

Textile Technology M.Tech

Uttar Pradesh Textile Technology Institute

Textile Technology Department

Course Scheme for M. Tech in Textile Technology Effective from 2021-22

M. Tech Sem. I

Course Code	Subject	Scheme of Studies per week			Credits	Ses .	ESE	Total
		L	T	P				
KMTT101	Program Core-I: Quality Evaluation of Textiles	3	0	0	3	30	70	100
KMTT102	Program Core-II: Advances in Yarn Manufacture	3	0	0	3	30	70	100
KMTT011 / KMTT012	Program Elective-I: Structural Mechanics of Yarn/Advances in Knitting & Nonwoven	3	0	0	3	30	70	100
KMTT021 / KMTT022 /KMTT023	Program Elective-II: Selected topics in Technical Textiles/High Performance Fibres & Composites /Specialty yarns and fabrics	3	0	0	3	30	70	100
KMTT104	Research Methodology & IPR	2	0	0	2	30	70	100
KMAU 101-108	Audit Course*:	2	0	0	0			
KMTT151	Evaluation of Textile materials Lab	0	0	4	2	20	30	50
KMTT152	Yarn Production Lab	0	0	4	2	20	30	50
					18			600

M. Tech Sem. II Semester

Course Code	Subject	Scheme of Studies per week			Credits	Ses sional	ESE	Total
		L	T	P				
KMTT201	Characterization of Fibres& Polymers	3	0	0	3	30	70	100
KMTT202	Advances in Fabric Manufacture	3	0	0	3	30	70	100
KMTT031/ KMTT032	Program Elective-III: Nano Technology in Textiles/ Advances in Fibre Production	3	0	0	3	30	70	100
KMTT041/ KMTT042/ KMTT043	Program Elective-IV: Mechanics of Fabric Structure /Textile Costing & Cost Control/Testing of Technical & Functional Textiles*	3	0	0	3	30	70	100
KMAU 201-208	Audit Course-II	2	0	0	0			
KMTT251	Fibres& Polymer Characterization Lab	2	0	4	2	20	30	50
KMTT252	Fabric Production lab	0	0	4	2	20	30	50
KMTT254	Mini Project with Seminar	2	0	0	2	30	70	100
					18			600

*Students are encouraged to go to Industrial Training/Internship for at least 2-3 months during semester break

Uttar Pradesh Textile Technology Institute
Textile Technology Department
Course Scheme for M. Tech in Textile Technology Effective from 2022-23
M. Tech Sem. III

Course Code	Subject	Scheme of Studies per week			Credits	Sessional	ESE	Total
		L	T	P				
KMTT051/ KMTT052	*Program Elective-V: Statistics & Control for Textile Industry/ Smart & Functional Textiles	3	0	0	3	30	70	100
KMOE051 -056	*Open Elective: 1. Business Analytics, 2. Industrial Safety, 3. Operation Research, 4. Cost Management of Engineering Projects, 5. Composite materials 6. Waste to Energy	3	0	0	3	30	70	100
KMTT351/ KMTT352	Dissertation-I/ Industrial Project	2	0	20	10	150	250	400
					16			600

*Students going for Industrial Project/Thesis will complete these courses through MOOCs.

M. Tech Sem. IV

Course Code	Subject	Scheme of Studies per week			Credits	Sessional	ESE	Total
		L	T	P				
KMTT4 51	Dissertation-II	0	0	32	16	200	400	600

Core 1: KMTT101: Quality Evaluation of Textiles

Core 2: KMTT102:Advances in Yarn Manufacture

Core 3: KMTT201: Characterization of Fibres & Polymers

Core 4: KMTT202: Advances in Fabric Manufacture

KMTT011: Structural Mechanics of Yarn

KMTT012: Advances in Knitting & Nonwoven

KMTT021: Selected Topics in Technical Textiles

KMTT022: High Performance Fibres & Composites

KMTT023: Specialty yarns and fabrics

KMTT031: Nano Technology in Textiles
KMTT032: Advances in Fibre Production/
KMTT041: Mechanics of Fabric structure
KMTT042: Textile Costing & Cost Control
KMTT043: Testing of Technical and Functional Textiles
KMTT051: Statistics & Control for Textile Industry
KMTT052: Smart & Functional Textiles

Open Elective: KMOE051-056

1. KMOE 011: Business Analytics,
2. KMOE012: Industrial Safety,
3. KMOE013: Operation Research,
4. KMOE014: Cost Management of Engineering Projects,
5. KMOE015: Composite materials,
6. KMOE016: Waste to Energy

Audit course 1 &2: Through online MOOCS/NPTEL

1. KMAU101/201: English for Research Paper Writing
2. KMAU102/202: Disaster Management
3. KMAU103/203: Sanskrit for Technical Knowledge
4. KMAU104/204: Value Education
5. KMAU105/205: Constitution of India
6. KMAU106/206: Pedagogy Studies
7. KMAU107/207: Stress Management by Yoga
8. KMAU108/208: Personality Development through Life Enlightenment Skills.

Semester 1:

Core 1:

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT101	Quality Evaluation of Textiles	3+2	3	4
Course Outcomes <ol style="list-style-type: none"> 1. Measure various fibre quality parameters. 2. Measure mass variations in various textile strands 3. Test tensile properties of textile materials. 4. Evaluate durability and shrinkage of textile fabrics 5. Evaluate comfort properties of textiles 				
Course Contents :- UNIT 1: Fibre classification, properties and standards, methods of measuring fibre fineness, Methods of Measuring fibre length, HVI testing- the basics, Application of HVI, AFIS- the basics, Testing & data analysis, maturity and fineness testing, Application of NIR spectroscopy for textile measurement, properties. Unit 2: Mass Variation of Textile Strands: Depiction of mass Variation of textile strands in time and frequency domain; interpretation and significance of U% and CV% for textile strands; classification and analysis of yarn faults created by mass variation, Variance Length Curves and Spectrogram of Textile Strands: Effect of specimen length and total length on mass variation measurements of textile strands; theory of construction of VL curve; analysis of variance length curves to understand and avoid the introduction of mass variation during the spinning operation; determination of periodic mass variation in the form of spectrogram; determination of theoretical wave length from spectrum; comparison between normal and ideal spectrum; type of faults and their representation in spectrogram; interpretation of superimposed waves in spectrogram UNIT 3: Strength & Elongation tests; definitions of different terms of tensile tests, factors affecting tensile testing, fibre strength, yarn strength & fabric strength test methods, Influence of testing factors on yarn tensile properties; measurement and application of yarn modulus; creep and stress relaxation of yarn; significance of estimating minimum yarn strength, seam strength. UNIT 4: Hygral expansion, relaxation shrinkage, swelling shrinkage, methods of measuring dimensional stability, Snagging test, wrinkle recovery & pilling resistance, abrasion resistance test, factors affecting abrasion resistance, UNIT 5: Thermal comfort, air permeability, moisture transport, sensorial comfort, water absorption and water repellency tests, colour fastness testing, objective evaluation of fabric handle. Kawabata system, FAST: fabric assurance by Simple testing, Fabric Appearance and other Properties Study of fabric appearance in terms of drape, formability, crease recovery, evaluation of fabric properties like flammability, impact resistance, absorbency				
Reference Books: <ol style="list-style-type: none"> 1. Advanced characterization and testing of textiles. Dolez, P. I., Vermeersch, O., & Izquierdo, V. (Eds.). (2017). Woodhead Publishing. 2. Physical testing of textiles. Saville, B. P. (1999). Elsevier Publications. 3. Principles of Textile Testing; an Introduction to Physical Methods of Testing Textile Fibers, Yarns, and Fabrics, Booth, J. (1961). New York, Chemical Pub. 4. Chemical testing of textiles. Fan, Q. (Ed.). (2005). CRC Press. 5. A Practical Guide to Textile Testing. Amutha, K. (2016). CRC Press. 				

