT TREATMENTS

3 0 0 3

EFFLUENT PARAMETERS AND TREATMENTS: Characteristics of textile effluents – pH, TDS, TSS, COD, BOD, Colour. Effluent treatment flow chart. Preliminary treatment – Screening, Shredding, Grit removal. Primary treatment – Equalization, coagulation, flocculation, sedimentation. Secondary treatment – activated sludge process. Tertiary treatment - Adsorption, Membrane technology, Radiation (UV, Gamma, Electron Beam), Electrochemical, Chemical (H₂O₂, Chlorine, Fenton's reagent), Thermal, Corona discharge. Marine discharge of effluent. (12)

BIOTECHNOLOGICAL AND ADVANCED OXIDATION TREATMENT: Biotechnology and dye effluent treatment, Microbial processes - General aspects, Aerobic treatment - Activated sludge, Fungi, Anaerobic treatment; Enzymatic processes - General aspects, Oxidative enzyme remediation, Reductive enzymes. Advance Oxidation Processes- Non-photochemical methods – ozonation, O₃/H₂O₂ process, Fenton's Reagent. Homogeneous Photochemical Oxidation method – Vacuum-UV Photo oxidation, UV/O₃, UV/H₂O₂, Photo-Fenton Method. Heterogeneous Photochemical Oxidation method - Photo catalytic, Catalytic ozonation. (11)

RECOVERY AND REUSE OF DYES AND CHEMICALS: Recovery of sizing agents, Caustic soda, dyes. Recycling and reuse of dyes and chemicals. Reject Management-Importance, Brine reject source, Thermal Evaporation – Mechanical Vacuum Recompression Evaporator, Multiple Effect Evaporators, Crystallizer, Sludge management. (11)

RECYCLING AND REUSE OF WASTE WATER: Water consumption in textile industry - Minimizing liquor to material ratio, Minimizing wash liquor, Re-using rinsing bath water, Impurities in water. Recycling and reuse of treated effluent. Efficient heat recovery from effluent. Water conservation, Direct steam injection. (11)

Total L: 45

REFERENCES:

1. Mohd Yusuf, "Handbook of Textile Effluent Remediation", Jenny Stanford Publishing, New York, 2018.
2. Himanshu Patel and R.T. Vashi, "Characterization and Treatment of Textile Wastewater", Elsevier Inc., 2015.
3. Manivasakam N, "Treatment of Textile Processing Effluents", Chemical Publishing Company, U.S.A, 2013.
4. Christie R M, "Environmental aspects in Textile Dyeing", Woodhead Publishing Ltd., UK, 2007.
5. Cavaco-Paulo and Gübitz G M, "Textile Processing with Enzymes", Woodhead Publishing Ltd., UK, 2003.
6. Peter J Hauser, "Advances in Treating Textile Effluent", InTech Publisher, Croatia, 2011.

21TT27 FASHION DESIGN

3 0 0 3

DESIGN BASICS: Definition and concepts of design, designs in fabric- motif and pattern, types of design- historical, natural, geometric, stylised and abstract. Garment design – structural, decorative and functional. Design requirements and development of designs. (10)

ELEMENTS OF DESIGN: Types. space, line, shape and form -texture -pattern. Colour-colour theories, primary, secondary, tertiary, intermediate colours, colour scheme, dimensions of colours, warm and cool colours, tint and shades, psychology of colours, application of colours to different components and in different seasons, colour combinations, colour contrast and colour harmony. (12)

PRINCIPLES OF DESIGN: Harmony, balance, proportion, emphasis and rhythm - Harmony – balance - symmetrical, asymmetrical and radial; proportion - emphasis - rhythm. (12)

FASHION: Terminology, Inspiration, mood board, colour board, fabric board, accessories board. Illusion in clothing- Visual illusions, types. Figure Analysis: proportions - design concepts. (11)

Total L: 45

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, New Delhi, 2000.
4. Laver J, "Costume and Fashion", Thames and Hutson, London 1995.
5. Bush G, "Psychology of Clothing", Macmillan Pub., Australia, 1990.

21TT28 CLOTHING COMFORT

3 0 0 3

HUMAN PHYSIOLOGY, COMFORT AND ROLE OF CLOTHING: Need and selection of clothing. Definition of comfort. Human physiological aspect of comfort. Various aspects of clothing comfort. Comfort variables. Comfort properties of fibres, yarns and fabric structures. Psychological comfort of fabrics and garments. (12)

THERMAL COMFORT: Thermal balance of human body. Mechanism of heat transfer through clothing. Parameters influencing heat transfer. Mathematical modeling of heat transfer through clothing. Liquid moisture transmission- wicking, water absorption. Principles of liquid vapour transfer. Dynamic heat and mass transmission characteristics of clothing. Factors influencing heat and mass transfer through fabrics. (10)

TACTILE COMFORT, CLOTHING FIT AND COMFORT: Tactile Comfort-Tactile comfort sensations, Fabric characteristics and tactile attributes, Fabric parameters influencing tactile sensation. Clothing Fit and Comfort. Body dimensions and pattern. Garment fit and comfort relationship. Factors related to clothing fit. (11)

IMPROVING COMFORT IN CLOTHING: Different approaches for improving thermal comfort in apparel-Appropriate use of textile materials, Garment design, Attachment of wearable devices. Improving moisture management in apparel- Sensing and responding textiles, Fabric with pore size gradient, Fibres with nano-structured surface, Mixture of hydrophilic and hydrophobic fibres. Improving tactile comfort in fabrics and clothing. Improving body movement comfort in apparel. Improving comfort in sports and leisure wear. (12)

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, The Textile Institute, Manchester, 2001.
4. Fan J and Hunter L, "Engineering Apparel Fabrics and Garments", Woodhead Publishing Limited, Cambridge, 2009.
5. Shishoo R, "Textiles for Sports wear", Woodhead Publishing Limited, Cambridge, 2015.

