

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



Study Programme	: Bachelor of Technology Honours in Engineering /Bachelor of Industrial Studies Honours
Name of the Examination	: Final Examination
Course Code and Title	: TAX5532/TAX7464 Yarn & Fabric Mechanics
Academic Year	: 2020/2021
Date	: 12 th February 2022
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 Six (06) 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. Questions 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). Distinguish between **mechanics** and **mechanics of solids**. (03 Marks)
- (b). What is understood by “yield point” of a fibre? Explain how yield point of a stress/strain curve can be determined by Meredith’s construction. (06 Marks)
- (c). Mention one (01) similarity and one (01) difference between the two (02) models proposed by Maxwell and Kelvin-Voigt to describe the visco-elastic behavior of textile fibres. (04 Marks)
- (d). With the use of a suitable diagram briefly explain the relationship between the characteristics “friction” and “moisture regain” of a fibre. (02 Marks)
- (e). Distinguish between the “fancy yarns” and the “metallic novelty yarn” with respect to their structures and properties. (03 Marks)
- (f). What are “wild fibres” as referred by Morton and Yen? (02 Marks)
- (g). Draw a cross-section of the 2/2 twill weave structure and include the following information in your sketch.
- Float spacing
 - Intersectional spacing
 - Weave repeat
- (03 Marks)
- (h). Briefly explain the phenomenon of “crimp interchange”. (02 Marks)

-----End of the Compulsory Question-----

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

- (Q2)** (a) Explain the following terms pertaining to textile fibres.
- Elastic recovery
 - Hysteresis of recovery
- (02 Marks)
- (b) Give a graphical representation to show the typical tensile loading and recovery curves of a textile fibre and indicate the following quantities in your presentation.
- Total work
 - Recovered work
 - Plastic extension
 - Elastic extension
- (04 Marks)

- (c) The Figure 1 illustrates how elastic recovery varies with the specific stress for different fibres.

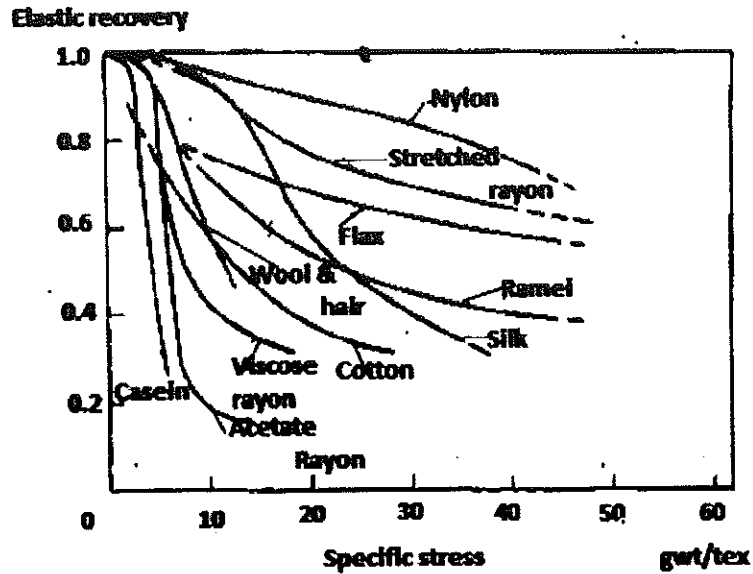


Figure 1

- i. Considering the Figure 1, Give the graphical representation of the characteristic load/recovery curves of the following fibres at a specific stress of about 20 gwt/tex. Indicate the elastic extension of each fibre in the illustration.
 - a. Nylon
 - b. Silk
 - c. Acetate rayon

(06 Marks)
- ii. Which one of the three (03) fibers listed above is the best choice for producing a fabric with a higher degree of dimension stability? Giving reasons explain your answer.

(03 Marks)

- (Q3) (a) Determine the second moment of area for the following rectangular cross section (Figure 2) about the given axis N-N. (04 Marks)

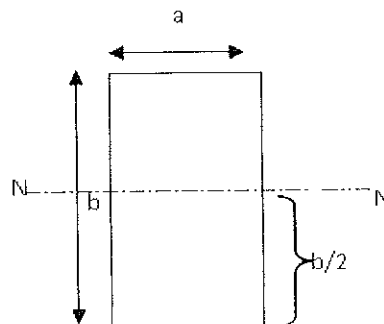


Figure 2

- (b) Define the term “flexural rigidity” and state the influence and importance of it for the yarn properties. You can use formulae where necessary. (04 Marks)

- (c) A fibre specimen of length "l", bent through an angle "θ" to a radius of curvature "r" is shown in the Figure 3.