Core 2:

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT102	Advances in Yarn Manufacture	3+2	3	4
<p>Course Outcomes: At the end of the Course Contents students will be able to</p> <ol style="list-style-type: none"> 1. Explain various aspects of opening and cleaning in modern blow room machinery and also process parameters involved in it 2. Analyze aspects of different zones of modern card and process parameters involved in it. 3. Analyze design aspects of various components of a comber & theories of drafting. 4. Explain fibre blending and process parameters involved in it. 5. Explain advancements of various spinning technologies 				
<p>Course Contents :- Unit I- Advances in spinning preparations: Fibre mixing and blending practices in industry, Bale Management, Blending Performance Evaluation, Evaluation of blow room performances and AFIS applications, Brief introduction about long fibre spinning like wool spinning, jute spinning Unit II –Advances in carding, theory of Fibre separation in carding, Design and actions of wire points in carding, Transfer efficiency in carding, Roller drafting, Causes of generation of irregularities, Advances in draw frame, Theory of hook removal in draw frame, Concept of Autolevellers in carding/ draw frame, Developments in cotton combing, Details of combing preparation, Developments in Speed frame, advances in woolen & worsted card, developments in Gill boxes, advances in rubbing frame Unit III –Advances in Ring spinning, Yarn tension in spinning balloon and its effect on yarn quality, Mass variation in ring spun yarns- basics, causes, measurements and detections, spinning of core spun yarn, Sewing thread manufacturing, Unit IV-Advances in Rotor Spinning:, Fibre properties and yarn quality, Yarn tension in rotor spinning, Process and machine parameters and yarn properties, Siro spun yarn manufacturing, Unit V - Air-vortex Spinning: Twisting and yarn formation, Process and machine parameters and yarn properties, Yarn structure and properties, Friction Spinning: Mechanism of yarn formation, Production of multi-layer and multi- component yarns by friction spinning, Yarn structure and property relation</p>				
<p>References Books:</p> <ol style="list-style-type: none"> 1. Spinning of Manmade and Blends on Cotton System, K. R. Salhotra 2. Textile Mathematics, Vol.-2 (The Textile Institute), J. E. Booth 3. The Technology of Short Staple Spinning, (Short Staple Spinning Series, Vol.-I), W. Klein 4. A Practical Guide to Opening and Carding, (Short Staple Spinning Series, Vol.-II), W. Klein 5. A Practical Guide to Combing and Drawing, Vol.-3 (The Textile Institute), W. Klein 6. A Practical Guide to Ring Spinning, Vol.-4 (The Textile Institute), W. Klein 7. New Spinning Systems, Vol.-5 (The Textile Institute), W. Klein 8. Fundamentals of Spun Yarn Technology (CRC Press), Carl A. Lawrence 9. The Principles and Theory of Ring Spinning, Vol.-V (The Textile Institute), A. E. De Barr and H. Catling. 10. Open-end Spinning (Elsevier Science), V. Rohlena 11. Rotor Spinning- Technical and Economic Aspects (Textile Trade Press, The Textile Institute), E. Dyson 12. Rotor Spinning (The Textile Institute, Manchester), C. A. Lawrence and K. Z. Chen 				
<p>Practical: Practical's are to be conducted based on the above Course Contents</p>				

Core 3: Semester 2

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT201	Characterization of Fibres & Polymers	3+4	3	4
<p>Course Contents Outcomes: At the end of the Course Contents students will be able to</p> <ol style="list-style-type: none"> 1. Characterize physical and chemical structures of textile fibres and polymers by using various instrumentation techniques. 2. Determine fibre morphology and its impact on properties 3. Evaluation of various properties of textile fibres such as mechanical, optical, and thermal properties. 4. Investigate internal and surface morphology of textile fibres 				
<p>Course Contents :-</p> <p>Unit 1: FIBRE STUDY: Basic concept of crystalline regions, and orientation - their effects on fibre properties. Fine structures and models of fibre structures such as, micelle, fibrillar, lamellar, three phase model etc. Sources of elucidation of fibre structure. Moisture Properties: Significance of moisture in textiles, hysteresis of moisture absorption, Quantitative theory of moisture absorption, effect of temperature, stresses and hydrophilic groups, crystalline and non-crystalline region, calculation of moisture regain, heat absorption and heat of wetting, Swelling.</p> <p>Unit 2- Refractive index and birefringence - absorption, dichroism, reflection and lustre of fibres. Nuclear Magnetic resonance (NMR): Radiation absorption by the nucleus in a magnetic field, Process of Relaxation , NMR Instrumentation, Fourier transform and continuous wave NMR Instruments, sample preparation of NMR, NMR study of major textile fibres. UV spectrophotometer, sample preparation, instrumentation, UV spectrometry of textile materials, Density Gradient Column. Brief Introduction to mass spectroscopy (11)</p> <p>Unit-3 Tensile behavior of textile materials, stress strain relations of fibres, Effect of moisture and temperature on stress, strain. Elasticity and elastic recovery of fibres. (6) Dynamic Modulus Analysis: Instrumentation Integration for DMA test, Axial and Torsional Deformation based DMA, Estimation of Polymeric Thermal Transition by DMA, creep behavior measurement, DMA result analysis (10)</p> <p>Unit-IV Principle of Spectroscopy, FTIR Spectroscopy, Fundamental of FTIR, FTIR Spectrometer Components, Sequence of Operations to scan a sample on FTIR Spectrometer, Detectors used in FTIR, FTIR analysis of major textile fibres, Mass Spectroscopy, Raman Spectroscopy, Inductively Coupled Plasma—Atomic Emission Spectrometry (ICP-AES): Atomic Emission Spectrometry Theory, major components, ICP-torch, sample preparation for IACP-AES, application of ICP-AES. (11)</p> <p>Unit-V- Optical microscopy, Scanning Electron Microscope, Transmission Electron Microscope, X-ray Diffractometer, Crystalline structure , Crystal Size, Bravais lattices, Cubic lattices, Bragg's Law of X-ray diffraction X-Ray sample preparation, Developments in X-Ray diffraction Techniques, Crystallinity by X-ray Diffraction, Crystalline Orientation, Herman's Orientation Factor, Differential Scanning Calorimetry, Heat Flux DSC, Power Consumption DSC, DSC Theory, Difference between a heat flow and a heat flux DSC, Sample Preparation for DSC, Crystallinity Measurement by DSC, Heat Capacity, Glass Transition Temperature, Crystallization during melting, Differential Thermal Analysis, Thermo Gravimetric Analysis, Thermo-Balance Principle in TGA, TGA study of measure textile fibres, Dynamic Mechanical Analysis (10)</p> <p>References Books:</p> <ol style="list-style-type: none"> 1. Turi E A "Thermal characterization of polymeric materials", Vol I and II, Academic Press, 1997. 2. Gedde, U. L. F. (1995). Polymer physics. Springer Science & Business Media. 3. Billmeyer F W, "Text book of polymer science", John Wiley and Sons, 1984. 4. Singh M K, Singh A, Characterization of Polymers and Fibres, 1st Edition, Elsevier and Textile Institute Publications, 2021 5. Morton W E and Hearle J W S, Physical Properties of Textile Fibres, 1st reprint, The Textile Institute, Manchester, 1986. 6. Gupta V B and Kothari V K, "Manufactured Fibre Technology" 1st Ed., Chapman and Hall, London, 1997. 7. Hearle JWS, Polymers and their properties, Vol. I, John Wiley and Sons, NY, 1982. 				
<p>Practical: Practical's are to be conducted based on the above Course Contents</p>				