21TT29 TEXTILE MARKETING AND MERCHANDISING

3 0 0 3

MARKETING: Concepts, Marketing system. Marketing environment ,and marketing organization. Textile Markets – Local clusters, Domestic, National and International markets. Customer Management - Defining customer value and satisfaction. Delivering customer value and satisfaction. Attracting and retaining customers. Modern marketing information system, Marketing research, Forecasting and demand measurement. Marketing strategies: Product Life Cycle, New product development. (12)

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. (11)

MERCHANDISING: Merchandiser in apparel industry –fashion merchandiser, retail merchandiser, production merchandiser. Components of merchandising activities - 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. (11)

VISUAL MERCHANDISING: Techniques to display the product, planning for visual merchandising, store planning and design, Case study: Visual merchandising in various textile sectors-home textile, handloom and garment. Functions of E-Visual merchandising in textile stores. (11)

Total L: 45

REFERENCES:

1. Philip Kotler and Kevin Keller, "Marketing Management", 15th edition Prentice Hall Inc., New Delhi, 2016.
2. Ruth E Glock and Grace I Kunz, "Apparel Manufacturing – Sewn Product Analysis", 4th edition Prentice Hall, New Jersey, 2004.
3. Philip Kotler, 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.
5. Jacob Solinger, "Apparel Manufacturing Hand Book - Analysis, Principles and Practice", Boblin Media Corp, Columbia, 1991.
6. Pegler, "Visual merchandising and display " 6th Edition, Fairchild books, New York, 2012.

21TT30 HOME TEXTILES

3 0 0 3

TEXTILE FURNISHING: Different types of furnishing materials, Woven and non-woven, factors for selection of home furnishings- Material, Finishing, Aesthetic, Performance, Advances in period style, different styles, use of colours, design & texture in home furnishing. **Home decoration:** Draperies, choice of fabrics, calculating the amount of material needed. Different types of doors and windows, applications. Curtains, need, types of curtains. method of finishing draperies, tucks or pleats. uses of drapery rods, hooks, tape rings and pins. (12)

FLOOR COVERINGS: Hard floor and wall coverings, resilient floor coverings, soft floor coverings, rugs, cushion and pads, recent development, care and maintenance. **Living room furnishing:** Sofa covers, wall hangers, cushion, cushion covers, upholstery, bolster and bolster covers. (11)

KITCHEN AND DINING TEXTILES: Types of kitchen linens, dish cloth, hand towels, fridge cover, fridge handle cover, mixer cover, grinder cover. Floor and wall cleaning materials, wipes and mops. Finishing requirements for kitchen textiles. **Dining:** Placemats, table cloth, hand towels. selection, use and care of kitchen and dining textiles. (11)

BED LINENS: Different types of bed linen, bed sheets, blankets, blanket covers, comforts, comfort covers, bed spreads, mattress and mattress covers, pads, pillows and pillow covers, uses and care. **Bath linen:** Towels, types, selection, use and care, mats and rugs – types, uses. **Testing:** Fastness properties of home textile products. Physical Testing: Drape, tearing Strength, pilling, abrasion, tensile, flammability. (11)

Total L: 45

REFERENCES:

1. Subrata Das, "Performance of Home Textiles" , The Textile Institute, Woodhead Publishing Ltd., Cambridge, 2010.
2. Wendy Baker, "Curtain and Fabric selector", Collins and Brown, London, 2000.
3. Elsasser, Virginia Hencken, "Know Your Home Furnishings", Fairchild Books & Visuals, 2003.
4. Goswami, K K, "Advances in Carpet Manufacture" Woodhead Publishing, Woodhead Publishing Ltd., Cambridge, 2011.
5. Charles Randall and Sharon Templeton, "Dream Windows", Randall International, California 2003.
6. Wingate I.B., & Mohler J.E., Textile Fabrics & Their Selection, Prentice Hall Inc, New York, 1984.

21TT31 TEXTILE COMPOSITES

3 0 0 3

COMPOSITES AND CONSTITUENT MATERIALS: Applications - Automotive, Civil and military and other applications. Composites-classification, constituents- reinforcement, matrix, their properties, interface, critical fibre length, rule of mixtures. Classification of textile reinforced structures based on axis and dimension: non-axial, mono-axial, biaxial, triaxial and

multiaxial structures, 3D structures, Non-crimp fabrics, Stitched fabrics. Geometrical aspects. Interface - mechanisms and theories. Textile Prepregs and Preforms for composite manufacturing. (15)

COMPOSITES MANUFACTURING: Hand layup, vacuum bag moulding, compression moulding, filament winding, vacuum forming, resin transfer moulding, pultrusion, injection moulding, selection criterion. Polymer-based and polymer-filled nanocomposites. Self-healing and Self-reinforced composites, Smart composites. (10)

MICRO-MECHANICAL ANALYSIS OF COMPOSITES: Volume and mass fraction, density and void content. Evaluation of four elastic moduli-Longitudinal Young's modulus, Transverse Young's modulus, Major Poisson's ratio and In-plane shear modulus. Failure and fracture mode in UD fibre composites. (10)

MODELLING AND PROCESSING OF COMPOSITES: Property requirements: Destructive testing-tensile, shear, compression, flexural, torsion, toughness, interlaminar fracture. Non-destructive testing. Textile reinforced concretes. Classical lamination theory, Need for modeling, flow through porous media, liquid injection molding simulation. (10)

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. Tsu Wei Chou and Frank K Ko, "Textile Structural Composites", Elsevier Science Ltd, USA, 1989.
4. Jang-Kyo Kim and Yiu-Wing Mai, "Engineered Interfaces in Fiber Reinforced Composites", Elsevier India, 1998.
5. Autar K Kaw, "Mechanics of Composite Materials", CRC Press LLC, New York, 1997.

