CBCS Scheme

USN 1AY15AE006 15AE54

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Aircraft Structures – I

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.

Module-1

1 a. Briefly explain factor of safety in engineering design. **(02 Marks)**

b. A mild steel bracket shown in Fig. Q1(b) is subjected to a pull of 10kN. The bracket has a rectangular cross section whose depth is twice the width. If the allowable stress for material is 80N/mm^2. Determine the cross section of the bracket. **(08 Marks)**

c. A point in a structural member subjected to plane stress is shown in Fig. Q1(c). Determine the following :
   i) Normal and tangential stress intensities on a plane inclined at 40°
   ii) Principle stresses and orientations of principal planes
   iii) Maximum shear stress and direction of plane on which they occur. **(06 Marks)**

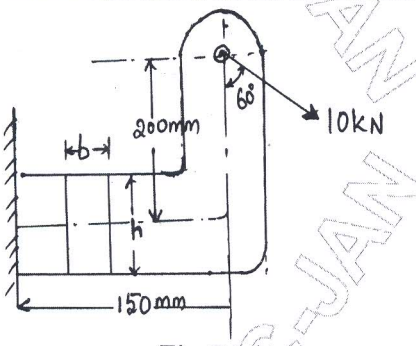

Fig Q1(b)

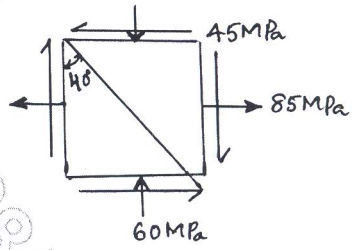

Fig Q1(c)

OR

2 a. A rod of circular section is to sustain a torsional moment of 300kN-m and bending moment 200kN-m yield stress for the material is 353MPa and assuming factor of safety as 3. Determine the diameter of rod as per following theories of failure.
   i) Maximum shear stress theory
   ii) Distortion energy theory
   iii) Maximum strain energy theory (take v = 0.3)
   iv) Maximum principal stress theory. **(08 Marks)**

b. A bar of Rectangular section is subjected to a axial pull of 500kN. Calculate its thickness if the allowable stress in the bar is 200MPa [Fig Q2(b)].

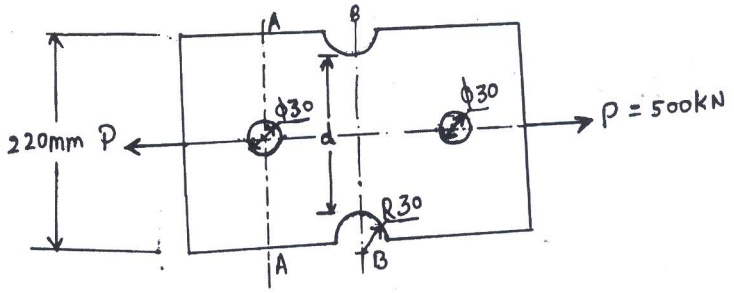

Fig Q2(b) **(08 Marks)**

Module-2

3 a. A unknown weight falls through 20mm on to a collar rigidly attached to the lower end of a vertical bar 2m long and 500mm^2 section. If the maximum instantaneous extension is 2mm, what is the corresponding stress and value of the unknown weight? Take E = 200GPa. **(04 Marks)**

b. Explain stress life(S-N) curve for Ferrous material. **(06 Marks)**

c. Determine the maximum load for the simply supported beam, cyclically loaded as shown in Fig. 3(c). The ultimate strength is 700MPa, the yield point in tension is 520MPa and the endurance limit in reversed bending is 320MPa. Use a factor of safety of 1.25. The load, size and surface correction factor are 1,0.75 and 0.9 respectively.

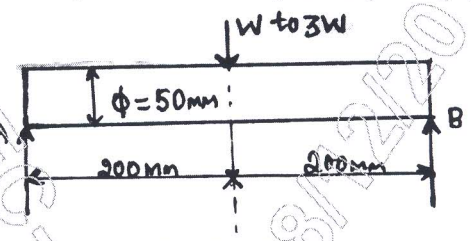

Fig Q3(c) **(06 Marks)**

OR

4 a. Formulate Miner's Rule for cumulative fatigue damage. **(04 Marks)**

b. A steel cantilever member as shown is Fig Q4(b), is subjected to a transverse load at its end that varies from 45N top to 135N down. An axial load varies from 110N compression to 450N tension. Determine the required diameter at the change of section of infinite life using a factor of safety of 2. The strength properties of material are σ_u = 550MPa, σ_y = 470MPa endurance limit from revered bending test σ_e = 275MPA. Notch sensitivity index q = 1.

