EXTENDED LECTURE OUTLINE

SPS6 311 **Physics and Chemistry of Fibres** **(2+0)**

Sl. No.	Topic
A. Theory	
01.	**Introduction, History and Classification of Fibres** • Introduction to fibre science and the importance of fibres in textile and sericulture-related industries • Historical development of natural and man-made fibres and their evolution with advances in polymer science and fibre technology • Definition of fibre and essential characteristics required for a material to be considered a textile fibre • Classification of fibres based on origin and composition into natural, regenerated and synthetic fibres • Classification of natural fibres into plant, animal and mineral fibres and classification of man-made fibres into regenerated, synthetic, inorganic and high-performance fibres • Basic distinction between cellulosic, protein, mineral and polymeric fibres
02.	**General Properties of Fibres and Fibre-Forming Polymers** • Concept of fibre-forming polymers and their importance in determining fibre characteristics. • Basic structure of polymers, monomers and polymer chains, molecular arrangement and degree of polymerization • Relationship between polymer structure and fibre-forming ability • Essential properties of fibre-forming polymers including adequate molecular weight, chain length, molecular orientation, intermolecular forces, flexibility, crystallinity and ability to form continuous fibres • Influence of molecular structure and orientation on strength, elasticity, flexibility and durability of fibres • General properties of fibres including strength, flexibility, durability, uniformity, fineness, moisture-related behaviour, thermal behaviour and resistance to environmental conditions.
03.	**Physical Properties of Fibres** *Study of important physical characteristics used for describing and identifying fibres* a. Fibre dimensions and fineness – Fibre length, width, diameter, fineness and length-to-width ratio. Importance of fibre dimensions in yarn formation, textile processing and fibre quality. b. Fibre morphology and cross-section – Shape and appearance of fibres, longitudinal characteristics and cross-sectional features. Relationship between fibre morphology and physical properties. c. Optical properties – Translucency, transparency and opacity of fibres. Lustre and factors influencing surface appearance and light reflection. d. Mechanical properties – Resiliency, pliability, elasticity and related behaviour of fibres. Basic concepts of tensile strength, elongation and recovery. Influence of molecular orientation and structure on mechanical behaviour. e. General physical behaviour – Effect of moisture, temperature and environmental conditions on

	physical properties of different classes of fibres.
04.	**Chemical Properties of Fibres** *Basic chemical composition of major classes of fibres and relationship between chemical structure and fibre properties.* a. Behaviour towards acids – Effect of acids on cellulosic, protein, synthetic and other fibres. Factors influencing acid resistance and damage. b. Behaviour towards alkalis – Reaction of different fibres to alkalis and comparative alkali resistance of natural and man-made fibres. c. Behaviour towards salts and chemicals – Effect of salts and selected chemical agents on fibres. Changes in fibre structure, strength, appearance and durability. d. Chemical resistance and degradation – General principles of chemical degradation, hydrolysis, oxidation and other chemical changes affecting fibres. Comparative study of the chemical behaviour of cellulosic, protein, mineral and synthetic fibres.
05.	**Plant-Based / Cellulosic Fibres** *Study of naturally occurring plant fibres, their botanical origin, fibre-forming components, structure, physical properties, chemical properties, advantages, limitations and uses.* a. Cotton – Origin and fibre structure; cellulose composition; physical and chemical properties; strength, fineness, moisture behaviour and applications. b. Flax / Linen – Source, fibre structure, composition, physical and chemical characteristics and uses. c. Hemp and Ramie – Origin, fibre composition, structure, physical and chemical properties and applications. d. Sisal, Abaca and Pina – Sources, fibre characteristics, strength, structure, chemical behaviour and important uses. e. Kapok – Origin, fibre structure, physical characteristics, buoyancy, limitations and applications. f. Coir – Source, composition, fibre structure, physical and chemical properties, durability and applications. g. Jute – Origin, fibre composition, structure, physical properties, chemical behaviour, advantages, limitations and industrial applications. Comparative study of major plant fibres based on source, composition, length, fineness, strength, elasticity, moisture behaviour, chemical resistance and applications.
06.	**Regenerated Cellulosic Fibres** • Concept and development of regenerated cellulosic fibres • Need for conversion of natural cellulose into usable man-made fibres. • General principles involved in dissolution, regeneration, fibre formation and orientation. a. Rayon – Definition and types of rayon; basic manufacturing principle; regenerated cellulose structure; physical and chemical properties; moisture absorption, strength, lustre, dyeability and applications. b. Acetate fibres – Basic chemistry and structure of cellulose acetate; fibre formation; physical

