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

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: TAX7464 Yarn & Fabric Mechanics**
Academic Year	: 2021/2022
Date	: 07th February 2023
Time	: 0930-1230 hrs
Duration	: 3 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of Eight (08) questions in Four (04) pages.
3. Write down your Index Number in all the pages of the answer script.
4. **Answer compulsory question one (Q1) and additional five (05) questions.**
5. Question one (Q1) is compulsory and carries twenty-five (25) marks.
6. Question two (Q2) to eight (Q8) carry fifteen (15) marks each.
7. Answer for 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.
8. Write down the answered question numbers in the space given in the answer book.
9. Answers should be in clear hand writing.
10. Do not use red colour pen.

Compulsory question

Q1.

a) Explain why the classical theories of solid mechanics must be carefully applied to textile materials. (02 marks)

b) What you understand by "Tensile properties" of fibres and yarns? (02 marks)

c) Distinguish between "Second moment of area" and "Polar moment of area" of a fibre. (02 marks)

d) Briefly explain the concept "Twist contraction" in relation to twisted multi-filament yarns. (02 marks)

e) Illustrate the relationships between the radial position of the fibre at any radius (r) of a twisted continuous multi-filament yarn in terms of the outer radius of the yarn (R) and the length of the fibre along the helix (q) for one cycle of idealized migration. (04 marks)

f) What do you understand by "Wild fibers"? Explain, this term with the aid of the zonal distribution of "ideal" and "wild" fibers as reported by Mortan in1956. (04 marks)

g) State the three (03) assumptions that are being made when analyzing the extension of filaments of a twisted continuous multi-filament yarn under small extensions. (03 marks)

h) Draw graphs comparing the tension along a filament in a continuous filament yarn and along fibres in the corresponding spun yarn when the multifilament yarn and staple yarn are subjected to extensions. (04 marks)

i) State two (02) fabric parameters that influence on the geometry of a woven fabric. (02 marks)

----------End of the compulsory question----------

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

Q2. (a) Calculate the stress of a cotton fibre if the fibre is under a load of 0.025 N. Here the fibre mass is 0.45 g, and the length is 1.6 cm. The density of cotton is 1.55 g/cm^3. (05 marks)

(b) Calculate the tenacity of 80 denier nylon fiber if it breaks at 400 gram force. (04 marks)

(c) A yarn specimen of 200 mm was extended by 10% when loaded with 500 cN force. The length of the specimen after removal of load was found to be 202 mm. Calculate the percentage elastic recovery of the yarn. (06 marks)

Q3. (a) With the use of suitable stress/time and extension/time graphs, explain the effect of time on the behavior of fibres when the fibres are subjected to the following physical conditions:

i. A constant load of "W" was applied to a fibre over a time of "T" and then removed and allowed to relax.

ii. Fiber was given a constant extension and kept at that extension.

(09 marks)

(b) Compare the structural features and performance characteristics of ring-spun and open-end spun yarns. (06 marks)

Q4. (a) Determine the second moment of area for the following hollow circular fiber cross section about the given N-N axis (Figure A). (09 marks)

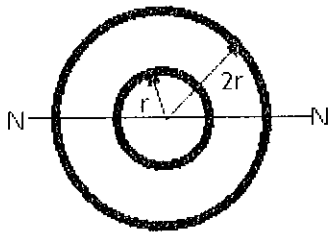

Figure A

(b) Explain the fundamental structural features of a yarn. (06 marks)

Q5. (a) State four (04) assumptions made when defining the geometry of a single yarn by using coaxial-helix model. (06 marks)

(b) With the aid of suitable diagrams, derive an equation to determine the length of a fibre at any radius "r" of the yarn, in terms of cylindrical polar coordinates. Assume that the yarn possesses idealized helical geometry. (09 marks)

Q6. (a) Considering the idealized open packing arrangement of circular fibres in a yarn, derive the following formula.

$$R = (2n-1)\, r_f$$

Where, R is the radius of the circle circumscribing n^{th} layer of the open packing arrangement of the yarn, and r_f is the radius of the fibre. Assume that all the fibres are of circular cross-sections and of same radius. (07 marks)

(b) A Nylon continuous multi-filament yarn has a fineness of 180 denier and consist of 37 filaments. All the filaments are of circular cross section and of same size. This multi-filament yarn has a twist of 100 turns per meter and the filaments of the yarns are in open packing arrangement in 4 layers. The Density of Nylon is 1.15 g/cm^3.

i. Determine the diameter of individual filaments. (04 marks)

ii. Determine the diameter of the yarn. (04 marks)

Q7. (a) Explain the term "Ideal migration pattern" pertaining to the yarns. Use suitable diagram where necessary. (03 marks)

(b) For a multi-filament yarn consisting of 169 filaments of each 0.1 mm radius having a yarn diameter of 1.4 mm, determine the specific volume in g/cm^3 assuming that the material of the yarn is Nylon. Density of Nylon is 1.15 g/cm^3. (08 marks)

(c) Using appropriate illustrations, explain the two (02) different methods of predicting yarn breakage under tensional load of multi-filament yarns with idealized helical yarn geometry. (04 marks)

Q8. (a) State three (03) assumptions made by Hearle et al. when analyzing the mechanics of staple yarns. (03 marks)

(b) A plain-woven fabric has 28 ends/cm and 25 picks/cm. If the warp and weft counts are 20 Ne and 15 Ne respectively, determine the cloth cover factor of the fabric. (06 marks)

(c) Illustrate the cross-sectional views of a plain-weave fabric to show all the geometrical parameters used in Peirce's elliptical model. (06 marks)