21TT32 FILTERS AND FILTRATION TEXTILES

3 0 0 3

FILTRATION PRINCIPLES AND MATERIALS FOR FILTER MEDIA: **Filtration principles-** Filtration and Separation, Contaminants, Surface and Depth Filtration. Filtration Mechanisms, Filtration Theory, Particle Filtration, Practical implications, Woven Filter Fabric design and selection considerations, Structure of Fibrous Filters. **Raw Materials for filter media:** Woven Filter media- Yarn types, Yarn combinations, Fabric constructions and properties. Finishing Treatment. Nonwoven Filter Media- Polymers, Fibers, Resins and Binders, Additives and Finishes. Materials for Membrane. (11)

PROCESSES AND CHARACTERISTICS OF FILTER MEDIA: **Processes for Nonwoven Filter Media-** Dry Formed, Meltspun Webs, Electrospun Webs, Centrifugal Spinning, Solution Spun Webs, Wet Lay Process, Composite Structures, the Pleating Process, Membranes. **Characteristics of Nonwoven Filter Media-** Air Laid Webs, Dry Laid Webs, Melt-spun Webs, Flash-spun Webs, Nanofiber Spun Webs, Wet Laid Webs, Electret Filter Media, Composite Structures, Coalescing Media, Sorption Media, Antimicrobial Media, Catalytic Media, Membrane Filter Media. (11)

AIR AND LIQUID FILTERS APPLICATIONS: **Air Filters-** Industrial Air Filtration, Heat Ventilation and Air Conditioning Systems, High Efficiency Air Filtration, Gas Turbine Air Intake Filters, Respirators, Gas Masks, and Facemasks, Vacuum cleaners, Air purifiers. **Liquid Filters-** Nonwoven Filter Media for Liquid Filter Applications, Testing of Liquid Filters, Membrane Filtration. (12)

ENGINE FILTRATION, TESTING AND STANDARDS FOR FILTER MEDIA: **Engine Filtration-** Lube Oil Filtration, Air Intake Filtration, Cabin Air Filtration, Fuel Filtration. **Testing of Filter Media-** Basis Weight, Volatiles and Moisture Content, Formaldehyde Content, Thickness, Air Permeability, Density and Bulk, Solidity and Porosity, Pore Size and Pore Structure, Other Techniques for Measuring Porosity, Pore Size, and Structure. Strength Properties, Water Repellency and Water/Moisture Resistance, Flammability, Color, Filter Media Filtration Testing. INDA – EDANA Harmonized Test Methods. (11)

Total L: 45

REFERENCES:

1. Philip Brown and Christopher Cox, "Fibrous Filter Media", Woodhead Publishing Limited, Cambridge, 2016.
2. Irwin M. Hutten, "Handbook of Nonwoven Filter Media", Butterworth-Heinemann, Elsevier, Burlington, 2015.
3. Ken Sutherland, "Filters and Filtration Handbook", Butterworth-Heinemann, Elsevier, Burlington, 2008.
4. Bipin Kumar, "Textiles for Advanced Applications", IntechOpen Limited, UK, 2017.
5. Horrocks A R and Anand S C, "Handbook of Technical Textiles", Woodhead publication and Textile Institute, England, 2000.

21TT33 BIOMECHANICAL ENGINEERING OF FUNCTIONAL TEXTILES

3 0 0 3

TEXTILE BIOMECHANICAL ENGINEERING: Fiber mechanics, Yarn mechanics, Fabric mechanics, Clothing mechanics, The human body, Mechanics of the human skin and underlying soft tissues, Contact mechanics in wearing garments, Clothing comfort and compression therapy, Pressure comfort measurements. (12)

MATERIAL PROPERTIES: Fibers, Yarns, Fabrics, Human skin and underlying soft tissue - Biomechanical testing of human skin, Frictional properties of human skin. Clothing biomechanical engineering design system (CBED), Body scanning. (11)

APPLICATIONS IN PRODUCT DEVELOPMENT: Biomechanical engineering of jeans, Sports bra, Compression stockings, Socks, Biomechanical engineering of footwear and aerobic sportswear. (11)

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. (11)

Total L: 45

REFERENCES:

1. Li Y and Dai X Q, "Biomechanical Engineering of Textiles and Clothing", Wood head Publishers, The Textile Institute, England, 2006.
2. Jennifer Gunning, "Ergonomic Handbook for the Clothing Industry", Union of Needle trades, 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), pp. 56-75.
5. Nakahashi, M, "Effect of Clothing Pressure on Front and Back of Lower Leg on Compressive Feeling", Journal of the Japan Research Association for Textile End-Uses, pp. 661-668, 1999.

21TT34 COATED AND LAMINATED TEXTILES

3 0 0 3

POLYMERIC MATERIALS AND 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 Coating. (12)

COATING AND LAMINATION METHODS: Knife coating, Roll coating, Dip coating, Transfer coating, Gravure Coating, Rotary screen printing, Calendering, Hot melt coating, Foam coating, Lamination by adhesives, Welding. (10)

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, (Poromeric), Hydrophilic Coatings, Smart temperature responsive breathable coatings. NONAPPAREL COATING: Synthetic Leather, Architectural Textiles, Fluid Containers, Tarpaulins, Automotive Applications, Carpet Backing, Flocking, Fusible Interlinings. (12)

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. **TESTING OF COATED TEXTILES:** Tensile strength, Elongation, Adhesion, Tear Resistance, Weathering behavior, Microbiological degradation, Yellowing, Testing Standards. (11)

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.

