# Indian Institute of Engineering Science and Technology, Shibpur

**B.E. 4th Semester (Aerospace Engineering) End Semester Examinations, May 2014**

**Aerospace Structure – I (AE 402)**

**Full Marks: 70** **Time: 3 hrs**

*Answer any five (5) questions*
*All questions carry equal marks*

1. The complete tension field beam as shown in Fig. Q1 has the c/s of flanges 300 $mm^2$ and that of stiffeners 250 $mm^2$. Elastic section modulus of each flange is 750 $mm^2$. Determine maximum stress in a flange and also whether or not the stiffeners will buckle. The thickness of the web is 2 mm and the second moment of area of a stiffener about an axis in the plane of the web is 2000 $mm^4$. Consider E = 75 x $10^3$ MPa.

2. In a tapered diagonal tension field beam as shown in Fig. Q2, derive the expressions for the diagonal stress, axial forces on the top and bottom flanges and the compressive force acting below the stiffener.

3. As shown in Fig. Q3, a uniform, pin-ended column of length $l$ and bending stiffness $EI$ has an initial curvature such that the lateral displacement at any point between the column and the straight line joining its ends is given by the relation $v_0 = \frac{4az}{l^2}(l - z)$. Show that the maximum bending moment due to a compressive end load $P$ is given by $M_{max} = -\frac{8Pa}{\mu^2 l^2}\left(\sec\frac{\mu l}{2} - 1\right)$ where $\mu^2 = \frac{P}{EI}$

4. Starting from fundamentals, derive the expression for critical load of a long column using stationary principle of TPE.

5. Write short notes on:
   (a) Principal planes & principal stress
   (b) Southwell plot
   (c) Property of interchangeability between strain energy and complimentary energy
   (d) Virtual displacement and virtual work

6. Starting from fundamentals, derive the expression for constitutive and compatibility equations for a three-dimensional body.

7. A circular fuselage frame supports a load $P$ at bottom point acting vertically downward which is reacted by a shear flow $q$ distributed around the circumference of the frame from the fuselage skin. Derive the expression of bending moment distribution.

8. Using the principle of virtual work, calculate the horizontal movement of the support D in the truss as shown in Fig. Q8. The c/s of each member is 1800 $mm^2$ and the modulus of elasticity of each member is 2 x $10^5$ MPa.

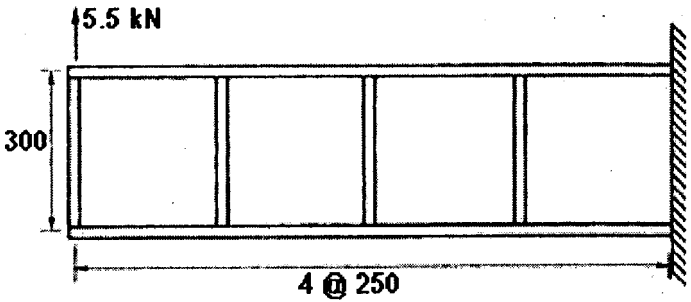


Fig. Q1

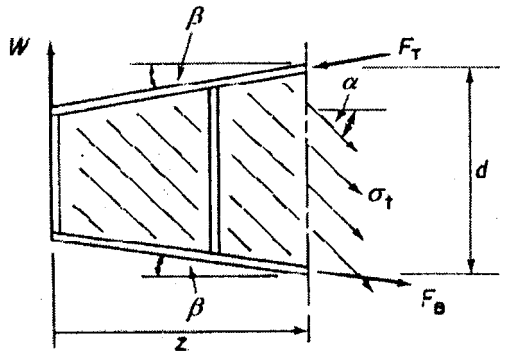


Fig. Q2

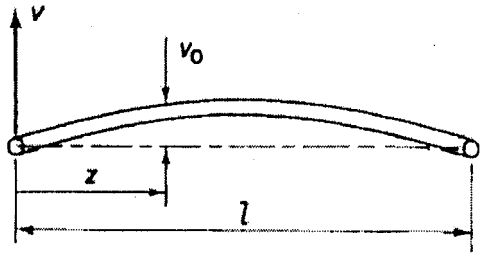


Fig. Q3

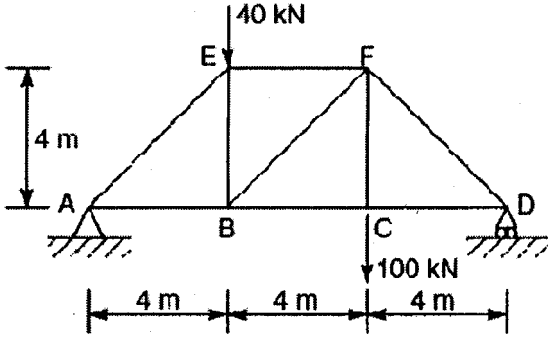


Fig. Q8