	and chemical properties; characteristics and applications. c. Triacetate fibres – Structure, properties and differences from acetate and rayon. Thermal, chemical and physical characteristics and applications. Comparative study of rayon, acetate and triacetate with respect to chemical composition, physical properties, moisture behaviour, strength and applications.
07.	**Animal / Protein Fibres** *Study of animal-derived fibres, their protein composition, structure, physical properties, chemical behaviour and applications* a. Wool – Source and structure of wool fibre; protein composition; surface characteristics; physical properties; elasticity, resiliency and felting behaviour. Chemical properties and reaction to acids, alkalis and other chemicals. Applications of wool. b. Silk – Source and structure of silk fibre; fibroin and sericin; physical characteristics, lustre, strength, elasticity and moisture behaviour. Chemical properties, effect of acids and alkalis, degumming and applications. c. Spider fibre – Nature and structure of spider silk; protein composition; mechanical properties, strength and elasticity. Comparison with conventional animal protein fibres. Comparative study of wool, silk and spider fibre based on structure, composition, physical properties and chemical behaviour.
08.	**Hair Fibres and Minor Hair Fibres** *Study of speciality animal hair fibres with emphasis on source, fibre structure, fineness, physical properties, chemical composition, processing characteristics and uses* a. Camel fibre – Source, structure, physical characteristics, properties and uses. b. Vicuna and Guanaco fibres – Source, fineness, softness, physical properties and applications. c. Llama and Alpaca fibres – Structure, characteristics, fibre quality, physical properties and uses. d. Mohair – Source, structure, lustre, strength, elasticity and applications. e. Angora – Source, fibre characteristics, softness, fineness and uses. f. Qiviut – Source, characteristics, fineness, warmth and applications. g. Human hair – Structure, composition, physical properties and chemical behaviour of hair fibres. h. Minor hair fibres – Camel and common rabbit hair; characteristics, properties and applications. Comparative study of speciality hair fibres based on fineness, length, lustre, strength, elasticity, softness, thermal properties and end uses.
09.	**Regenerated Protein Fibres** *Concept and development of regenerated protein fibres and their importance as man-made alternatives to natural protein fibres* a. Casein fibre – Source and composition of casein; basic principles of fibre formation; physical and chemical properties; advantages, limitations and applications.

	b. Ardil – Origin and development; protein basis; fibre characteristics, properties and applications. c. Vicara – Composition, fibre characteristics, physical and chemical properties and applications. Comparative study of casein, Ardil and Vicara with respect to source, protein composition, fibre formation, physical properties and uses.
10.	**Mineral, Inorganic and High-Performance Fibres** *Study of fibres derived from mineral and inorganic materials and fibres developed for specialized high-performance applications* a. Asbestos fibres – Nature, structure, physical characteristics, heat resistance and historical applications. General limitations associated with asbestos fibres. b. Glass fibres – Composition, structure and fibre formation; physical and chemical properties; strength, heat resistance, chemical resistance and applications. c. Carbon fibres – Basic composition and structure; principles of production; molecular arrangement and orientation; high strength, stiffness and thermal properties. Applications in advanced materials. d. Silicon carbide fibres – Composition, structure, thermal stability, strength and resistance to harsh environments. Applications in high-performance materials. e. Stainless-steel fibres – Composition and structure; mechanical, thermal and chemical properties; durability and applications. Comparative study of mineral, inorganic and high-performance fibres based on strength, stiffness, thermal stability, chemical resistance, durability and specialized applications.
11.	**Synthetic Fibres** *Introduction to synthetic fibres produced from synthetic polymers. Classification based on chemical composition and polymer structure. General principles of polymerization and fibre formation. Relationship between polymer structure and fibre properties* a. Nylon – Chemical composition and polymer structure; types of nylon; fibre formation; physical properties, strength, elasticity, abrasion resistance and chemical behaviour. Applications. b. Polyester – Chemical structure; fibre formation; physical and mechanical properties; dimensional stability, strength, chemical resistance and applications. c. Polyacrylic fibres – Chemical composition, polymer structure, fibre characteristics, physical and chemical properties, thermal behaviour and applications. d. Vinyon / Polyvinyl fibres – Basic chemical structure, fibre properties, chemical resistance and applications. e. Vinylidene chloride fibres – Composition, structure, properties, chemical resistance and applications. f. Polyethylene fibres – Polymer structure, fibre characteristics, strength, chemical resistance and applications. g. Polypropylene fibres – Structure, physical and chemical properties, low density, moisture behaviour, strength and applications. h. Polyurethane fibres – Structure and fibre-forming characteristics; elasticity, recovery, strength

	and chemical behaviour. Applications of polyurethane fibres. Comparative study of major synthetic fibres based on polymer structure, strength, elasticity, moisture absorption, thermal properties, chemical resistance, durability and applications.
12.	**Comparative Study and Applications of Fibres** • Integrated study of fibres covered under natural, regenerated, synthetic, mineral and high-performance categories. • Comparative evaluation based on: origin and source; chemical composition; polymer type; molecular structure; fibre morphology; length and fineness; strength and elongation; elasticity and resiliency; pliability; lustre and translucency; moisture behaviour; thermal properties; reaction to acids; reaction to alkalis; resistance to salts and chemicals; durability; processing characteristics; and major applications • Comparison of plant, animal, regenerated, synthetic, mineral and high-performance fibres with emphasis on their distinguishing physical and chemical characteristics.