21TT35 TEXTILE PREFORMS AND PREPREGS

3 0 0 3

PREFORMS: Property requirements for fibre, fabric and matrix, Importance of preforms in composite preparation. Classification of preforms: 1D, 2D-nonaxial, Mono-axial, Multi-axial multi-ply non-crimp fabrics, 3D fabrics. Knitted Preforms - Weft knitted preforms with inlay, Warp Knitted multi-axial fabrics, 3D raschel warp knitted fabrics. Characterization of textile Preforms, Application of preforms. (11)

WOVEN PREFORMS: Fabrication of 2D, 3D and multi-axial preforms, 3D forms - Orthogonal, warp interlock, angle interlock structures, Multilayer woven structures, 3D hollow woven preforms, 3D shell woven preforms, 3D woven preforms from specially made devices, Near net shaped preforms. Profile fabrics - T profile, π profile. (11)

BRAIDED PREFORMS: 2D braiding, two-step 3D braiding, four-step 3D braiding, Multilayer interlock braiding. Stitched preforms - Traditional stitching, Technical Embroidery, Z- Pinning. Nonwoven preforms, Robotic approach in preform production. Preform considerations - Sealing, Tooling, Component Quality. Modelling of internal geometry of textile preforms. (11)

PREPREGS: Property requirements, Compaction, Prepreg processing - Solution route, Film transfer route. Prepregs material form - UD Tape, Slit Tape, Woven forms. Automated layup process, Prepreg sandwich construction, Formation of towpregs, Thermoplastic hybrid yarns for prepreg production. Physical/Chemical tests on prepregs, Challenges in prepreg storage and safety, Theoretical calculations for fibre volume fractions in prepreg composite. Applications of prepregs. (12)

Total L: 45

REFERENCES:

1. Tsu Wei Chou and Frank K Ko, "Textile Structural Composites", Elsevier Science Ltd., USA, 1989.
2. Alagirusamy R, Fanguero R, Ogale V and Padaki N, "Hybrid Yarns and Textile Preforming for Thermoplastic Composites" Textile Progress, 38 (4), 2006.
3. Hull D and Clyne T W, "An Introduction to Composite Materials", Cambridge University Press, 1996.
4. Liyong Tong, Adrian P Mouritz and Michael K Bannister, "3D Fibre Reinforced Polymer Composites", Elsevier Science Ltd., India, 2002.
5. Long A C, "Design and Manufacture of Textile Composites", Woodhead Publishing Ltd., London, 2005.

21TT36 ELECTROACTIVE TEXTILES**3 0 0 3**

TERMS AND MATERIALS: Electrical conductivity, metal conductors, ionic conductors, inherently conducting polymers. Conductive yarns and fabrics: Electro spinning process, process variables, formation of yarns and fabrics. Electro active nano fibres, fabrics and nano composites. Application areas. (11)

CONDUCTIVE TEXTILE PREPARATION: Traditional techniques: Weaving, printing, stitching and embroidery. Extrusion, solution coating, In-situ polymerization and electrochemical polymerization. Integration of fibre optic sensors and sensing networks. (11)

TESTING & CHARACTERIZATION: Electrical characterization- surface resistance and volume resistance, EMI shielding efficiency, electro mechanical and thermo electric characterization. Characterization of ageing behavior. (11)

TEXTILE SENSORS: Design system, material selection and characterization methods for textile sensors - Textile based strain sensors, pressure sensors, ECG and ICG electrodes, heating fabrics. (12)

Total L: 45**REFERENCES:**

1. Mattila HR, "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 LV, "Smart Textiles for Medicine and Healthcare", Textile Institute & CRC press, Woodhead publishing Ltd, England, 2007.
4. Vldan Koncar, Smart Textiles and Their Applications, Elsevier, Wood head Publishing Ltd, England, 2016.
5. Jane McCann and David Bryson, Smart Clothes and Wearable Technology, Wood head Publishing Ltd, England, 2009.

21TT37 MEDICAL TEXTILES**3 0 0 3**

INTRODUCTION TO MEDICAL TEXTILES AND WOUND CARE PRODUCTS: Medical Textiles-Definition, classification, market overview and growth projections of medical textiles. Requirements from medical textiles. Application areas of textiles in medical field. **Wound care products:** Wounds-Categorization of wounds, wound healing mechanism and factors affecting wound healing. Wound dressings- Functional requirements, Different types of wound dressings, materials used, design aspects and utility. Antimicrobial Wound Dressings. Test methods for wound dressings. (11)

BANDAGES AND IMPLANTABLE DEVICES: Bandages: Different types of bandages and its use. Material characteristics. Textile processes involved in the formation of dressings and bandages. **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. (12)

SURGICAL GOWNS AND FACE MASKS: 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. (11)

OTHER HEALTHCARE AND HYGIENE PRODUCTS: Surgical drapes, beddings, Wipes and Diapers-Functional requirements, material characteristics and design procedure. Evaluation and standards. Key issues with disposable medical textile products. Disposable procedure of medical textiles in different countries. Ethical and legal issues in medical textiles. (11)

Total L: 45**REFERENCES:**

1. Lieva Langenhove, "Advances in Smart Medical Textiles", Wood head publishing Ltd, Cambridge, UK, 2015.
2. Anand S C , Kennedy J F, Mirafab M and Rajendran S, "Medical and Healthcare Textiles" Wood head publishing Ltd, Cambridge, UK, 2014.
3. Bartels V, "Handbook of Medical Textiles", Wood head publishing Ltd, Cambridge, UK, 2011.
4. McCarthy B J, "Textiles for Hygiene and Infection Control" Wood head publishing Ltd, Cambridge, UK, 2011.
5. Rajendran S, "Advanced Textiles for Wound Care", Wood head publishing Ltd, Cambridge, UK, 2009.