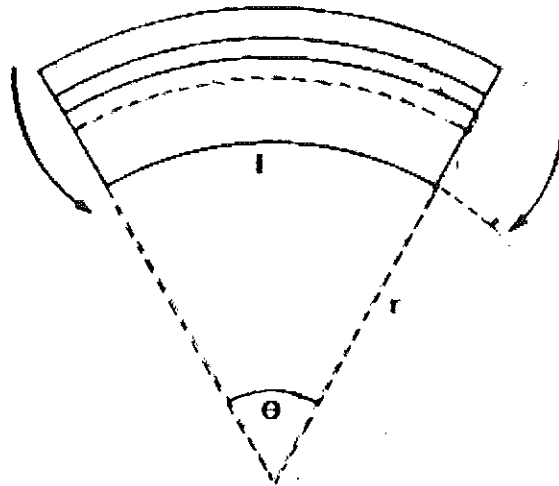


Figure 3

- i. Explain why internal couple of forces are generated in the bent fibre. (02 Marks)
- ii. With the aid of the Figure 3, show that the total internal couple generated in the cross section of a bent fibre "M" is

$$M = \frac{Y}{r} \cdot I$$

Where, Y = Young's modulus of the fibre material

I = Second moment of area of the cross section of the fibre

(05 Marks)

- (Q4) (a) Provide graphical representations of the time effect on a textile fibre when the following conditions are applied. Explain briefly why the observed shape in the graphs occur under the given conditions.

- i. A constant load is applied over a time "T" and the load is removed
- ii. A constant extension is applied

(06 Marks)

- (b) What do you understand by ideal migration of fibres in a yarn?

(03 Marks)

- (c) Explain the influences of following factors on yarn hairiness of staple fibres.

- i. Yarn Twist
- ii. Fibre blend composition
- iii. Fibre properties

(06 Marks)

- (Q5) (a) Considering the idealized open packing arrangement of circular fibres in a yarn, derive the following formula.

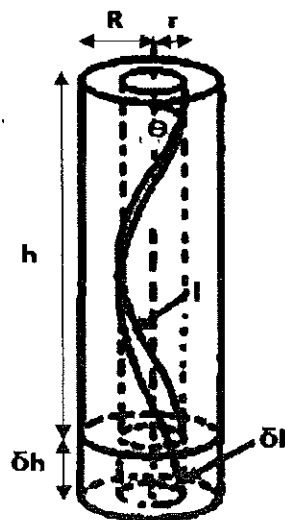
$$R = (2n-1) r_f$$

Here "R" is the radius of the circle circumscribing "nth" layer of the open packing arrangement of the yarn. "r_f" is the radius of the circular fibre. Assume that all the fibres are of circular cross-section and of same radius. (07 Marks)

- (b) An idealized open packed yarn having 37 fibres and these fibres are arranged in 4 layers. The fibre radius (r_f) is 0.02mm.
- Calculate the yarn radius at 4th layer (R). (02 Marks)
 - Calculate the area of the circumscribed by the outer layer (yarn cross sectional area). (02 Marks)
 - Calculate the total area covered by all the fibers in cross section. (02 Marks)
 - Calculate the percentage of area of the cross section covered by the fibres. (02 Marks)

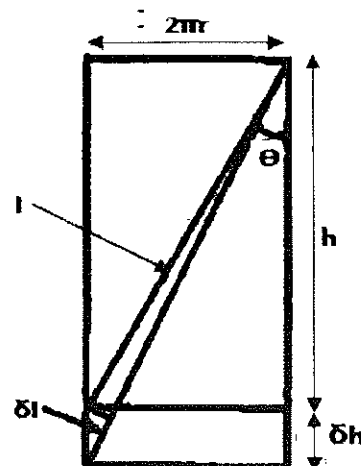
- (Q6) (a) State five (05) assumptions made when analyzing the stress of continuous filament yarns under small extensions when lateral contractions and traverse forces of filaments are also considered. (05 Marks)

- (b) The Figure 4a shows a twisted multi filament yarn having the idealized helical structure under a tensional load. The original length 'h' of one turn of twist is elongated by a length of 'δh' due to the tensional load. Assume that the yarn does not change its diameter under this extension. 'R' is the yarn radius. Out of many filaments, one filament at radius "r" is considered. The filament length 'l' at the radius 'r' is elongated in a length 'δl' due to this extension 'δh'. The Figure 4b shows the envelopes of the surface of the cylinder of radius "r". Here "r" is the radius of cylinder containing helical path of a particular filament and "θ" is the helix angle of the filament at radius "r".



a. Yarn under tension
(only one filament is shown separately)

Figure 4a



b. Envelopes of the surface of the cylinder of radius 'r'

Figure 4b

Show that $\epsilon_f = \epsilon_y \cdot \cos^2\theta$

Where ϵ_f = Strain or percentage elongation of a filament at radius "r"

ϵ_y = Strain or percentage elongation of the yarn

(10 Marks)

- (Q7) (a) Determine the relationship between the cotton count and the diameter of a cotton yarn if specific volume of the cotton yarn is $1.1 \text{ cm}^3/\text{g}$. State all the assumptions that you made for the computation. (08 Marks)
- (b) If the yarn is having an idealized helical yarn geometry, with the aid of suitable diagrams, calculate the length of a fibre at radius "r" in terms of the cylindrical polar co-ordinates. (07 Marks)
- (Q8) (a) A plain-woven fabric has 32 ends/cm and 27 picks/cm. If the warp and weft counts are 18 Ne and 15 Ne respectively, determine the cloth cover factor of the fabric. (05 Marks)
- (b) There are many different forms of geometry proposed to represent the configuration of yarns in plain woven fabric, and each has its own advantages and disadvantages. Discuss any two (02) of these theories in terms of the assumptions made in developing the theory and its applicability. (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. (04 Marks)

-----End of the Questions-----