

**THE OPEN UNIVERSITY OF SRI LANKA**  
**BACHELOR OF INDUSTRIAL STUDIES/**  
**BACHELOR OF TECHNOLOGY**  
**FINAL EXAMINATION 2009/2010**  
**TTX5131 STRUCTURE AND PROPERTIES OF FIBRES**  
**DURATION: THREE (3) HOURS**



**DATE:05.03.2010**

**TIME:0930 – 1230 HOURS**

**Answer Question Number one (1) which is compulsory and five (5) more questions. Question number 1 carries 25 marks and others carry fifteen (15) marks each.**

01. a) A researcher wants to determine, whether the polymer system that he has discovered, is suitable for producing textile yarn. What are the properties or requirements that he has to look for, in order to decide whether the polymer is suitable for production of textile yarn? (5 Marks)
- b) "As a rule entropy decreases ( $\Delta S < 0$ ) upon polymerization of a monomer" Do you agree? (1 mark)
- c) Give reasons for your answer to (b) above. (3 Marks)
- d) Explain "chain-growth propagation" and "step growth propagation". (4 Marks)
- e) Do we have to consider two different "rate constants" for "Chain-growth propagation" and "step-growth propagation"? Give reasons for your answer. (2 Marks)
- f) How does "Dispersion Forces" or "Van der Waals forces" occur between molecules? (2 Marks)
- g) "As a rule, within a chemically uniform polymer, the density of packing increases with the increasing degree of "crystallinity". The fibre density has an influence over the properties such as dye absorption." Do you agree with the above statement? With the increasing fibre density would you expect the dye-absorption to increase or decrease? (2 Marks)
- h) What are the factors that favour the process of crystallization of fibre molecules? (4 Marks)
- i) In a fibre forming polymer, how are the highest possible order and highest possible disorder of elementary cells known? (2 Marks)

02. If we consider the continuous filament Yarn Production process of Nylon or Polyester, it involves, Spinning, Drawing/draw twisting, Texturing and Heat setting. Explain with reasons the effect of changes given under A (*keeping all the other parameters constant*) on the properties given under B.

Based on the theory you will have to think imaginatively to answer these questions.

**Spinning Process**

|                                      | <b>Effect B on the yarn</b>      |
|--------------------------------------|----------------------------------|
| Increase of Spinning Temperature     | Tenacity, elongation, dyeability |
| Increase of Viscosity of the polymer | Tenacity, elongation, dyeability |
| Increase of spinning speed           | Tenacity, elongation             |

**Drawing**

| <b>Cause A</b>         | <b>Effect B on the yarn</b> |
|------------------------|-----------------------------|
| Increase of Draw Ratio | Tenacity, elongation        |

(15 Marks)

03. a) Define the terms: Surface Moisture, Capillary Moisture, Bound Moisture and Chemically bound moisture. (8 Marks)

b). Explain how thermal conductivity of fibre materials vary with moisture regain. (7 Marks)

04. a) Explain the "Porous Model" and the Free Volume Model" for the diffusion of dyes into Fibre. Compare the application of these two models on Cellulose and Polyester. (10 marks)

b) What do you understand by "Glass Transition Temperature"? (1 mark)

c) What are the factors that affect the Glass Transition Temperature of polymers? (2 marks)

d) How does water affect the Glass Transition Temperature, and how is this reflected in ironing a cotton garment, with an steam iron? (2 marks)

05. a) What do you understand by "Drawing" with regard to processing of man made yarn? (3 marks)

What are the five occurrences that take place during drawing, in relation to the yarn or fibre? (10 marks)

b) What is the test that can be applied to measure the Orientation at a single point of a fibre? (2 marks)

06. a) Polymers can be classified as i. Homopolymers, ii. Random copolymers, iii. Alternating copolymers, iv. Block copolymers, v. Graft copolymers, based on the chemical composition of polymer chains in terms of monomers in the polymer molecules. If A, B and C are the monomers, illustrate the chain arrangement of the above polymers i to v. (10 marks)

b) Explain the difference in thermal behaviour of "thermoplastics" and "thermosets" and the reason for such behaviour. (5 marks)

07. A solubility test was carried out on three fibres A, B, and C suspected to be Cotton, Wool and Silk. (not in the order given).

**Fibre A:** Dissolves in 80%  $H_2SO_4$ , and does not dissolve in Con  $HNO_3$  and Con  $HCl$  at  $30 - 40^\circ C$ . It swells in 5%  $NaOH$

**Fibre B:** Dissolves in 5%  $NaOH$ , insoluble in 80%  $H_2SO_4$  and Conc.  $HCl$  at  $30 - 40^\circ C$ . It stains yellow in Conc.  $HNO_3$

**Fibre C:** Dissolves in 5%  $NaOH$ , Stains yellow in Conc.  $HNO_3$ , Dissolves to a certain extent in 80%  $H_2SO_4$ , and does not dissolve in Conc.  $HCl$  at  $30 - 40^\circ C$ .

Identify the three fibres A, B and C.

(15 marks)

08. a) What are the parameters that can influence the heat-setting efficiency of synthetic fibres?

(5 marks)

b) Briefly explain the changes taking place in a fibre during heat setting.

(5 Marks)

c) If a material of high dielectric property is brought between the two plates of a condenser, how does that affect the capacitance of the condenser?

(3 mark)

d). How does moisture affect the static electricity charge in textile material? (2 mark)