USN | | | | | | | | | | 17AE54

Fifth Semester B.E. Degree Examination, July/August 2022
Aircraft Structures – I

Time: 3 hrs.   Max. Marks: 100

Note: 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Any missing data may be suitably assumed.*

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 pull of 10kN. The bracket has a rectangular cross section whose depth is twice the width. If the allowable stress for material is 80N/mm². Determine the cross section of the bracket.
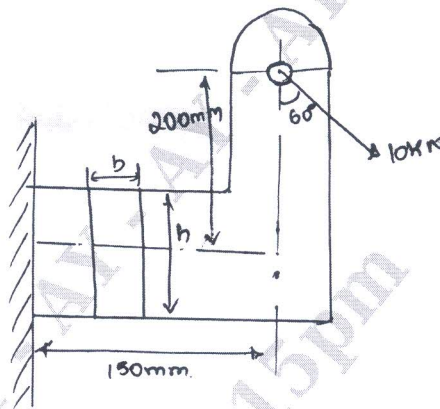

Fig Q1(b)   **(08 Marks)**

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

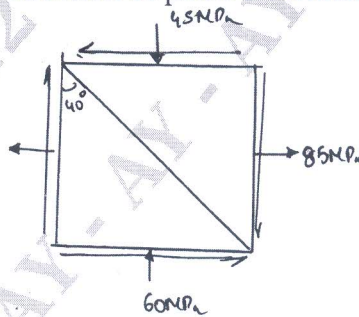Fig Q1(c)   **(10 Marks)**

OR

2 a. A rod of circular section is to sustain a trosional 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.   **(12 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)).
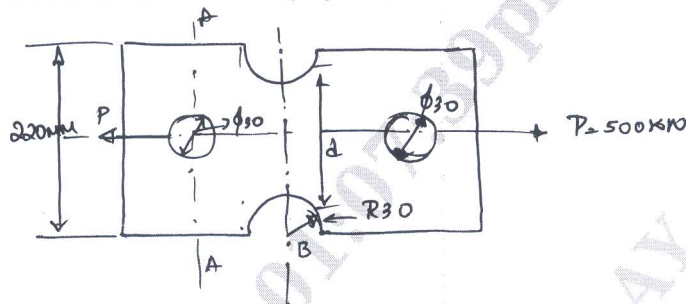

Fig Q2(b)

(08 Marks)

Module-2

3 a. Explain stress life (S-N) curve for Ferrous material. (08 Marks)

b. Determine the maximum load for the simply supported beam, cyclically loaded as shown in Fig Q3(b). 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.
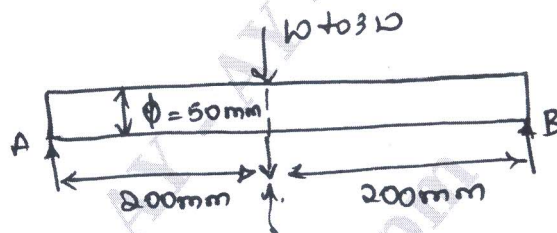

Fig Q3(b)

(12 Marks)

OR

4 a. Formulate Miner's rule for cumulative fatigue damage. (06 Marks)

b. A steel cantilever member as shown in Fig Q4(b), is subjected to a transverse load at it 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 reversed bending test σ_c = 275MPa Notch sensitivity index q = 1.
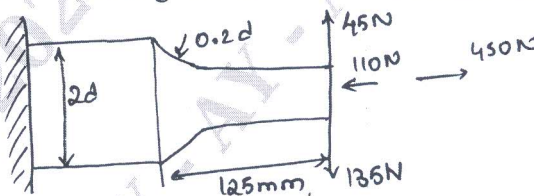

Fig Q4(b)

(14 Marks)

Module-3

5 a. With 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 in the cable, the load on the under carriage strut. And shear and axial loads in the fuselage at section A-A. The weight of the aircraft aft of A-A is 45kN. Calculate also the length of deck covered by the aircraft before to rest if the touchdown speed is 25m/s.
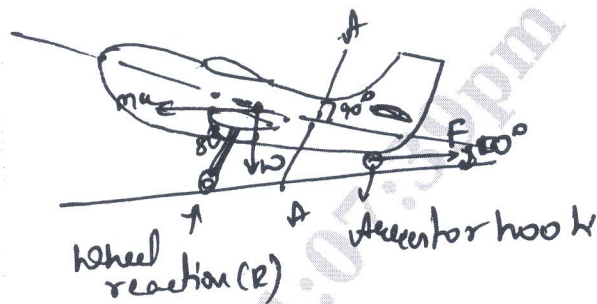
Fig Q5(b)   **(12 Marks)**

OR

6 a. Briefly, explain Griffith's theory and derive on expression for stress required for creation of new crack surface. **(10 Marks)**

b. Write short notes on : i) Titanium alloys   ii) Properties of materials used in aircraft structure. **(10 Marks)**

Module-4

7 a. Briefly explain state of stress at a point. **(05 Marks)**

b. Derive the equilibrium for three dimensional stress systems. **(10 Marks)**

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

OR

8 a. Explain statistically determinate and indeterminate structure. **(06 Marks)**

b. Using the methods of joint, determine the forces in all member of truss shown in Fig Q8(b).
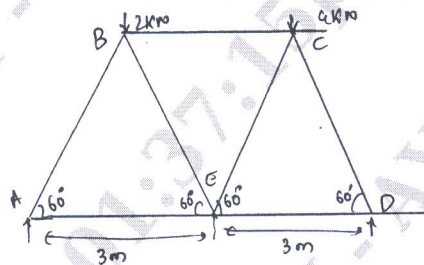

Fig Q8(b)   **(14 Marks)**

Module-5

9 a. What is strain energy? Derive the equation for strain energy due to bending and torsion. **(10 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. **(10 Marks)**

OR

10 a. State the assumptions and explain the limitation of Euler's theory. **(05 Marks)**

b. Formulate Rankine Gordon equation. **(05 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 diameter of the column. Take σ_c = 320MPa, a = $\dfrac{1}{7500}$ for material of column, FOS = 2.5. **(10 Marks)**

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