

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Textile and Apparel Technology



Study Programme : Bachelor of Science in Engineering
Name of the Examination : Final Examination
Course Code and Title : TAX7464 - Yarn and Fabric Mechanics
Academic Year : 2023/2024
Date : 05th March 2025
Time : 1330-1630hrs
Duration : **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Five (5)** pages.
3. Write down your Index Number in all the pages of answer scripts.
4. Answer the question one (Q1), which is compulsory and five (05) more questions from Q2 to Q8. Question one (Q1) carries thirty (30) marks and questions two (Q2) to eight (Q8) carry fourteen (14) marks each.
5. Answers to each question should commence on a new page. If a question has many parts, all the parts should be answered in the chronological order under the same question.
6. Write down the answered question numbers on the answer book.
7. Answers should be in clear hand writing.
8. Do not use red colour pens to write the answers.

Compulsory Question

(Q1)

- a) List three (03) physical characteristics of textile materials that affect their durability. (03 marks)
- b) Draw a characteristic Load-elongation curve for a crimped fibre. (03 marks)
- c) Briefly explain why Wool has two (02) different coefficients of friction. (02 marks)
- d) Derive the relationship between contraction factor, C_y and retraction, R_y of a twisted yarn. (03 marks)
- e) State the variation of filament strain across the radius of a twisted multi-filament yarn providing the relevant mathematical relationship and outline the key assumptions made in this analysis. (05 marks)
- f) What makes the energy method simpler than stress analysis in calculating yarn deformation? (02 marks)
- g) Name any three (03) parameters that have to be controlled during the measurement of load-extension characteristics of continuous filament yarns? (03 marks)
- h) List any three (03) assumptions made by Hearle et al in the theoretical analysis of staple yarn mechanics. (03 marks)
- i) What happens to the warp and weft crimps of a woven fabric subjected to a tensional load in the warp direction? (02 marks)
- j) How did Peirce mathematically adjust the circular yarn diameter to account for elliptical yarn sections in his approximate circular theory? (02 marks)
- k) What advantage does Kemp's racetrack geometry have over approximate circular or elliptical geometries in fabric structure analysis? (02 marks)

Answer any five (05) questions from the following seven (07) questions

(Q2)

(a) Compare the tensile properties of Cotton, Flax and Wool based on their stress-strain behavior. Use their stress-strain curves to highlight key characteristics of breaking strength and elongation at break. (06 marks)

(b) What is the work factor for materials in the ideal elastic state, and how is it determined? Briefly explain with the help of a diagram, how the work factor changes for materials that deviate from the ideal elastic state. (08 marks)

(Q3)

(a) i) Define stress relaxation in fibres. (02 marks)

ii) Briefly explain with an aid of a suitable diagram, the mechanism of stress relaxation when a fibre is held at a constant extension. (03 marks)

(b) Compare and contrast stress relaxation and creep, discussing their differences in terms of deformation behavior, influencing factors and significance in textile applications. (06 marks)

(c) Briefly explain how the shape factor of different textile fibres influences their bending rigidity. (03 marks)

(Q4)

(a) Briefly describe the role of filament migration in twisted multifilament yarns and how it contributes to the yarn stability and processability. (08 marks)

(b) Briefly explain the concept of the fuzz zone in staple yarns and what impact does it have on the yarn's performance and appearance. (06 marks)

(Q5)

(a) The coaxial-helix model commonly used to define the geometry of a single yarn is based on several assumptions. State the six postulates that form the basis of the coaxial-helix model. (06 marks)

(b) A Nylon continuous multi-filament yarn has a fineness of 200 denier and consists of 50 filaments, all with circular cross-sections of identical size. The filaments are arranged in five (05) openly packed layers and the density of Nylon is 1.14 g/cm^3 . Determine;

i) The diameter of an individual filament (06 marks)

ii) The overall diameter of the yarn. (02 marks)

(Q6)

(a) What technique did Riding use to measure the radial position of fibres in yarn and how were the measurements made using this technique? (06 marks)

(b) Name the three (03) categories of fibres that considered as yarn hairiness. (03 marks)

(c) Name two (02) methods used for measuring yarn hairiness and briefly explain the working principle of one of these methods. (05 marks)

(Q7)

(a) Briefly describe the two (02) assumptions made regarding yarn tension propagation (stress distribution) during the development of models for multi-filament yarn breakage. Provide illustrations to explain these two (02) rupture modes. (08 marks)

(b) Illustrate the comparison between the experimentally obtained and theoretically predicted stress-strain curves for Rayon yarn and briefly explain how increasing twist affects the accuracy of the theoretical predictions? (06 marks)

(Q8)

(a) Assume that you are tasked with designing a high-performance Cotton plain woven fabric and need to determine its cover factor to assess fabric density and end-use suitability.

i) Derive the formula for fractional cover using the following parameters.

(03 marks)

- n = Number of threads per inch (warp or weft)
- p = Thread spacing
- d = Yarn diameter

ii) Using the above derivation & based on Peirce's Cover Factor Theory, express the cover factor (K) in terms of yarn count (N) and thread density (n).

(04 marks)

iii) Given the following fabric specifications, calculate the total cover factor.

(03 marks)

- Warp count = 40 Ne
- Weft count = 30 Ne
- Warp density = 80 ends per inch
- Weft density = 60 picks per inch

(b) Define 'float spacing' in the context of non-plain weave fabrics and discuss how it varies in relation to the yarn diameter in high-sett fabrics.

(04 marks)