Bengal Engineering and Science University, Shibpur

B.E. 4th Semester (Aerospace Engineering) Final Examinations, April 2013

Aerospace Structure – I (AE 402)

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

Answer any five(5) questions

1. What is the plane strain condition? Starting from the fundamentals derive the expression of Beltrami–Michell equation for plane stress. 03 + 11

2. The component of stress at a point is given by $\sigma_y = (5xyz + 3y), \sigma_z = (x^2 y + y^2 z), \sigma_x = (3xy^2 z + 2x), \tau_{xy} = 0, \tau_{yz} = \tau_{zx} = (3xy^2 z + 2xy)$. Determine whether those components of stress satisfy equilibrium equations or not at the point (3, 2, – 4). If not then, determine the suitable body force required at this point so that these stress components become under equilibrium. 14

3. (a) Explain complete and incomplete tension field beam
(b) The beam shown in Fig. Q3 is assumed to have a complete tension field web. If the c/s area of each stiffener and flange are 275 mm^2 and 325 mm^2 respectively and the elastic section modulus of each flange is 750 mm^3, determine the maximum stress in a flange and also whether or not the stiffener will buckle. Assume web thickness 1.5 mm, second moment of area of a stiffener about an axis in the plane of the web 1875 mm^4, and E = 7 x 10^4 MPa. 04 + 10

4. (a) State the principle of virtual work
(b) Using the principle of virtual work, calculate the vertical deflection of the joint ***B*** in the truss shown in Fig. Q4. The c/s area of each member is 1800 mm^2 and modulus of elasticity for the material of the members is 200000 MPa. 02 +12

5. Using the principle of stationary value of TPE, derive the expression for the critical load for a long column, hinged at both ends. Show a Southwell Plot for the experimental determination of the elastic buckling load of an imperfect column schematically, indicating salient values. 12 +02

6. (a) Establish the principle of interchangeability between strain energy and complementary energy.
(b) A plane, pin-jointed framework consists of 6 bars forming a rectangle ABCD, 4 m x 3 m with two diagonals as shown in Fig. Q6. The c/s area of each bar is 200 mm^2 and the frame is unstressed when the temperature of each member is the same. Due to local conditions the temperature of one of the 3 m long members is raised by 30°C. Determine the resulting forces in all the members if the coefficient of linear expansion α of the bars is 7 x 10^{-6} per °C. Take E = 200000 MPa. 04 + 10

7. Using stationary principle of total complementary energy, compute the vertical displacements of the quarter and mid-span points ***B*** and ***C*** of the simply supported beam ABCD of length ***L*** and flexural rigidity ***EI*** loaded, as shown in Fig. Q7. 14

8. A circular fuselage frame, as shown in Fig. Q8 supports a load ***P*** which is reacted by a shear flow ***q***. Prove that the distribution of bending moment over the frame follows the equation $M = \frac{Pr}{2\pi}\left(1 - \frac{\cos\theta}{2} - \theta\sin\theta\right)$.

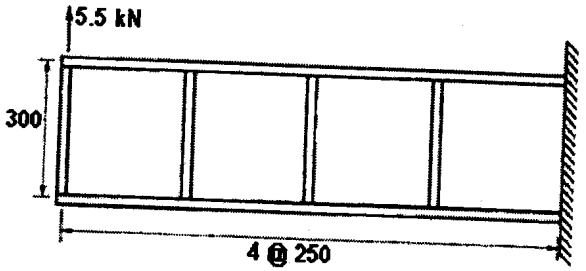

Fig. Q3

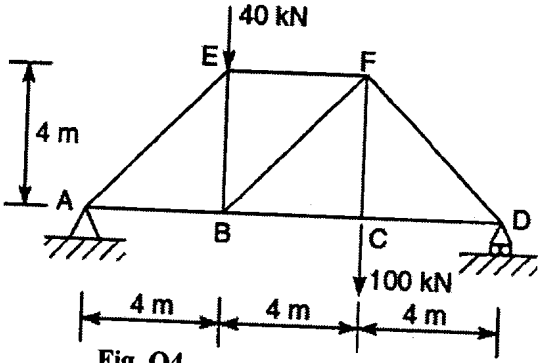

Fig. Q4

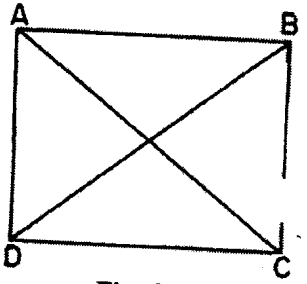

Fig. Q6

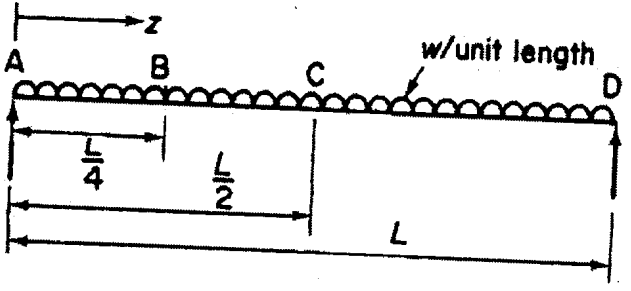

Fig. Q7

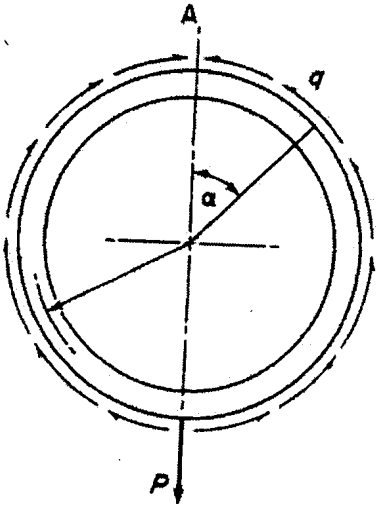

Fig. Q8