21TT38 ACOUSTICS AND TEXTILE SOUND ABSORBERS

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. (11)

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. (12)

TEXTILE STRUCTURES AS SOUND ABSORBENTS : Types of Sound Absorptive Materials. Mechanism of Sound Absorption in Fibrous Materials. Different types of Sound Absorptive Textile structures. Factors influencing Sound absorption-Fiber type, Fiber Size, Airflow Resistance, Porosity, Tortuosity, Thickness, Density, Fiber compactness, Surface Impedance. End uses of Sound Absorptive textiles. Reducing noise in automotive interiors. (11)

DEVELOPMENTS IN TEXTILE BASED SOUND ABSORPTIVE MATERIALS: Textile Based Sound Absorptive Materials: Key technology developments in Textile Composites for Sound Absorption, Bicomponent Fiber in Sound Absorbent Production, Nanofibres as Sound absorbants. Technologies for the production of coated textiles for Sound Absorption. Environmental impact, manufacturing concerns, recycling of materials and components, sustainable product development. (11)

Total L: 45

REFERENCES:

1. Padhye, Rajiv, Nayak, Rajkishore, "Acoustic Textiles", Springer, Singapore, 2016.
2. Michel Bruneau and Catherine Potel, "Materials and Acoustics Handbook", Wiley Publishers, 2010.
3. Randall F. Barron, "Industrial Noise Control and Acoustics", Marcel Dekker, Inc. New York, 2003.
4. Alton Everest, Master Handbook of Acoustics, 4th edition, McGraw-Hill, New York San Francisco Washington, 2001.
5. Muller Gerhard and Moser Michael, "Handbook of Engineering Acoustics", Springer Dordrecht Heidelberg London New York, 2013.

21TT39 SMART MATERIALS FOR INTELLIGENT TEXTILES

3 0 0 3

STIMULI RESPONSIVE AND SHAPE MEMORY POLYMERIC MATERIALS: Stimuli Responsive polymer-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. 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. (12)

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. (11)

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. (11)

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) sensor. Textile sensors - healthcare, monitoring pregnancy and patients with heart conditions, Conductivity Based Sensors for Protection and Healthcare Optical Chemical Sensors and Personal Protection. (11)

Total L: 45

REFERENCES:

1. Vldan Koncar, "Smart Textiles and their applications", Woodhead Publishing Limited, UK, 2016.
2. L. Van Langenhove, "Smart Textiles for Medicine and healthcare, Materials, Systems and Applications", Woodhead Publishing Limited, Cambridge, England, 2007.
3. Xiaoming Tao, "Smart fibres, fabrics and clothing", Woodhead Publishing Limited, Cambridge, England, 2007.
4. Gilsoo Cho, "Smart Clothing Technology and Applications", CRC Press Taylor & Francis Group, US, 2010.
5. H. R. Mattila, "Intelligent textiles and clothing", CRC Press, Boca Raton Boston New York Washington, DC Woodhead Publishing Limited, Cambridge, England, 2006.
6. Gordon G. Wallace, Geoffrey M. Spinks, Leon A. P. Kane-Maguire, Peter R. Teasdale, "Conductive Electroactive Polymers Intelligent Polymer Systems", Woodhead Publishing Limited, Cambridge, England, 2009.

21TT40 INDUSTRIAL TEXTILES

3 0 0 3

INDUSTRIAL TEXTILES: Classification, market overview and growth projections of industrial textiles. Technical fibers, yarns and fabrics. Coloration, finishing and coating of technical textiles. Filtration textiles - filter fabric requirements, types-dry and wet filtration. Filtration mechanism. Fibers, yarn and fabric structures used for filtration. Design of filter fabrics. Finishing treatments. Developments in filter fabrics-melt blown and electrospun fabric filters. Evaluation and standards. (12)

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, aircrafts and marine. (11)

GEO AND AGRICULTURE TEXTILES: 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. Textiles in agriculture -requirement and properties of textiles used in crop covers, bird netting, shade fabrics, soil mats and sacks. (11)

PACKAGING AND OTHER INDUSTRIAL TEXTILES: Requirement and properties of textiles used in food packaging and transport bags. Ropes, nets, belts, hose and their types, method of production, characteristics and applications. Manufacture and properties of textiles used in scrub pads and coated abrasives. Paper machine clothing. (11)

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.

21TT41 CIRCULAR DESIGN AND SUSTAINABILITY IN TEXTILES

3 0 0 3

INTRODUCTION AND APPLICATIONS OF RECYCLED TEXTILES : Systems theory. Importance of textile and apparel recycling process. Sorting process. The pyramid model. Textile recycling constituents. Life cycle of textile products. Recycling Issues and Technology- Designing of easily recyclable textile products. Systems planning for carpet recycling. Carpet recycling technologies. Upcycling process. Recycling of textile used in operating theatre. Composite products from post-consumer carpet. Utilization of recycled carpet waste fibres for reinforcement of concrete and soil. (12)

RECYCLING POLYMER AND FIBRE WASTE: 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. (11)

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. (11)

ENERGY AND ENVIRONMENT: Recycling waste water from textile production. Recycling and reuse of textile chemicals. Conservation of resources like water and chemicals. Products, technology and marketing - Natural fibre composites, Bast and other cellulosic fibres as alternatives, Life cycle assessment, Consumer awareness and global status. (11)

Total L: 45

REFERENCES:

1. Youjiang Wang, "Recycling in Textiles", Woodhead Publishing Limited, Cambridge, 2006.
2. Marion I. Tobler-Rohr, "Handbook of Sustainable Textile Production", The Textile Institute, Woodhead Publications, UK, 2011.
3. R.S. Blackburn, "Sustainable Textiles – Life Cycle and Environmental Impact", Woodhead Publications, UK, CRC Press, 2009.
4. MirafTAB M and Horrocks R, "Eco-Textiles", Woodhead Publishing Limited, Cambridge, 2007.
5. Gupta V B and Kothari V K, "Manufactured Fibre Technology", Chapman & Hall, London, 1997.
6. "Eco -Textiles, Special Report", The Bombay Textile Research Association, Mumbai, 1996.
7. Chavan R B and Radhakrishnan J, "Environmental Issues - Technology Options for Textile Industry", IIT Delhi Publication, 1998.
8. Sabit Adanur, "Wellington Sears Handbook of Industrial Textiles", Technomic Publications Co. Inc., Lancaster, 2006.

