*Name* : .....

*Roll No.* : .....

*Invigilator's Signature* : .....

**CS/M.Tech(TT)/SEM-1/MTT-104/2011-12**

**2011**

# THEORY OF TEXTILE STRUCTURE – I

*Time Allotted* : 3 Hours *Full Marks* : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

Answer any *five* of the following. 5 × 14 = 70

1. a) Prove the theoretical relationship between contraction factor and surface twist angle of a twisted yarn. Hence, find out the relationship between retraction and surface twist angle. 5

   b) What is the significance of using the equation $C_y \left( C_y - 1 \right) = \frac{1}{4} \tan^2 \alpha$ where, the symbols have their usual meanings. 2

   c) Find out the relationship between true twist ( $T$ ), nominal twist $\left( T_0 \right)$ of a twisted yarn. Hence, determine the maximum twist angle of a yarn that can be inserted in any textile operation. 7

2. a) Explain ideal migration with a neat diagram. Also plot the pattern of ideal migration envelop. 4

b) Determine the general equation expressing the change in radial position of a fibre with the length measured along the fibre ( in ideal migration ) for a full migration period. 5

c) Prove that, the ideal migration equation for the first half cycle is $\left(\frac{r}{R}\right)^2 = \frac{4z}{z\,(1+\sec\alpha)} + \frac{4z^2\tan^2\alpha}{z^2\,(1+\sec\alpha)^2}$ where, the symbols carry the usual meaning. 5

3. a) Explain the crucial parameters for characterisation of migration behaviours in a yarn. 5

b) Prove that $\bar{Y} = \frac{1}{3}\cot^2\alpha\left(\tan^2\alpha + \sec\alpha - 1\right)$ and

$$D = \frac{1}{3\,(1+\sec\alpha)}\left\{\frac{4}{5}\sec^2\alpha + \frac{7}{5}\sec\alpha + \frac{4}{5}\right\}^{\frac{1}{2}}.$$ 6

c) How is migration mechanism affected by tension variation ? Explain. 3

4. a) Define 3-dimensional yarn elements with a neat diagram for the analysis of stress and strain on continuous filament yarn considering transverse force and lateral contraction. Also calculate the forces acting on these cuboidal yarn elements. 9

b) If $\sum f$ is the filament strain in above analysis, then show that $\sum f = \left(1 - \sigma_y \tan^2\theta\right)\sum f_0$ where, $\sum f_0$ is the filament strain without transverse force and lateral contraction for simple analysis of stress-strain model and $\sigma_y$ is the yarn lateral contraction ratio and $\theta$ is the twist angle. 5

5. a) Deduce the equation governing radical equilibrium in the yarn in terms of $g$, $u$, $c$, $\sigma_1$ and $\sigma_y$ ( all are representing the usual meanings ) and hence evaluate the relative level of tensile and transverse stresses throughout the twisted yarn. 10

b) Prove that, mean normalized yarn stress is

$$\frac{2}{1-c^2}\int_C^1 \left[ x\frac{c^2}{u^2} - g\left(1-\frac{c^2}{u^2}\right)\right] u\,du. \qquad 4$$

6. a) Define the basic distribution of stresses and strains in the extended staple fibre yarn. 4

b) Derive the conditions for which a fibre will slip and magnitude of the tensions which can develop in slipping fibres. 7

c) What are the accessory fibre characteristics required for this analysis ? 3

7. a) What are the different levels of approach to analyse the staple yarn stress-strain mechanism ? Discuss the approach related to approximate treatment on the staple spun yarns. 5

b) Write down the expression of mean normalized stress $\left(x_s\right)$ and the factor ( $\beta$ ) responsible for the reduction of stress in outer layer of staple fibre yarn and determine its application on whole yarn. 6

c) Explain the separate effects of obliquity $\left(\cos^2\alpha\right)$ and slip ( $1 - k$ cosec $\alpha$ ) with the help of numerical plot of the equation $\cos^2\alpha$ ( $1 - k$ cosec $\alpha$ ). 3

8. a) Explain the mechanism of breakage of staple yarn. 5

b) Compare the structure and properties of MVS yarns with ring and open end spun yarns. 5

c) Write the different categories of configuration of fibres within yarn in compact and ring spun yarns and compare between them. 4

9. a) What are the different rigidities of fibre affecting yarn structure ? Explain briefly. 3

b) Describe the model to calculate the bending rigidity of yarn. What are the factors affecting the bending rigidity of the yarn. 5

c) For blended yarn of short staple fibre derive

$$E_L / E_B = \left[ B_a \frac{E_a}{E_b} + \left( 1 - B_a \right) \right] V_f \; n_L \; n_1 \; \theta$$

( where the symbols have their usual meanings ) 6