Core 4: Semester 2

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT202	Advances in Fabric Manufacture	3+2	3	4
Course Outcomes: <ol style="list-style-type: none">1. Compare technology of manufacturing and applications of weaving, knitting and nonwoven fabrics.2. Explain recent advancement in weaving, knitting and nonwoven technology.3. Explain various mechanisms of machineries related to fabric production.4. Describe various features or fabric manufacturing machineries and there developments.5. Correlate structure and property relationship of manufactured fabrics.				
Course Contents :- <p>Unit 1: Advancement in wrap winding machines, study of automatic wrap winding machines, mechanism used in wrap winding machine. Yarn tension during unwinding of yarn, Tension measurement of running yarn, Different type of pirn winding machines, advancement in pirn winding machines.</p> <p>Unit 2: High production warping machines with creel development. Modern developments in sectional warping machines. Equation for drum capacity in warping machine, Loom development trends and objectives. Kinematics of sley and heald motion with reference to shuttle loom. Mechanism of shuttle checking. Analysis of warp tension during weaving.</p> <p>Unit 3: Theoretical analysis of weft insertion in shuttleless loom. Cloth fell position, beat-up force and pick spacing. Electronic control of different motions of loom. Techno-economics of different methods of fabric production.</p> <p>Unit 4: Types of weft knitting machines and its cam profile. Quality control in weft and warp knitted fabrics. Mechanics of knitted loop formation.</p> <p>Unit 5: Designing nonwoven for engineering applications. Effect of machine, fiber and process variables on the properties of nonwoven fabrics. Developments in nonwoven machineries.</p>				
References Books: <ol style="list-style-type: none">1. Majumdar, Abhijit. Principles of woven fabric manufacturing. CRC Press, 2016.2. Marks R and Robinsons A T C, "Principles of weaving", Textile Institute, UK, 1986.3. Banerjee P K, Principles of Fabric Formation, CRC Press, 20144. Ormerod A, "Modren preparations and weaving machinery", Buttersworth and Co., UK, 1983.5. Talavasek O and Svaty V, "Shuttleless weaving machine", Elsevier Scientific Publishing Co., Amsterdam, 1981.6. Lunenschloss J and Albrecht W, "Non-Woven Bonded Fabric", Ellis and Horwood Ltd., UK, 1985.7. Russell, S. J. (2006). Handbook of nonwovens. Woodhead Publishing.8. Spencer, D. J. (2001). Knitting technology: a comprehensive handbook and practical guide. Woodhead Publishing.9. Au, K. F. (Ed.). (2011). Advances in knitting technology. Elsevier.				
Practical: Practical's are to be conducted based on the above Course Contents				

Department Elective 1A: Semester 1

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT011	Structural Mechanics of yarn	3	3	0
Course Contents Outcomes: After this course student will be able to: <ol style="list-style-type: none">1. Explain the theoretically derived laws of yarn structure2. Derive relationship among yarn count, twist and diameter3. Derive expression for yarn irregularity using basic assumptions4. Explain theoretical models for yarn structure from initial assumptions5. Derive expression for tensile mechanics of yarn				
Course Contents :- <p>Unit 1: Fibre-The building blocks of yarns, Elements of yarn geometry. Basic characteristics of yarn, Relation among yarn, twist & diameter</p> <p>Unit 2: Geometry of helix and its application to yarn structure. Geometry of folded yarn.</p> <p>Unit 3: Mass irregularity of yarns, radial fibre migration in yarns, yarn shrinkage due to washing</p> <p>Unit 4: Tensile mechanics of yarn, Theoretical analysis of effect of fiber properties and their geometrical configuration on the tensile and bending properties of yarn. Theories and analysis of yarn strength, Breakage of continuous filament and spun yarns. Effect of properties of constituent fibres and blend composition on behavior of composite yarns.</p> <p>Unit 5: Effect of yarn structure on different properties of yarns, Structure and property relationship of ring, rotor, air-jet and friction spun yarns, Strength-length relation in yarn</p>				
References: <ol style="list-style-type: none">1. Hearle J W S, Grosberg P and Backer S, "Structural mechanics of fibres yarns and fabrics", Wiley Interscience, New York, 1969.2. Goswami B C Martindale J G and Scardino F, "structure and applications", Wiley Interscience Publisher, New York, 1995.3. Hearle J W S, Thwaites J J and Amirbayat J, "Mechanics of flexible fibre assemblies", Sijthff and Noordhoff International Publishers BV, Alphen aan den Rijn, Netherlands, 1980.				

Department Elective 1B

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT012	Advances in Knitting & Nonwoven	3	3	0
Course Outcomes: <ol style="list-style-type: none">1. Enumerate recent advances in the field of knitting and nonwoven technology.2. Explain mechanism of knitting and action of various knitting elements.3. Explain structure property relationship between knitted and nonwoven fabrics.4. Distinguish various nonwoven manufacturing technology, machines and mechanisms.5. Find suitable applications of knitted and nonwoven fabrics.				
Course Contents :- <p>Unit 1: Concepts of loop formation in weft and warp knitting. Different forces acting on the needle butt and mechanics of loop formation. Study of dynamics of knitting process. Study of different machines, process and yarn parameters affecting the yarn tension in knitting zone and loop length.</p> <p>Unit-2I: Concept of 'Robbing Back' of yarn in loop. Study of design and performance of high sped knitting cam and increase in machine production. Yarn feeding devices on circular knitting machines.</p> <p>Unit-3: Geometry and properties of weft knitted fabrics –k-values and Pierce's geometry. Outlines of process control in knitting. Use of electronics and computers and other developments in knitting. Features of warp knitted fabrics and their uses.</p> <p>Unit 4-Classification and areas of application of nonwoven fabrics. Different methods of production of nonwoven fabrics. Effect of machines, fibre and process variables on properties of nonwoven fabrics. Failure mechanism of nonwoven fabrics.</p> <p>Unit-5: Prediction of needle punched nonwoven fabric behavior. Designing of nonwoven for engineering applications. Development in nonwoven machineries. Developments in various nonwoven manufacturing techniques.</p>				
References: <ol style="list-style-type: none">1. Lunenschloss J and Albrecht W, "Non-Woven Bonded Fabric", Ellis and Horwood Ltd., UK, 1985.2. Russell, S. J. (2006). Handbook of nonwovens. Woodhead Publishing.3. Kellie, G. (Ed.). (2016). Advances in technical nonwovens. Woodhead Publishing.4. Spencer, D. J. (2001). Knitting technology: a comprehensive handbook and practical guide. Woodhead Publishing.5. Maity, S., et. al., (Ed.). (2021), Advanced Knitting Technology, Woodhead Publishing, UK.6. Au, K. F. (Ed.). (2011). Advances in knitting Technology. Elsevier.7. Ray, S. C. (Ed.). (2012). Fundamentals and advances in knitting technology. CRC Press.				

