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10AE56

Fifth Semester B.E. Degree Examination, June/July 2017
Aircraft Structures – I

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What are the factors that influence magnitude of factor of safety? **(05 Marks)**

b. Define : (i) Limit load (ii) Ultimate or design load (iii) Load factor **(06 Marks)**

c. A large transport aircraft whose gross weight is 50000 kg and pitching moment of inertia 20×10^6 kg sec^2 cm is making a level landing, with nose wheel slightly off the ground. The reaction on the rear wheels is inclined at such an angle to give drag component 50000 kg and vertical component 14142 kg. Find when wing lift is zero, (i) The inertia forces on the airplane. (ii) The resultant load on the pilot whose inertia is 180 kg. The pilot seat is 80 cms above the ground and 750 cms forward of C.G. of the aircraft. The rear wheel is 215 cm aft C.G. and 120 cm above the ground. **(09 Marks)**

2 a. Discuss in detail the desirable properties of aerospace materials. **(10 Marks)**

b. List the reasons for use of composites in aircraft design as a preferred material. **(07 Marks)**

c. Explain any three tests peculiar to glass to qualify for aerospace application. **(03 Marks)**

3 a. Define with applicable mathematical relation:
(i) Stress concentration factor (ii) Stress intensity factor (iii) Proof stress
(iv) Fracture toughness (v) Soderberg criterion. **(10 Marks)**

b. List elastic constants and state why they are called elastic constants. **(03 Marks)**

c. A steel rod $\sigma_{y,t} = 689.4$ MPa, $\sigma_{-1} = 427.6$ MPa, $\sigma_{u,t} = 1089.5$ MPa is subjected to a tensile load which varies from 120 kN to 40 kN. Design the safe diameter of the rod using Soderberg relation. Adopt factor of safety 2, stress concentration factor unity and correction factor for load, size and surface finish as 0.75, 0.85 and 0.91 respectively. **(07 Marks)**

4 a. Define : (i) External redundancy (ii) Internal redundancy (iii) Composite beams **(03 Marks)**

b. Find the internal load in member 5 of the coplanar truss structure shown. **(12 Marks)**

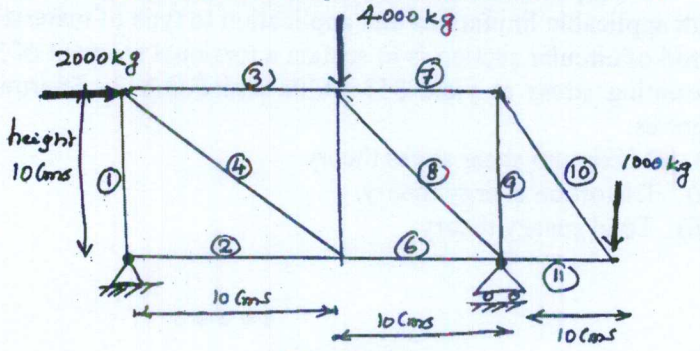

Fig. Q4 (b)

4 c. State the type of indeterminate and its order. **(05 Marks)**

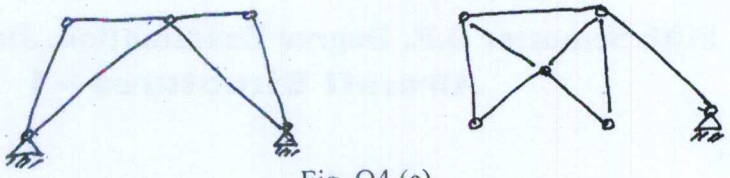

Fig. Q4 (c)

PART – B

5 a. State (i) Maxwell reciprocal theorem (ii) Castigliano's theorem – I
(iii) Castigliano's theorem – II **(09 Marks)**

b. An unknown weight W falls through 15 mm on a collar attached to lower end of vertical bar 3 m long and 500 mm^2 in section. If the maximum instantaneous extension is known to be 2 mm, what is the corresponding stress and weight? E = 200 kN/mm^2. **(05 Marks)**

c. Obtain deflection and slope at the end of a Cantilever beam subjected to a couple M and end load P. **(06 Marks)**

6 a. Derive the Euler Buckling load of the column when both ends are fixed. **(08 Marks)**

b. A uniform pin ended column of length 'l' and bending stiffness EI has an initial curvature such that lateral displacement at any point between the column and straight line joining its end is given by $y_0 = a\frac{4x}{l^2}(l-x)$.

Show that the maximum bending moment due to compression is given by $M\max = \frac{-8aP}{(\lambda l)^2}\left(\sec\frac{\lambda l}{2} - 1\right)$ **(12 Marks)**

7 a. What are stress invariants? Give formula of the stress invariants. **(06 Marks)**

b. Explain traction and displacement boundary conditions. **(04 Marks)**

c. At a point in a given material, the three dimensional state of stress is given by $\sigma_x = \sigma_y = \sigma_z = 10$ N/mm^2, $\tau_{xy} = 20$ N/mm^2 and $\tau_{yz} = \tau_{zx} = 10$ N/mm^2. Compute the principal stress and plane corresponding to $\sigma_1 = 37.3$ N/mm^2, $\sigma_2 = -10$ N/mm^2, $\sigma_3 = 2.7$ N/mm^2. **(10 Marks)**

8 a. Explain : (i) Maximum principal strain theory.
(ii) Maximum strain energy theory.
with applicable limitations and application to type of materials. **(08 Marks)**

b. A rod of circular section is to sustain a torsional moment of 300 kN-m and B.M. 200 kN-m. Assuming stress at yield 353 MPa and F.O.S 3, determine dia of rod under following theories:
(i) Maximum shear stress theory.
(ii) Distortion energy theory.
(iii) Total energy theory. **(12 Marks)**

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