21TT42 FINANCIAL MANAGEMENT

3 0 0 3

FINANCIAL STATEMENT: Nature of financial statement, Taxes, and Cash-Flow, Analysis of Financial Statements, Types of analysis- External VS Internal analysis, Horizontal VS Vertical analysis. Financial Ratios – Du Pont Analysis, Tools of analysis, Trend analysis, common size statement and comparative statement – Standardized Financial Statements. (12)

BUSINESS TRANSACTION: Analysis of business transaction- Accounting equation approach and traditional approach. Accounting equation approach- Rules for recording transaction with case studies. Traditional approach- Rules of accounting with case studies. Valuation of Bonds and Stocks- Bond Market – Bond Valuation – Measurement of Market Risk. (11)

FINANCIAL STATEMENTS OF PROFIT MAKING ENTITIES: Computation of cost of finished goods manufacturing, Need for Inventory Management - Order quantity –EOQ Model valuation of inventories in a manufacturing department with case studies. (10)

FINANCIAL STATEMENT ANALYSIS: Forecasting Financial Statements – Risk Adjusted Expected Rates of Return and the Dividends Valuation Approach - Different types of financial statements- Income statement, balance sheet, statement of retained earnings and ratio analysis case studies. (12)

Total L: 45

REFERENCES:

1. Prasanna Chandra, "Financial Management, Theory and Practice", 10th Edition, McGraw Hill, New Delhi, 20 April 2019.
2. Narayanaswamy, R., "Financial Accounting – A Managerial Perspective", 6th Edition, Prentice Hall of India, New Delhi, 2017.
3. Gupta, Amrishi, "Financial Accounting for Management - An Analytical Perspective", 4th Edition, Pearson Education, New Delhi, 2012.
4. Subramanyam, K. R. and John, J.W., "Financial Statement Analysis", 12th Edition, Tata McGraw Hill, New Delhi, 2014.
5. Maheswari S N, "Fundamentals of Cost Accounting", Sultan Chand & Sons, New Delhi 2011.

21TT43 INDUSTRIAL ENGINEERING

3 0 0 3

WORK STUDY: Evolution - techniques of industrial engineering. Work study - Method study-steps. Information collection techniques- Charts and Diagrams - outline and flow process chart, multiple activity chart, left hand & right hand chart, flow diagram, string diagram. Motion Study – principles, therbligs, SIMO chart. (12)

WORK MEASUREMENT: Various techniques. Time study-equipments, steps involved, rating allowances, Operation break down, SMV / SAM and Efficiency calculations. PTMS- MTM, General Sewing Data (GSD). (11)

LINE BALANCING AND PRODUCTIVITY: Objectives, Line Balancing Case study in sewing line. Productivity - definition, difference between production & productivity. Productivity analysis in textile industries. Suggestions for productivity improvement. (11)

LAYOUT AND DESIGN OF WORKPLACE: Layout –Types, Selection, planning. Design of Workplace, Working Processes, Working Environment. Material Handling- Classification and characteristics, equipments used in Textile Industries. (11)

Total L:45

REFERENCES:

1. ILO Geneva, "Introduction to Work Study", Universal Publishing Corporation, Mumbai, 2006.
2. Khanna O P, "Industrial Engineering & Management", Dhanpat Rai & sons, New Delhi, 2004.
3. Ruth E Glock, Grace I Kunz, "Apparel Manufacturing – Sewn Product Analysis", 1st Edition, Prentice Hall, New Jersey, 2004.
4. Rajesh Bheda, "Managing Productivity of Apparel industry", 1st Edition, CBS Publishers and Distributors, New Delhi, 2002.

21TT44 PROJECT FORMULATION AND APPRAISAL

3 0 0 3

PROJECT CYCLE AND FORMULATION: Nature of planning project, Project cycle- Phases, identification, preparation, evaluation, documentation & Supervision. Various functions in project cycle - Technical, commercial, financial, economic and managerial. Project formulation- capital investments, feasibility study, feasibility report and detailed project report. Project Management-CPM & PERT. (12)

PROJECT COSTING AND APPRAISAL: Project costing-Investment criteria, project cash flow, cost of capital. Project appraisal-capital budgeting- net present value, payback period, discounted payback, internal rate of return, profitability index. (11)

PROJECT FINANCING: Financing Institutions, special schemes, key financial indicators, Financial ratios-case studies. (11)

PRIVATE SECTOR PARTICIPATION: Private sector participation in infrastructure developments projects- build operate own transfer (BOOT), build operate transfer (BOT), build operate lease transfer (BOLT), design build operate transfer (DBOT), case study of technology transfer and foreign collaboration. (11)

Total L: 45

REFERENCES:

1. Albert Lester, "Project Management-Planning and Control", 7th edition, Elsevier Publication, UK,2017.
2. Harold Kerzner,"Project Management: A Systems approach to planning, scheduling, Controlling", 12th edition John Wiley& Sons Publication,Newyork, 2017.
3. PrasannaChardra, "Projects preparation ,appraisal, budgeting and implementation", Tata McGraw hill publishing, New Delhi,1993.
4. Ormerod A, "Textile Project Management", The Textile Institute, Manchester, 1992.
5. Joy P.K, "Total project management- The Indian context", macmillan India ltd., New Delhi, 1992.