Department Elective 2A

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT021	Selected Topics in Technical Textiles	3	3	0

Course Outcomes:

1. Classify and explain various sectors of technical textiles.
2. Explain features, merits, demerits, types and applications of textile structural composites.
3. Describe the applications of textiles in various sectors of technical textiles.
4. Explain the technology of industrial tapes and narrow weaving for technical textiles.
5. Find applications of carpet and home textiles.

Course Contents :-

Unit-1: Composites: Basic concepts, classification, manufacturing techniques-from fibre to composite, textile composites, composite applications, reuse & recycling;

Geotextiles: Geotextiles: basic classification, main functions of a geotextiles, applications; Architectural textiles, concepts of tensegrity structures.

Unit-2: Automotive Textiles: requirements on automotive textiles including tyre cords, air bags, seat belts and seat fabrics, carpets, trims.

Filtration: Principles of filtration, industrial filtration in textile, chemical, food and metallurgical applications.

Unit-3: Medical Textile: Medical textile materials and structures; application of compression bandage technology for medical care; integrating electronic sensors into medical textiles; knitted electro-textiles.

Protective Textiles: Bullet proof, stab proof vests. Impact protection: impact mechanism and cellular textile composites. Ballistics and body armour.

Technical clothing, sportswear, spacewear, sailing equipment. Medical and Smart Textiles

Unit-4: Industrial Tapes: Slide fastener tapes - Insulating tapes – Book binder's tapes - Labeling Tapes – Border Tapes – Elastic- Pleated lingerie ribbing. Classification of braids – Trimmed braids – Flat braids – Circular Braids - Hollow braids. Production techniques. Properties and applications.

Unit-5: Carpet and Home Textiles: Non-pile carpet weaves and their looms. Pile surfaced carpet weaves and their looms. Needle felt floor coverings. Definition of home textiles-requirements. Kitchen linen, Bedlinen, Furnishing, Floor coverings, Wall coverings, Decoration fabrics.

References:

1. Horrocks, A. R., & Anand, S. C. (2000). Handbook of Technical Textiles: Technical Textile Applications (Vol. 2). UK: Woodhead Publishing.
2. Horrocks, A. R., & Anand, S. C. (Eds.). (2015). Handbook of Technical Textiles: Technical Textile Processes. Woodhead Publishing.
3. Paul, R. (2019). High Performance Technical Textiles. John Wiley & Sons, Incorporated.
4. Sabit Adanaur, Wellington Sears Handbook of Industrial Textiles, Technomic Publishing Company, Inc., Pennsylvania, USA, 1995.
5. P.K. Mallick, (2007) Fiber-Reinforced Composites Materials Manufacturing and Design-CRC Press.
6. Butola, B. S., Shahid-ul-Islam, Advances in Functional and Protective Textiles (2020). Elsevier, Woodhead Publishing.
7. Kumar, R. S. (2013). Textiles for industrial applications. CRC Press.

Department Elective 2B

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
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KMTT022	High Performance Fibres & Composites	3	3	0
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Course Outcomes:

1. Classify various high performance fibres and role of its phases.
2. Describe manufacturing process of various high performance fibres.
3. Use the high performance fibres for various applications including structural composites.
4. Explain nano-composites and its applications.
5. Evaluate properties of high performance fibres and composites.

Course Contents :-

Unit 1: Aramids & Co Polyesters: Fibres formation – Fibre & structure properties, performance and Application. **Carbon and Graphite:** Classification and Types, manufacturing Processes from Polyacrylonitrile (PAN) and Rayon structured pitch based fibres, properties.

Unit-2: Glass Fibres: Types and Composition, Manufactures Processes, Fibre structures, Properties and Applications. **Poly EtheleneFibres: Types-** UHMWPE, HDPE, Manufacturing process, properties and applications **Ceramic Fibres:** Classification and fibre formation, composition, structure, properties and application

Unit-3: **Polyurethane Elastomeric Fibres:** Manufacturing Processes, Fibre Properties, Application and future trends **Metallic Compound Fibres:** Aluminium Oxide fibres and lead oxide fibres – Preparation and processes, Fibre structure, properties and Application.

Unit 4: **Optical Fibres:** Light Propagation. Silica Fibres- Fibre manufacture and Application, **Definition of composite.** General introduction to fibres and resins for composites. Composite fabrication techniques. Matrices and interphase. Applications of natural fibres and technical fibres in composite.

Unit 5: Nano-composite: Introduction, advantages and different nanomaterials commonly used as fillers (Carbon nanotubes, carbon nanofibres and Nano clay).

References:

1. Horrocks, A. R., & Anand, S. C. (2000). Handbook of Technical Textiles: Technical Textile Applications (Vol. 2). UK: Woodhead Publishing.
2. Horrocks, A. R., & Anand, S. C. (Eds.). (2015). Handbook of Technical Textiles: Technical Textile Processes. Woodhead Publishing.
3. Paul, R. (2019). High Performance Technical Textiles. John Wiley & Sons, Incorporated.
4. Sabit Adanaur, Wellington Sears Handbook of Industrial Textiles, Technimic Publishing Company, Inc., Pennsylvania, USA, 1995.
5. P.K. Mallick, (2007) Fiber-Reinforced Composites Materials Manufacturing and Design-CRC Press.
6. Kumar, R. S. (2013). Textiles for industrial applications. CRC Press.
7. Rana, S. and Fanguero R. (eds.), (2016). Fibrous and Textile Materials for Composite Applications, Springer.

Department Elective 2C

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT022	Specialty Yarns & Fabrics	3	3	0

Course Outcomes: After successful completion of this course, the students should be able to;

1. Describe the characteristics of raw materials and techniques and parameters required for formation of textured yarn.
2. Outline the process sequences for formation of yarn from man-made staple fibres
3. Demonstrate the methods of formation of core yarn.
4. Describe the working principle of different new spinning technology for formation of yarn

and application of those yarns.

Course Contents :-

Unit 1 Textured Yarn Technology:

False Twist Texturising Techniques. Principle of False twists texturising machines, Single heater and double heater. Twisting elements. Factors influencing Twist, Properties of Textured yarn, Effect of feed material and process variables. Basics of air jet texturing, types of yarns produced, process variables - over feed, air pressure temperature and water content. Nozzles, evaluation of textured yarn. Measurement of shrinkage force. Crimp contraction and dye uniformity. Texturamat, M Dynafil tester.

Unit 2 (10 Hours) Spinning of man-made staple fibres:

Study of the spinning of man-made staple fibres, material preparation, processing guidelines, problems, settings, modifications required on cotton and worsted spinning system, steaming and stabilization of yarns. Spinning of dyed fibres, Spinning of micro fibres. Conversion of filament to spun yarn, Principles of stretch breaking and cutting tow to sliver and yarn converter. Formation bulked Acrylic yarn.

Unit 3 Production of Fancy yarn: Classification of fancy yarn. Methods of producing slub yarn, Drawn and spun yarn, Methods of producing Knop yarn, Snarl yarn, Loop yarn, Spiral yarn etc. Methods of producing mélange yarn. Method of producing melange yarn, Chennile yarn. Hybrid yarn. High bulk yarn, reflective yarn, electro-coated yarn, Elastomeric yarn.