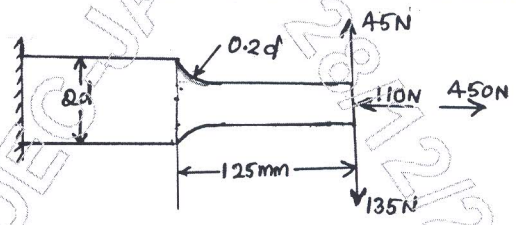

Fig. Q4(b) **(12 Marks)**

Module-3

5 a. With a neat sketch, explain velocity diagram. **(08 Marks)**

b. An aircraft having a total weight of 45kN lands on the deck of a aircraft carrier and is brought to rest by means of a cable engaged by an arrestor hook as shown in Fig. Q5(b). If the deceleration induced by the cable is 3g. Determine the tension T is the cable, the load on the undercarriage sturt. And shear and axial loads in the fuselage at the section A-A. The weight of the aircraft aft of A-A is 4.5 kN. Calculate also the length of deck covered by the aircraft before it is brought to rest if the touchdown speed 25m/s. **(08 Marks)**

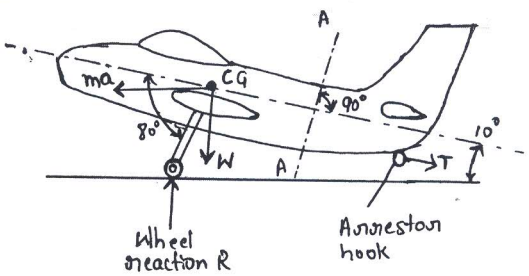

Fig Q5(b)

OR

6 a. Briefly, explain Griffith's theory and derive an expression for stress required for creation of new crack surface. **(08 Marks)**

b. List the desirable properties of materials used in aircraft structures. **(04 Marks)**

c. Write a short note on Titanium Alloys. **(04 Marks)**

Module-4

7 a. Briefly explain state of stress at a point. **(03 Marks)**

b. Derive the equilibrium equations for three dimensional stress systems. **(08 Marks)**

c. Consider the displacement field $u = [y^2 i + 3yzj + (4 + 6x^2)K] \times 10^{-2}$, what are the rectangular strain components at the point P(1, 0, 2)? Use only linear terms. **(05 Marks)**

OR

8 a. Explain statically determinate and indeterminate structure. **(04 Marks)**

b. Using the method of joints, determine the forces in all members of truss shown in Fig. Q8(b). **(12 Marks)**

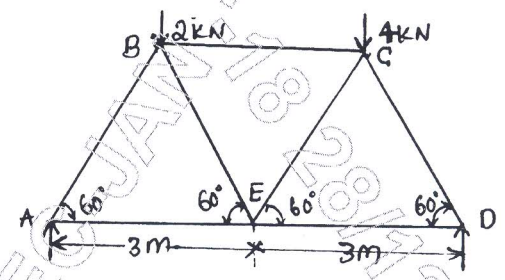

Fig Q8(b)

Module-5

9 a. What is strain energy? Derive the equation for strain energy due to bending and torsion. **(09 Marks)**

b. State and explain Castiglino's theorem. Using Castiglino's theorem find the deflection of a cantilever subjected to point load P at its free end. **(07 Marks)**

OR

10 a. State the assumptions and explain the limitations of Euler's theory. **(04 Marks)**

b. Formulate Rankine-Gordon Equation. **(04 Marks)**

c. A 2.5m long hollow circular column with inner diameter to outer diameter ratio 0.8 is to carry a load of 136kN. One end of the column is fixed and the other end is hinged. Determine the diameters of the column. Take σ_c = 320MPa, $a = \frac{1}{7500}$ for material of column, FOS = 2.5. **(08Marks)**

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