21TT45 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. (11)

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. (11)

INDUSTRIAL AUTOMATION: Introduction, integration, material handling system, simple systems for motions by electrical and mechanical devices, Mechanical design for automatic feeding assembly and transfer line. **Electronic textile instruments-** Electronic principles in evenness tester, classification of faults, digital fibrograph, hairiness meter, Vibroscope, thickness measuring instruments, HVI, Universal tensile testers. (11)

CONTROL SYSTEM AND AUTOMATION IN TEXTILE MACHINERY: Spinning. Machinery material flow, variation controls, feeders & stop motions, auto levelers, safety switches, production and quality monitors, full doff and pre-set length monitors. Data acquisition system, spinning preparatory, ring spinning, rotor spinning. Weaving. Yarn clearer controls, knotter /splicer carriage controls, pre-set length/full cone monitors. Warping machine monitors, controls, sizing machine monitors, controls, auto-reaching/drawing-in and knotting machine monitors, controls. Data acquisition system in weaving preparatory, weaving. Humidification system. (12)

Total L:45

REFERENCES:

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

21TT46 HIGH PERFORMANCE AUTOMOTIVE TEXTILES

3 0 0 3

AUTOMOTIVE INTERIORS: Various types of textile components in automotive interiors, Woven and knitted fabrics, Finishing of textiles, processing multilayer system. Nonwovens used in automobiles- headliners, bonnet liners, boot (trunk) liners, door and parcel shelf, seat, floor covering, acoustic insulation, filters. (11)

OTHER AUTOMOTIVE INTERIORS: Smart textiles in automotive interiors-Technical elements enabling the production of smart textiles, textile sensors, textile actuators. Reducing noise in automotive interior- Theory of noise minimizing properties of textiles, Textile materials for noise absorption, Engineering of acoustic textiles for noise control in vehicles, testing methods for acoustical properties of textile materials. (11)

TEXTILE COMPOSITES IN AUTOMOTIVES: Textile structural composites- 3D fabrics for automotive applications, 3D woven structures for reinforcements, advantages of 3D woven performs. Comfort Properties of Automotive Interior-parameters of seating comfort, warmth sensation and moisture sensation. (11)

RECYCLING OF AUTOMOTIVE TEXTILES: Legislative considerations with regard to the disposability of used vehicles, Shortcomings in the textile materials used today, recyclable engine air filters for the automotive industry, recyclable textile acoustic insulation structures for the automotive market. (12)

Total L:45

REFERENCES:

1. Paul R, "High performance Technical Textiles" John Wiley and Sons Ltd, New Jersey, USA, 2019.
2. Horrocks A R and Anand S C, "Handbook of Technical Textiles", Second Edition, Woodhead publishing Ltd, UK, 2016.
3. Shishoo R, "Textile advances in the automotive industry" Wood head publishing Ltd, Cambridge, UK, 2008.
4. Fung W and Hardcastle M, "Textiles in automotive Engineering", Wood head publishing Ltd, Cambridge, UK, 2001.
5. Horrocks A R and Anand S C, "Handbook of Technical Textiles", First Edition, Woodhead publishing Ltd, UK, 2000.

OPEN ELECTIVE

21TT91 QUALITY EVALUATION OF INDUSTRIAL TEXTILE PRODUCTS

3 0 0 3

Automotive Interiors: Automotive Fabrics -Fogging tester, UV – Weatherometer, UV transmittance analyzer, Hydro head tester, Process tensiometer, Wet scrub abrasion tester, Martindale abrasion tester, Tabor abrasion tester, Colour fastness and crocking. Fabric Fire Testing: Vertical flammability tester, Horizontal flammability tester, Inclined flammability tester and limited oxygen index. (13)

Filters, Sound and Oil sorbents: Filters-Fuel filter multi pass test rig, Oil filter multi pass test rig, Capillary flow meter and Air permeability tester. Sound insulation testing- Impedance tube tester, Thermal conductivity tester. Testing of oil sorbents- oil sorption capacity, oil retention capacity, Kruss tensiometer- Contact angle measurement, Measurement of kinetics of oil sorption. (12)

Analytical characterization of Industrial Fabrics: Field Emission Scanning Electron Microscope, Energy Dispersive X-Ray Spectroscopy, Differential Scanning Calorimeter, Thermo Gravimetric Analysis, Simultaneous DSC & TGA, Fourier Transform Infrared Spectroscopy, UV Spectroscopy, Wide Angle X-ray Diffraction. (10)

Physical characterization of Industrial Fabrics: Tensile strength tester, Tear strength tester, Bursting strength tester, Spray rating tester, Stiffness tester, Pilling, Seam strength measurement, Surface resistivity, Thickness and GSM measurement. (10)

Total L : 45

Text Books:

1. Shishoo R, "Textile Advances in the Automotive Industry", Woodhead Publishers, Cambridge, England, 2008.
2. Patricia Dolez, Olivier Vermeersch, and Valerio Izquierdo, Advanced Characterization and Testing of Textiles, The Textile Institute, Elsevier, 2017.
3. Walter Fung, Mike Hardcastle, "Textiles in automotive Engineering", The Textile Institute, Technomic Publishing Co, Woodhead publishing Ltd, Cambridge, UK, 2001.

Reference:

1. Horrocks A R and Anand S C, "Handbook of Technical Textiles", Woodhead Publishers and Textile Institute, England, 2000.
2. Karl Mahall, "Quality Assessment of Textiles – Damage Detection by Microscopy", Springer-Verlag, New York, 2003.
3. Alagirusamy R and Das A, "Technical Textile Yarns", Woodhead Publishers, Cambridge, England, 2010.