Unit 4: Narrow fabrics: Introduction to fibre and yarn types, fabrics. Preparation for narrow fabric production, winding, warping, sizing, looming. Narrow fabric production, Woven narrow fabrics and their constructions, structure of narrow fabrics woven on shuttleless looms. Conventional shuttle looms. Needle looms for narrow fabrics production. Braided fabrics 3D Fabric and Spacer fabric production. Profiled fabrics, Contour fabrics. Polar fabrics, Spiral fabrics

Unit 5: Industrial tapes: Slide fastener tapes - Insulating tapes, Book binder's tapes, Labeling Tapes, Border Tapes, Elastic- Pleated lingerie ribbing. Carpets: Non-pile carpet weaves and their looms. Pile surfaced carpet weaves and their looms. Needle felt floor coverings. Home textile products: Definition – requirements and production of Kitchen linen, Bed linen, Furnishing, Floor coverings, Wall coverings, Decoration fabrics.

References:

1. Hearle, J. W. S., (2001). Yarn Texturing Technology, Woodhead Publishing.
2. Eric Oxtoby, "Spun Yarn Technology".
3. Goswami, Martindle, Scardino, "Textile Yarns".
4. Klien W, "New Spinning Technology", The Textile institute, Manchester.
5. Salhotra K R, "Spinning of Manmades and blends on cotton system", The Textile Association, India.
6. Lawrence C A, "Fundamentals of Spun Yarn Technology", CRC Press LLC, Florida, USA.
7. Chattopadhyay R, "Advance in Technology of yarn Production", Nodal Centre for Upgradation of Textile Education, IIT Delhi.

Department Elective 3A

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT031	Nano Technology in Textiles	3	3	0

Course Outcomes:

1. Explain the concept of nanotechnology and manufacturing of some nano materials
2. Elucidate electrospinning in nanofibre production and applications of these fibres
3. Describe fabrication and usage of nanocomposites in textiles

4. Explain the mechanism of nano finishing on properties of textiles.

Course Contents :-

Unit 1: Fundamentals of nanotechnology, Basic properties of nanomaterial, Fabrication of nanomaterial, Top down and Bottom up approaches. Outline of Various methods of synthesis of nanomaterial.

Unit 2: Different methods of production of Polymer Nanofibres, comparison of the methods namely Drawing, Electrospinning, Self-assembly, Template synthesis, and Thermal-induced phase separation. Polymer nanofibres: Properties of polymer relevant to electrospinning, Polymer Crystallinity, Polymer Molecular Weight, Glass Transition Temperature (T_g), Solution properties - Surface tension and Viscosity, polymer solubility, evaporation, basics of electrostatics and conductivity of solutions.

Unit 3: Parameters affecting nanofibres production by electrospinning and other methods. Controlling structure and properties of nanofibres by different ways. Various applications of Nanofibres and nanofibre coated textile fabrics such as in filtration, scaffolds, composites, dye sensitised solar cells, catalysis etc. Outline of the characterization methods

Unit 4: Nanocomposites, polymers with CNTs: synthesis and their application, Polymer – nanoclay composites fabrication and application, Principles of Polymer/Inorganic-inorganic nano composites in various Textile applications

Unit 5: Classification of nano finishing on textile, use in preparatory processes of the textile fabrics. Nano-coating of textiles: electroless deposition, layer-by-layer deposition, CVD and PVD Organic and Inorganic Atomic Layer deposition techniques on textiles, Nano finishing of textiles by sol-gel methods, smart Nano coating of textiles. Nanofinishes such as antimicrobial finishes, soil release finishes, flame retardants, antistatic, fluoro chemical, Nanotechnology based finishes for personal protection, such as bacteria, virus, toxic gas and chemicals, chemical warfare agents (CWA) etc.

References:

1. Brown, P., & Stevens, K. (Eds.). (2007). *Nanofibers and nanotechnology in textiles*. Elsevier.
2. Mishra, R., & Militky, J. (2018). *Nanotechnology in Textiles: Theory and Application*. Woodhead Publishing.
3. Smith, W. C. (Ed.). (2010). *Smart textile coatings and laminates*. Elsevier.
4. Noor-Evans, F., Peters, S., & Stingelin, N. (2012). Nanotechnology innovation for future development in the textile industry. In *New Product Development in Textiles* (pp. 109-131). Woodhead Publishing.
5. Shabbir, M., & Mohammad, F. (2017). Insights into the functional finishing of textile materials using nanotechnology. In *Textiles and clothing sustainability* (pp. 97-115). Springer, Singapore.

Department Elective 3B

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT032	Advances in Fibre Production	3	3	0

Course Outcomes

1. Judge raw material quality for manufactured fibres and parameters needed for their spinning process.
2. Explain rheology and kinetics of Melt and solution spinning processes.
3. Illustrate the mechanism of dry and wet spinning and control the spinning processes.
4. Identify the control parameters affecting fibre morphology.
5. Explain the process and effects of drawing and heat setting on fibre structure and

properties.

Course Contents

Unit 1: Manufacture and specifications of raw materials and monomers. Types, methods of manufacture, mechanism of polymerisation and production techniques of viscose, nylon 6 and 66, PET, PAN and PP.

Unit 2: Introduction to new developments. Other fibres including PU, PVA, PE, PVC and polyvinylidene chloride. General definition of manmade or manufactured fibres, introduction to general principles of spinning and spinning processes,

Unit 3: Melt spinning: Basic principles of fluid flow during fiber spinning, Primary and secondary variables and their effect on melt spinning, factors affecting shear viscosity. Melt Rheology, Elongational flow, spinnability and flow instabilities. Extruder design, spin head, spinneret, quench chamber. Spin finish application, wind up mechanism.

Unit 4: Solution spinning: Wet and dry spinning, various variants of wet solution spinning, Rheology, Spinnability in solution spinning, kinetics, Mechanism for development of fibre morphology, Effect of polymer modification on morphology,

Unit 5: Drawing: Concept, Drawing Machines, drawing parameters, Structure development during drawing

High speed spinning, spinning of microfibre, Heat-setting of fibres.

Reference Books

1. Vaidya A A, "Production of Synthetic Fibres", 1st Ed., Prentice Hall of India, New Delhi, 1988.
2. Gupta V B and Kothari V K, "Manufactured Fibre Technology", 1st Ed., Chapman and Hall, London, 1997
3. Mark H F, Atlas S M and Cernia E, "Man Made Fibre Science and Technology", Vol. 1, 2, 3, 1st Ed., Wiley Inter Science Publishers, New York, 1967.
4. Macintyre J E, "Synthetic Fibres", Woodhead Fibre Science Series, UK, 2003.
5. Fourné F, "Synthetic Fibres: Machines and Equipment, Manufacture, Properties", Hanser Publisher, Munich, 1999.

Department Elective 3C

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT033	Testing of Technical and Functional Textiles*	3	3	0
Course Objectives: <ol style="list-style-type: none">1. Explain performance properties and functions of technical textiles2. Evaluate various functional properties of technical textiles.3. Identify various parameters affecting performance of functional and technical textiles.4. Find applications of the functional and technical textiles.				
Course Contents :- <p>Unit 1: Testing of Low Stress Mechanical Properties of Textile Fabrics: fabric handle, bending length, flexural rigidity, cantilever principle, hanging loop method, Kawabata Evaluation System KES, Fabric</p>				

Assurance by Simple Testing FAST.

