GATE Syllabus

Textile Engineering and Fibre Science

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TEXTILE ENGINEERING & FIBRE SCIENCE

Subject Code: TF

Course Structure

Sections/Units	Topics
Section A	**Engineering Mathematics**
Unit 1	Linear Algebra
Unit 2	Calculus
Unit 3	Vector Calculus
Unit 4	Differential Equations
Unit 5	Probability and Statistics
Unit 6	Numerical Methods
Section B	**Textile Fibers**
Section C	**Yarn manufacture, Yarn structure and Properties**
Section D	**Fabric manufacture, Structure and Properties**
Section E	**Textile Testing**
Section F	**Chemical processing**

Course Syllabus

Section A: Engineering Mathematics

Unit 1: Linear Algebra

- ➢ Matrices and Determinants
- ➢ Systems of linear equations
- ➢ Eigen values
- ➢ Eigen vectors

Unit 2: Calculus

- Limit, continuity and differentiability
- Partial Derivatives
- Maxima and minima
- Sequences and series
- Test for convergence
- Fourier series

Unit 3: Vector Calculus

- Gradient
- Divergence and Curl
- Line
- Surface and volume integrals
- Stokes, Gauss and Green's theorems

Unit 4: Differential Equations

- Linear and non-linear first order ODEs
- Higher order linear ODEs with constant coefficients
- Cauchy's and Euler's equations
- Laplace transforms
- PDEs –Laplace, heat and wave equations

Unit 5: Probability and Statistics

- Mean, median, mode and standard deviation
- Random variables
- Poisson, normal and binomial distributions; Correlation and regression analysis

Unit 6: Numerical Methods

- Solutions of linear and non-linear algebraic equations
- Integration of trapezoidal and Simpson's rule
- Single and multi-step methods for differential equations

Section B: Textile Fibers

- Classification of textile fibers
- Essential requirements of fiber forming polymers
- Gross and fine structure of natural fibers like cotton, wool, silk, Introduction to important bast fibres
- Properties and uses of natural and man- made fibres including carbon, aramid and ultra-high molecular weight polyethylene (UHMWPE) fibers
- Physical and chemical methods of fiber and blend identification and blend analysis
- Molecular architecture, amorphous and crystalline phases, glass transition, plasticization, crystallization, melting, factors affecting Tg and Tm
- Production process of viscose and other regenerated cellulosic fibres such as polynosic, lyocell
- Polymerization of nylon-6, nylon-66, poly (ethylene terephthalate), polyacrylonitrile and polypropylene
- Melt Spinning processes for PET, polyamide and polypropylene
- Wet and dry spinning processes for viscose and acrylic fibres
- Post spinning operations such as drawing, heat setting, tow- to-top conversion and different texturing methods
- Methods of investigating fibre structure e.g., Density, X-ray diffraction, birefringence, optical and electron microscopy, I.R. spectroscopy, thermal methods (DSC, DMA/TMA, TGA)
- Structure and morphology of man-made fibres, mechanical properties of fibres, moisture sorption in fibres
- Fibre structure and property correlation

Section C: Yarn manufacture, Yarn structure and Properties

- Principles of opening, cleaning and mixing/blending of fibrous materials, working principle of modern opening and cleaning equipment
- The technology of carding, carding of cotton and synthetic fibres
- Drafting operation, roller and apron drafting principle, causes of mass irregularity introduced by drafting
- Roller arrangements in drafting systems
- Principles of cotton combing, combing cycle, mechanism and function, combing efficiency, lap preparation
- Recent developments in comber
- Roving production, mechanism of bobbin building, roving twist
- Principle of ring spinning, forces acting on yarn and traveler, ring & traveler designs, mechanism of cop formation, causes of end breakages
- Working principle of ring doubler and two for one twister, single and folded yarn twist, properties of double yarns, production of core spun yarn

- ➢ Principles of compact, rotor, air jet, air vortex, core, wrap, twist less and friction spinning
- ➢ Yarn contraction, yarn diameter, specific volume & packing coefficient
- ➢ Twist factor, twist strength relationship in spun yarns
- ➢ Fibre configuration and orientation in yarn
- ➢ Cause of fibre migration and its estimation
- ➢ Irregularity index
- ➢ Structure property relationship of compact ring, rotor, air-jet and friction spun yarns

Section D: Fabric manufacture, Structure and Properties

- ➢ Principles of winding processes and machines, random, precision and step precision winding, package faults and their remedies
- ➢ Yarn clearers and tensioners
- ➢ Different systems of yarn splicing
- ➢ Features of modern cone winding machines
- ➢ Different types of warping creels
- ➢ features of modern beam and sectional warping machines
- ➢ Different sizing systems, sizing of spun and filament yarns, sizing machines
- ➢ Principles of Pirn Winding processes and machines
- ➢ Primary and secondary motions of loom, cam design & kinematics of sley, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; Dobby and jacquard shedding
- ➢ Mechanics of weft insertion with shuttle, warp and weft stop motions, warp protection, weft replenishment
- ➢ Principles of weft insertion systems of shuttle-less weaving machines
- ➢ Principles of multiphase and circular looms
- ➢ Principles of weft and warp knitting, basic weft and warp knitted structures
- ➢ Classification, production, properties and application of nonwoven fabrics, principle of web formation & bonding
- ➢ Basic woven fabric constructions and their derivatives
- ➢ crepe, cord, terry, gauze, leno and double cloth constructions
- ➢ Peirce's equations for fabric geometry
- ➢ Elastica model of plain woven fabrics
- ➢ Thickness, cover and maximum set of woven fabrics

Section E: Textile Testing

- ➢ Sampling techniques, sample size and sampling errors
- ➢ Measurement of fibre length, fineness, crimp
- ➢ measurement of cotton fiber maturity and trash content

- High volume fibre testing
- Measurement of yarn count, twist and hairiness
- Tensile testing of fibers, yarns and fabrics
- Evenness testing of slivers, rovings and yarns
- Classimat fault analysis
- Testing equipment for measurement of fabric properties like thickness, compressibility, air permeability, wetting & wicking, drape, crease recovery, tear strength, bursting strength and abrasion resistance
- Instruments and systems for objective evaluation of fabric hand
- Statistical analysis of experimental results, frequency distributions, correlation, significance tests, analysis of variance and control charts

Section F: Chemical Processing

- Impurities in natural fibre
- Chemistry and practice of preparatory processes for cotton, wool and silk
- Mercerization of cotton
- Preparatory processes for manmade fibres and their blends
- Classification of dyes
- Dyeing of cotton, wool, silk, polyester, nylon and acrylic with appropriate dye classes
- Dyeing of polyester/cotton and polyester/wool blends
- Dyeing machines
- Dyeing of cotton knitted fabrics and machines used
- Dye fibre interaction
- Introduction to thermodynamics and kinetics of dyeing
- Methods for determination of wash, light and rubbing fastness
- Styles of printing
- Printing thickeners including synthetic thickeners
- Printing auxiliaries
- Printing of cotton with reactive dyes, wool, silk, nylon with acid and metal complex dyes, Printing of polyester with disperse dyes
- Pigment printing
- Resist and discharge printing of cotton, silk and polyester
- Transfer printing of polyester
- Inkjet printing
- Mechanical finishing of cotton
- Stiff, soft, wrinkle resistant, water repellent, flame retardant and enzyme (bio-polishing) finishing of cotton
- Milling, decatizing and shrink resistant finishing of wool; Antistatic and soil release finishing
- Heat setting of synthetic fabrics
- Minimum application techniques

➢ Pollution control and treatment of effluents