ONE CREDIT COURSES

21TK01 GEOSYNTHETICS

1 0 0 1

OVERVIEW:Geo-synthetics; Designing with geo-textiles: Geo-textile properties, test methods and construction and design methods. (4)

GEO-GRIDS:Geo-grid properties and test methods and design; Designing with geonets – Geo-net properties and test methods and designing with geonet. (4)

DESIGNING WITH GEOMEMBRANES:Manufacturing,Geo-membrane properties and Test methods, Applications. (3)

DESIGNING WITH GEOCOMPOSITES – Geo-textile-Geo-net composites, Geo-membrane-Geo-grid composites, Other Geo-composites; Geo-composites in separation, reinforcement, filtration and drainage. (4)

Total L: 15

REFERENCES:

1. BabuSivakumar, "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 GeosyntheticEngg.", Imperial College Press, London, 2006.
5. Shukla, S.K. and Shukla, S.K. eds., Geosynthetics and their applications, London: Thomas Telford. 2002.

21TK02 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. (4)

CHARACTERIZATION OF FIBRE REINFORCED CONCRETES: Test methods and standards, Applications of FRC. (4)

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", Gordon and Breach Science Publishers, Taylor & Francis, 2010.

21TK03 IE TECHNIQUES

1 0 0 1

WORK STUDY: Definition, purpose, techniques of work study. Procedure for work study. Method Study: Method study-steps in conducting method study. Information collection techniques. Motion Study- therbling, SIMO 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 . (5)

Case studies in textile and apparel industries related to time study and motion study and its use in improvement in productivity. (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.

21TK04 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.

21TK05 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, Poka-yoke. (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.

21TK06 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)

Industry and competitor analysis (2)

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.

21TK07 OIL SPILL CLEAN-UP PADS

1 0 0 1

STRUCTURED FIBRE ASSEMBLES FOR OIL SORPTION: Oil sorption phenomenon. Fluid flow through fibrous materials. Methods of oil spill cleanup, Oil sorbents, Characteristics of oil sorbent materials. Oil sorption and retention Characteristics. (4)

Sorption capacity of loose fiber assembly, Fiber materials used for oil sorption and their characteristics - Other materials used for oil sorption. (5)

STANDARDS AND TEST METHODS: Test for sorption capacity, oil sorption rate, oil retention. Test for recovery of sorped oil and reusability of sorbents. Test for water uptake and buoyancy methods for oil sorbents. (6)

Total L: 15

REFERENCES:

1. William B Katz, "The ABCs of Environmental Science" Scarecrow press Inc, Maryland, USA, 2005.
2. Russel.S, "Handbook of Nonwovens", Textile Institute Publication, UK, 2004.
3. Horrocks A R and Anand S C, "Handbook of Technical Textiles", Woodhead publication and Textile Institute, England, 2000.

21TK08 COLD WEATHER PROTECTIVE TEXTILES

1 0 0 1

THERMAL INSULATION CHARACTERISTICS : Human thermoregulation in the cold. Thermal and tactile comfort in the cold. Yarn/fabric structure and thermal insulation. Layering the cold weatherclothing. New trends in thermoregulatory textiles for cold protection. (5)

COATING AND LAMINATED FABRICS FOR COLD WEATHER APPAREL : Breathable membranes. Manufacture and properties of hot melt coated and laminated fabrics. Testing of coated and laminated fabrics. (5)

STANDARDS AND LEGISLATION GOVERNING COLD WEATHER TEXTILES: Development of legislation and standards. Directives on personal protective equipment. standards for cold protective clothing. (5)

Total L: 15

REFERENCES:

1. Williams J T Textiles for cold weather apparel, Woodhead publishing Ltd, Cambridge, UK, 2009.
2. Richard A. Scott, Textiles for protection, The Textile Institute, CRC Press, Woodhead publishing Ltd, Cambridge, UK, 2005.
3. Horrocks A R and Anand S C, "Handbook of Technical Textiles", The Textile Institute, CRC Press, Woodhead publishing Ltd, Cambridge, UK, 2001.

21TK09 FABRIC SOURCING

1 0 0 1

SOURCING: Need for sourcing , sourcing materials ,Manufacturing Resources Planning (MRP). sourcing strategies. Local, National and International sourcing. (5)

COMMERCIALY AVAILABLE WOVEN AND KNITTED STRUCTURES: Woven –Crepe, Seersucker. Knitted- Airtex, Honeycomb, Pique. (5)

SAMPLE DEVELOPMENT: Fabric construction, analysis and sample development and applications. (5)

Total L: 15

REFERENCES:

1. E.Glock Ruth and I. Kunz Grace, "Apparel Manufacturing - Sewn Product Analysis",Blackwell Scientific Publications, 1996.
2. Course materials prepared by the Industry expert / Department of Textile Technology.

21TK10 SPECIALITY FABRIC SOURCING

1 0 0 1

SOURCING: Need for sourcing , sourcing materials ,Manufacturing Resources Planning (MRP). sourcing strategies. Local, National and International sourcing. (5)

SPECIALITY FABRIC :Technical woven and knitted fabrics, Spacer knitted fabric. (5)

SAMPLE DEVELOPMENT: Fabric construction, analysis and sample development and applications. (5)

Total L: 15

REFERENCES:

1. Course materials prepared by the Industry expert / Department of Textile Technology.

21TK11 INDUSTRY 4.0

1 0 0 1

INTRODUCTION: Globalization and Emerging Issues, Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories. (5)

SYSTEM AND TECHNOLOGY ENABLERS: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform, Artificial Intelligence, Big Data and Advanced Analytics. (5)

BUSINESS ISSUES IN INDUSTRY 4.0: Opportunities and Challenges, Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in Industry 4.0 world, Case Studies from Industry domains. (5)

Total L: 15

REFERENCES:

1. Geissbauer, R. "Industry 4.0: Building the digital enterprise", Global Industry 4.0 Survey, 2016.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", 2016.