Testing of Transmission Characteristics of Textile Fabrics: air, moisture and heat transmission, air permeability, evaluation of liquid water transmission, wetting, wicking, tensiometry and goniometry, evaluation of liquid water transmission, wicking: Test methods of transplanar or transverse wicking, in plane wicking, vertical wicking, moisture management tester, evaporative dish method, upright cup method, Upright cup method, sweating guarded hot plate method, PERMETEST method, Measurement of thermal transmission. Tog and Clo,togmeter, guarded hot plate, KESF thermo-lab. Testing of Thermal transmission characteristics for extreme heat condition, Flame exposure test, Radiant heat, steam, hot water splash exposure test, etc.,

Unit 2: Testing of Fibre Reinforced Composite Materials: Characterization and test for thermoset and thermoplastic matrix, get time evaluation, moisture content, melt flow index, density, thermal characteristics, reinforced material fibre characterization, fibre surface characterization, FTIR, testing of mechanical properties: tensile, compression, impact, dynamic test, fibre-matrix interfacial strength test, Various methods of void test,

Unit 3: Testing of Filter Fabrics: woven, nonwoven and composite filters, liquid filtration, surface and depth filtration, particle capture mechanisms, variables of particle capture mechanism, various properties of filter fabric, filtration efficiency, particl;e collection efficiency, penetration efficiency, permeability, filter life, air filtration: apparatus, parameters, cleaning efficiency, capillary flow porometry, tensile and bursting strength of filter fabrics, various types of filters, air quality, N95 mask,

Unit 4: Testing of Geo-textiles: Functions of geotextiles, laboratory and filed tests, In-isolation test, performance tests, physical, mechanical, hydraulic, endurance and degradations tests.

Testing of Ballistic Protective Clothing: bulletproof test, dynamic impact test weapon test, back face signature test.

Testing of UV Radiation Protective Textiles: Measurement ofUltraviolet Protection Factor, Erythema Weighted Transmittance, sun protection factor, UV index, Parameters affection UV protections of fabrics.

Unit 5: Testing of Compression Bandages: compression therapy,Oedema, filtration and reabsorption, measurement of bandage pressure and stiffness, parameters e\ affecting bandage pressure.

Testing of Electromagnetic Shielding Textiles: Concept of electromagnetic waves, its effects, EMI shielding efficiency, measurement, co-axial transmissions, wave-guide principle, s-parameters, various EMI shielding materials and their performance.

Reference Books

1. Prof. Apurba Das, Testing of Functional and Technical textiles, NPTEL course.
2. Horrocks, A. R., &Anand, S. C. (2000). Handbook of Technical Textiles: Technical Textile Applications (Vol. 2). UK: Woodhead Publishing.
3. Horrocks, A. R., &Anand, S. C. (Eds.). (2015). Handbook of Technical Textiles: Technical Textile Processes. Woodhead Publishing.
4. Paul, R. (2019). High Performance Technical Textiles. John Wiley & Sons, Incorporated.
5. SabitAdanaur, Wellington Sears Handbook of Industrial Textiles, Technimic Publishing Company, Inc., Pennsylvavania, USA, 1995.
6. P.K. Mallick, (2007) Fiber-Reinforced Composites Materials Manufacturing and Design-CRC Press.
7. Kumar, R. S. (2013). Textiles for industrial applications. CRC Press.

Department Elective 4A

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT041	Mechanics of Fabric structure	3	3	0

Course Outcomes: The students be able to-

1. Apply the concept of Pierce Geometry & calculate the maximum cover factor, crimp and GSM of fabric under jammed and special conditions.
2. Analyze the limitations of Pierce model and their modifications
3. Derive expression for modeling of fabric behavior under tension, bending & shear

4. Derive expression for structural and mechanical properties of knitted fabrics

Course Contents :-

Unit 1: Engineering approach for fabric formation, cloth geometry, practical aspect of cloth geometry, jammed structure, racetrack section of yarn. Fabric cover and its significance.

Unit 2: Graphical relationship in cloth geometry for plain, twill and sateen weaves. Theoretical investigation of weavability limit of yarns.

Unit 3: Elastic thread model for fabric. Concept of fabric relaxation. Tensile and tearing behaviour of fabric. Bending deformation of fabric, bending hysteresis of woven fabric. Buckling, shear and drape behaviour of woven fabric.

Unit 4: Compression behavior of woven fabrics, creasing in woven fabrics, Geometrical and mechanical properties of warp and weft knitted fabrics. Mechanical properties of nonwoven needle punch and stitch bonded fabric.

Unit 5: Formability, tailorability and hand of apparel fabric, Application of woven fabrics.

References:

1. Hearle J W S, Grosberg P and Backer S, "Structural Mechanics of Fibres Yarns and Fabrics", Wiley Interscience, New York, 1969.
2. Peirce F T and Womersley J R, "Cloth Geometry", The Textile Institute, Manchester, 1978.
3. Hearle J W S, Thwaites J J and Amirbayat J, "Mechanics of Flexible Fibre Assemblies", Sijthff and Noordhoff International Publishers BV, Alphen aan den Rijn, Netherlands, 1980.
4. B.K. Behera & P.K. Hari, Woven Textile Structure, Woodhead Publishing Ltd, CRC press, 2010

Department Elective 4B

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT042	Textile Costing & Cost Control	3	3	0
<p>Course Contents Outcomes: The students be able to Explain the basic concept of costing, elements of costing, methods of costing Apply the concept of costing to calculate fixed and variable cost & overall cost of production in spinning & weaving Apply the knowledge in calculating the break-even point of production & optimizing the product mix. Identify critical cost control area and suggest ways to control the cost of production</p>				
<p>Course Contents :- Unit 1: FUNDAMENTALS OF COSTING: Cost concept. Classification of cost, elements of cost. Methods of costing. Unit and operating costing, preparation of cost sheet. Estimation of cost of production and component of total cost. Profit planning, job order, batch process, conversion cost. Inventory costing. Unit 2: COSTING IN SPINNING INDUSTRY: Elements of cost – Ascertainment of Clean Cotton Cost – Cost Statements Quantity and value of total cotton/ Man-made fiber issued input, wastage and output in each processing cost center up to yarn stage- Net Mixing Cost- Waste multipliers for each cost center mixing wise Cost Centrewise conversion cost, Selling price of various wastes. Power cost estimation, Yarn realisation statement, Decision making using Contribution per frame shift among various counts of yarn production. Unit 3: COSTING IN WEAVING INDUSTRY:–Elements of cost Calculation of Yarn requirements for weaving –computation of value loss and net realization, Cost Statements– Cost centre wise conversion cost from winding to weaving, Sort wise cost of production of Grey Cloth sort wise stock accounting of Grey cloth, Cost of Sizing material, Cost of sales of cloth sold in grey stage and sales realization Unit 4: COSTING IN KNITTING AND GARMENT INDUSTRY:– Elements of cost –Calculation of garment weight of different sizes, Dia determination, Setting the knitting program, Dyeing program,Consumption of fabric per garment. Estimating of cost of process loss in Compacting, Bleaching, Raising, Shearing, Printing and Dyeing. Estimating the Knitting rates, Calculation of CMT charges. Cost sheet with Profit margins and foreign quotes. Unit 5: COST CONTROL AND COST REDUCTION: Introduction, Process of Cost Control and Cost Reduction, Cost Reduction Programme and its implementation, Methods and Techniques-Value analysis and Value Engineering, Just -In-Time (JIT), Activity Based Costing(ABC).</p>				
<p>References: Bhava P V and Srinivasan V, "Cost accounting in textile mills", ATIRA monograph, Ahmedabad, India, 1974 Varma H K, "Costing in Textile Industry", Dhanpat Rai publications, New Delhi, 1965 Shinn William, "Elements of Textile Costing" School of Textiles, North Carolina state, 1965 Jain IC, "Cost accounting-An introduction", Prentice hall, New Delhi, 2001 Ratnam T V, "Cost control and costing in spinning mills", Seshan printers, Coimbatore, India, 1992</p>				

