

## ENGINEERING MATHEMATICS

**Linear Algebra:** Matrices and Determinants; Systems of linear equations; Eigenvalues and Eigenvectors.

**Calculus:** Limit, continuity and differentiability; Successive differentiation; Partial differentiation; Maxima and minima; Errors and approximations; Definite and improper integrals; Sequences and series; Test for convergence; Power series; Taylor series.

**Differential Equations:** First order linear and non-linear differential equations; Higher order linear differential equations with constant coefficients; Euler-Cauchy equation; Partial differential equations; Wave and heat equations; Laplace's equation.

**Probability and Statistics:** Random variables; Poisson, binomial and normal distributions; Mean, mode, median, standard deviation; Confidence interval; Test of hypothesis; Correlation analysis; Regression analysis; Analysis of variance; Control charts.

**Numerical Methods:** Numerical solutions of linear and non-linear algebraic equations; Numerical integration by trapezoidal and Simpson's rules; Single-step and multi-step numerical methods for differential equations.

## TEXTILE ENGINEERING AND FIBRE SCIENCE

### Section 1: Textile Fibres

Classification of textile fibres; Essential requirements of fibre forming polymers; Gross and fine structures of natural fibres like cotton, wool, silk; Introduction to bastfibres; Properties and uses of natural and man-made fibres including carbon, aramid and ultra-high molecular weight polyethylene fibres; Physical and chemical methods of fibre and blend identification and blend analysis.

Molecular architecture, amorphous and crystalline phases, glass transition, plasticization, crystallization, melting, factors affecting  $T_g$  and  $T_m$ ; Polymerization of nylon-6, nylon-66, poly (ethylene terephthalate), polyacrylonitrile and polypropylene; Melt spinning processes for PET, polyamide and polypropylene; Preparation of spinning dope; Principles of wet spinning, dry spinning, dry-jet-wet spinning and gel spinning; Spinning of acrylic, viscose and other regenerated cellulosic fibres such as polynosic and lyocell; Post spinning operations such as drawing, heat setting, tow-to-top conversion; Spin finish composition and applications; Different texturing methods.

Methods of investigating fibre structure such as density, x-ray diffraction, birefringence, optical and electron microscopy such as SEM and TEM, I.R. spectroscopy, thermal methods such as DSC, DMA, TMA and TGA; Structure and morphology of man-made fibres; Mechanical properties of fibres; Moisture sorption of fibres; Fibre structure-property correlation.

### Section 2: Yarn Manufacture, Yarn Structure and Properties

Principles of ginning; Principles of opening, cleaning and blending; Working principles of modern blowroom machines; Fundamentals of carding; Conventional vs. modern carding machine; Card setting; Card clothing; Periodic mass variation in card sliver; Card autoleveller; Principles of roller drawing; Roller arrangements in drafting systems; Periodic mass variation in drawn sliver; Drawframe autoleveller; Principles of cotton combing; Combing cycle and mechanisms; Recent developments in combing machine; Principles of drafting, twisting, and bobbin building in roving formation; Modern developments in roving machine; Principles of drafting, twisting and cop building in ring spinning; Causes of end breakages; Modern developments in ring spinning machine; Working principles of ring doubler and two-for-one twister; Relationship between single yarn twist and folded yarn twist; Principles of compact, rotor, air-jet, air-vortex, friction, core, wrap and twist-less spinning processes.

Influence of fibre geometry, fibre configuration and fibre orientation in yarn; Fibre packing density of yarn; Yarn diameter; Yarn twist and its relation to yarn strength; Helical arrangement of fibres in yarns; Yarn contraction;

Fibre migration in yarns; Stress-strain relation in yarn; Mass irregularity of yarn; Structure-property relationship in ring, compact, rotor, air-jet and friction spun yarns.

### Section 3: Fabric Manufacture, Structure and Properties

Principles of winding processes; Classification of winding methods; Patterning mechanism; Yarn clearers and tensioners; Different systems of yarn splicing; Warping objectives and classification; Different types of warping creels; Features of beam and sectional warping machines; Different sizing systems; Sizing of spun and filament yarns; Drawing-in process; Principles of pirn winding.

Primary and secondary motions of loom; Shedding motion; Positive and negative shedding mechanisms; Type of sheds; Tappet, dobby and jacquard shedding; Weft insertion; Mechanics of weft insertion with shuttle; Shuttle picking and checking; Beat-up; Kinematics of sley; Loom timing diagram; Cam designing; Effect of sley setting and cam profile on fabric formation; Take-up and Let-off motions; Warp and weft stop motions; Warp protection; Weft replenishment; Principles of weft insertion systems of shuttle-less weaving machines such as projectile, rapier, water-jet and air-jet; Principles of functioning of multiphase and circular looms; Types of selvages.

Basic woven fabric constructions and their derivatives; Crepe, cord, terry, gauze, leno and double cloth constructions; Drawing and lifting plans.

Fundamentals of weft knitting; Classification of weft knitting technologies; Weft knitted constructions such as plain, rib, interlock and purl; Different knit stitches such as loop, tuck and float.

Principle of warp knitting; Classification of warp knitting technologies; Swinging and shogging motion of guide bar; Basic warp knit constructions such as pillar, tricot, atlas, inlay and nets.

Fibre preparation processes for nonwovens; Web formation and bonding processes; Spun-bonding and melt-blowing technologies; Applications of nonwoven fabrics.

Principles of braiding; Type of braids; Maypole braiding technology.

Peirce's equations for plain woven fabric geometry; Elastic model of plain-woven fabric; Thickness, cover and maximum set of woven fabrics; Geometry of plain weft knitted loop; Munden's constants and tightness factor for plain weft knitted fabrics; Geometry of tubular braids.

### Section 4: Textile Testing

Sampling techniques for fibres, yarns and fabrics; Sample size and sampling errors.

Moisture in textiles; Fibre length, fineness, crimp, maturity and trash content; Tensile testing of fibres; High volume fibre testing.

Linear density of sliver, roving and yarn; Twist and hairiness of yarn; Tensile testing of yarns; Evenness testing; Fault measurement and analysis of yarns.

Fabric thickness, compressibility, stiffness, shear, drape, crease recovery, tear strength, bursting strength, pilling and abrasion resistance; Tensile testing of fabrics; Objective evaluation of low stress mechanical characteristics; Air permeability; Wetting and wicking; Water-vapour transmission through fabrics; Thermal resistance of fabrics.

### Section 5: Chemical Processing

Impurities in natural fibre; Singeing; Chemistry and practice of preparatory processes for cotton; Preparatory processing of wool and silk; Mercerization of cotton; Preparatory processes for manmade fibres and their blends; Optical brightening agent.

Classification of dyes; Dyeing of cotton, wool, silk, polyester, nylon and acrylic with appropriate classes of dyes;

Dyeing of polyester/cotton and polyester/wool blends; Dyeing machines; Dyeing processes and machines for cotton knitted fabrics; Dye-fibre interaction; Introduction to thermodynamics and kinetics of dyeing; Brief idea about the relation between colour and chemical constitution; Beer-Lambert's law; Kubelka-Munk theory and its application in colour measurement; Methods for determination of wash, light and rubbing fastness.

Methods of printing such as roller printing and screen printing; Preparation of printing paste; Various types of thickeners; Printing auxiliaries; Direct styles of printing of (i) cotton with reactive dyes, (ii) wool, silk, nylon with acid and metal complex dyes, (iii) polyester with disperse dyes; Resist and discharge printing of cotton, silk and polyester; Pigment printing; Transfer printing of polyester; Inkjet printing; Printing faults.

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.