Department Elective 5A

Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT051	Statistics & Controls for Textile Industry	3	3	0
<p>Course Outcomes:</p>				

1. Calculate all central tendencies, variations, and their confidence intervals using statistical probability distributions.
2. Test significance difference between mean, difference between means, variance, ratio of variance by using statistical technique.
3. Design an experiment accounting all parameters and analyse the effect of all parameters on response.
4. Derive empirical relationship between all independent and dependent variables using theory of regression and ANOVA and interpret goodness of fit.
5. Control and monitor the quality of product and process by applying the concepts of variable and attribute control charts.

Course Contents :-

Unit 1: STANDARD PROBABILITY DISTRIBUTIONS: Mean and variance of Probability distribution, Geometric distribution, Binomial distribution, Poisson distribution, Normal approximation to Binomial and Poisson.

Unit 2: 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.

Unit 3: ANALYSIS OF VARIANCE: ANOVA for different models, test of significance – comparison with a control, global comparisons. Rank test.: **DESIGN OF EXPERIMENTS:** Introduction. Random variation in experiments – randomization, 2ⁿ full-factorial designs – Yate’s algorithm, fractional replication. Optimization techniques using composite designs.

Unit 4: LINEAR REGRESSION: Introduction. Method of least squares – linear regression equation – correlation coefficient. Regression through origin – multiple regression. Confidence limits.

Unit 5: CONTROL CHARTS: General principle of control charts – action and warning limits – interpretation of control charts. Control charts for defectives, defects, averages, ranges. Cusumcharts. Process capability analysis.

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.

Department Elective 5B

Departmental Elective-				
Code	Name of the course	Total Credits	Lectures/week	Practical/ week
KMTT052	Elective: Smart &	3	3	0

	Functional Textiles			
<p>Course Outcomes</p> <ol style="list-style-type: none"> 1. Describe general introduction of smart textiles and modelling of intelligent materials. 2. Elucidate temperature sensitive shape memory polymers. 3. Explain solar textiles and introduction to conductive materials. 4. Describe applications of smart / intelligent textiles. 				
<p>Course Contents</p> <p>Unit I - General introduction: Definition, classification, intelligent systems and general applications.</p> <p>Unit II - Modelling of intelligent materials: Background, underpinnings of interdisciplinary, scientific practices and research strategies for intelligent garments</p> <p>Unit III - Phase change materials: Heat balance and thermo-physiological comfort, Phase change technology, PCM in textiles, Future prospects of PCM in textiles and clothing Intelligent textiles with PCMs: Basic information of phase change materials, Phase change properties of linear alkyl hydrocarbons, Textiles</p> <p>Unit IV - Temperature sensitive shape memory polymers: A concept of smart materials, Shape memory polymer and smart materials, Some examples of shape memory polymer for textile applications, Potential use of shape memory polymer in smart textile, General field of application, Challenges and opportunities. Study of shape memory polymer films for breathable textiles: Breathability and clothing comfort, Breathable fabrics, Water vapor permeability (WVP) through shape memory polyurethane Chromic and conductive materials: Photo chromic materials, Thermochromics materials, Color changing, Electro chromic materials</p> <p>Unit V - Solar textiles: production and distribution of electricity coming from solar radiation: Solar cells, Textiles as substrates, Technological specifications, Challenges to be met, Suitable textile constructions. Introduction to conductive materials: Electric conductivity, Metal conductors, Ionic conductors, inherently conducting polymers, Application technologies for conducting fibre materials Multipurpose textile based sensors: Introduction, Conductive polymer textile sensors, Conductive polymer composites (CPCs) textile sensors Textile micro system technology: Textile micro system technology, Textiles are inherent microstructures, Textile-based compliant mechanisms in micro-engineering and mechatronics</p> <p>Unit VI - Applications: Intelligent textiles for medical and monitoring applications, Context aware textiles for wearable health assistants, Intelligent garments in prehospital emergency care, Intelligent textiles for children, Wearable biofeedback systems, Applications for woven electrical fabrics</p>				
<p>Reference Books</p> <ol style="list-style-type: none"> 1. Smart fibres, fabrics and clothing edited by Xiaoping Tao, Wood head publishing Ltd., England. 2. Intelligent Textile and clothing edited by H. R. Mattila, Wood head Publishing, England. 3. Clothing bisensory Engineering edited by Y. L. and A. S. W Wang, Wood head publishing Ltd. England. 				

Research Methodology and IPR: Lectures: 2 hrs/week

Course Outcome:

At the end of this course, students will be able to

- Formulate research problem.
- Analyze research related information and data.
- Follow research ethics
- Explain Computer applications, Information Technology ruled by ideas, concept, and creativity.
- Explain IPR for the growth of individuals & nation.
- Describe IPR protection that provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Syllabus Content:

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IIT.

References:

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
- Mayall, "Industrial Design", McGraw Hill, 1992.
- Niebel, "Product Design", McGraw Hill, 1974.
- Asimov, "Introduction to Design", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Audit 1 & 2

A) ENGLISH FOR RESEARCH PAPER WRITING:

Course Outcomes: Students will be able to:

1. Explain the methods of improving your writing skills and level of readability
2. Write in each section
3. Write a good quality of paper at very first-time submission

Syllabus

Units	Contents	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	4
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	4
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	4
6	useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	4

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. . Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

B) Audit 1 & 2: Disaster Management

Course Objectives: -Students will be able to:

1. Demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

4. Analyse the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus

Units	Contents	Hours
1	Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4	Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Cooperation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	4
6	Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	4

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" "New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

C) AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives

1. Culture illustrious Sanskrit, the scientific language in the world
2. Apply Sanskrit to improve brain functioning

3. Apply Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. Explore the huge knowledge from ancient literature.

Syllabus

Units	Contents	Hours
1	<ul style="list-style-type: none"> • Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences 	8
2	<ul style="list-style-type: none"> • Order • Introduction of roots • Technical information about Sanskrit Literature 	8
	<ul style="list-style-type: none"> • Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics 	8

Suggested reading

1. "Abhyastakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" PrathamaDeeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

D) AUDIT 1 and 2: VALUE EDUCATION

Course Objectives Students will be able to

1. Explain value of education and self- development
2. Imbibe good values in students
3. Know about the importance of character

Syllabus

Units	Contents	Hours
1	<ul style="list-style-type: none"> • Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. • Moral and non- moral valuation. Standards and principles • Value judgments 	4
2	<ul style="list-style-type: none"> • Importance of cultivation of values. • Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. • Honesty, Humanity. Power of faith, National Unity. •Patriotism.Love for nature ,Discipline 	6
3	<ul style="list-style-type: none"> • Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking. • Free from anger, Dignity of labour. 	6

	<ul style="list-style-type: none"> • Universal brotherhood and religious tolerance. • True friendship. • Happiness Vs suffering, love for truth. • Aware of self-destructive habits. • Association and Cooperation. • Doing best for saving nature 	
4	<ul style="list-style-type: none"> • Character and Competence –Holy books vs Blind faith. • Self-management and Good health. • Science of reincarnation. • Equality, Nonviolence ,Humility, Role of Women. • All religions and same message. • Mind your Mind, Self-control. • Honesty, Studying effectively• 	6
Suggested reading 1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi		

Course outcomes

Students will be able to

1. Get knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

E) AUDIT 1 and 2: CONSTITUTION OF INDIA

Course Objectives:

Students will be able to:

1. Explain the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. Address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution

Units	Contents	Hours
1	<ul style="list-style-type: none"> • History of Making of the Indian Constitution: • History Drafting Committee, (Composition & Workin 	4
2	<ul style="list-style-type: none"> • Philosophy of the Indian Constitution: • Preamble Salient Features 	4
	<ul style="list-style-type: none"> • Contours of Constitutional Rights & Duties: • Fundamental Rights • Right to Equality • Right to Freedom • Right against Exploitation • Right to Freedom of Religion • Cultural and Educational Rights • Right to Constitutional Remedies • Directive Principles of State Policy • Fundamental Duties. 	4

	<ul style="list-style-type: none"> • Organs of Governance • Parliament • Composition • Qualifications and Disqualifications • Powers and Functions • Executive • President • Governor • Council of Ministers • Judiciary, Appointment and Transfer of Judges, Qualifications • Powers and Functions 	4
	<ul style="list-style-type: none"> • Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy 	4
	<ul style="list-style-type: none"> • Election Commission: • Election Commission: Role and Functioning. • Chief Election Commissioner and Election Commissioners. • State Election Commission: Role and Functioning. • Institute and Bodies for the welfare of SC/ST/OBC and women 	4

Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes: Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

F) AUDIT 1 and 2: PEDAGOGY STUDIES

Course Objectives: Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Syllabus

Units	Contents	Hours
1	<ul style="list-style-type: none"> • Introduction and Methodology: • Aims and rationale, Policy background, Conceptual framework and • terminology • Theories of learning, Curriculum, Teacher education • Conceptual framework, Research questions. • Overview of methodology and Searching 	4
2	<ul style="list-style-type: none"> • Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. • Curriculum, Teacher education. 	2
	<ul style="list-style-type: none"> • Evidence on the effectiveness of pedagogical practices • Methodology for the in depth stage: quality assessment of included studies. • How can teacher education (curriculum and practicum) and the school • curriculum and guidance materials best support effective pedagogy? Theory of change. • Strength and nature of the body of evidence for effective pedagogical practices. • Pedagogic theory and pedagogical approaches. • Teachers' attitudes and beliefs and Pedagogic strategies. 	4
	<ul style="list-style-type: none"> • Professional development: alignment with classroom practices and follow-up support. • Peer support Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes 	4
	<ul style="list-style-type: none"> • Research gaps and future directions • Research design • Contexts • Pedagogy • Teacher education • Curriculum and assessment • Dissemination and research impact. 	2

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, *Compare*, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, *Journal of Curriculum Studies*, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

G) AUDIT 1 and 2: STRESS MANAGEMENT BY YOGA

Course Outcomes

1. Achieve overall health of body and mind
2. Overcome stress
3. Learn to perform yoga

Syllabus

Units	Contents	Hours
1	<ul style="list-style-type: none"> • Definitions of Eight parts of yog. (Ashtanga) 	8
2	<ul style="list-style-type: none"> • Yam and Niyam. Do`s and Don`t`s in life. • i) Ahinsa, satya, astheya, bramhacharya and aparigraha • ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan 	8
3	<ul style="list-style-type: none"> • Asan and Pranayam i) Various yog poses and their benefits for mind & body ii) ii)Regularization of breathing techniques and its effects- Types of pranayam 	8

Suggested reading

1. ‘Yogic Asanas for Group Training-Part-I’ : Janardan Swami YogabhyasiMandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

Course Outcomes: Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency.

H) AUDIT 1 and 2: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Course Outcomes

1. Learn to achieve the highest goal happily
2. Become a person with stable mind, pleasing personality and determination
3. Awaken wisdom in students

Syllabus

Units	Contents	Hours
1	<ul style="list-style-type: none"> • Neetisatakam-Holistic development of personality • Verses- 19,20,21,22 (wisdom) • Verses- 29,31,32 (pride & heroism) • Verses- 26,28,63,65 (virtue) • Verses- 52,53,59 (dont`s) • Verses- 71,73,75,78 (do`s) 	8
2	<ul style="list-style-type: none"> • Approach to day to day work and duties. 	8

	<ul style="list-style-type: none"> • ShrimadBhagwadGeeta : Chapter 2-Verses 41, 47,48, • Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, • 23, 35, Chapter 18-Verses 45, 46, 48 	
3	<ul style="list-style-type: none"> • Statements of basic knowledge. • ShrimadBhagwadGeeta: Chapter2-Verses 56, 62, 68 • Chapter 12 -Verses 13, 14, 15, 16,17, 18 • Personality of Role model. ShrimadBhagwadGeeta: • Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39 • Chapter18 – Verses 37,38,63 	8

Suggested reading

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

Open Elective: 1. Business Analytics, 2. Industrial Safety, 3. Operation Research, 4. Cost Management of Engineering Projects, 5. Composite materials, Waste to Energy

A) Business Analytics

Teaching Scheme: 3 Hr/week

Total Number of Lectures: 48

Course Outcomes:

1. Describe the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. Gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. Familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Manage business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Syllabus

Units	Contents	Hours
1	Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling,	9

	sampling and estimation methods overview	
2	Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	8
3	Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	9
4	Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	10
5	Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making	8
6	Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	8

Reference:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.
- 3.

B) OPEN ELECTIVES: Industrial Safety

Teaching Scheme: 3h/week

Syllabus

Units	Contents	Hours
1	Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	9
2	Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	9
3	Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii.	9

	Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	
4	Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	9
5	Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance	9

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

C) OPEN ELECTIVES Operations Research

Teaching Scheme: 3h/week

Course Outcomes: At the end of the course, the student should be able to

1. Apply the dynamic programming to solve problems of discrete and continuous variables.
2. Apply the concept of non-linear programming
3. Carry out sensitivity analysis
4. Model the real world problem and simulate it.

Syllabus Contents:

Units	Contents	Hours
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models	9
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming	9
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT	9
4	Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	9
5	Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	9

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

D) Open Elective: Cost Management of Engineering Projects

Teaching scheme: 3 h/week

Syllabus Contents:

Units	Contents	Hours
1	Introduction and Overview of the Strategic Cost Management Process	4
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.	10
3	Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process	11
4	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	11
5	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	8

References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

E) Open Elective Composite Materials

Teaching Scheme: 3 h/week

Syllabus Contents:

Units	Contents	Hours
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1	INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.	9
2	REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.	9
3	Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.	9
4	Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.	9
5	Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first ply failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.	9

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.

2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

1. Hand Book of Composite Materials-ed-Lubin.

2. Composite Materials – K.K.Chawla.

3. Composite Materials Science and Applications – Deborah D.L. Chung.

4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

F) Open Elective Waste to Energy

Teaching Scheme: 3h/week

Syllabus Contents:

Unit s	Contents	Hour s
1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	8
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic	8

	oils and gases, yields and applications.	
	Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	9
	Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors	10
	Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.	10

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.