



CBCS SCHEME

23

15AE54

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020 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. What is standardization? Define code. (02 Marks)
- b. Under what conditions higher factor of safety is chosen for design against static loads. (06 Marks)
- c. The maximum load on a bolt consists of an axial pull of 10 kiloNaton (kN) together with a transverse shear of 5kN. Find the size of the bolt if the tensile elastic limit is 100N/mm^2 and Poisson's ratio is 0.3 under maximum principle stress theory (Fig.Q1(c)). (08 Marks)

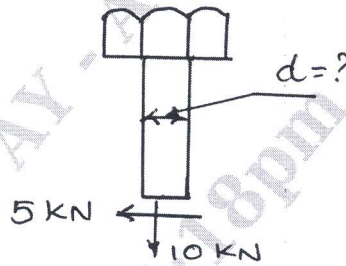


Fig.Q1(c)

OR

- 2 a. What is stress concentration? What are its causes? (02 Marks)
- b. Explain various methods by which stress concentration can be reduced with sketches. (06 Marks)
- c. A flat plate subjected to a tensile force of 5kN is as shown in the Fig.2(c). The plate material is grey cast iron FG200 and the factor of safety is 2.5. Assuming that at the fillet stress concentration factor $K_t = 1.8$, determine the thickness of the plate. Take hole section $K_t = 2.16$. (08 Marks)

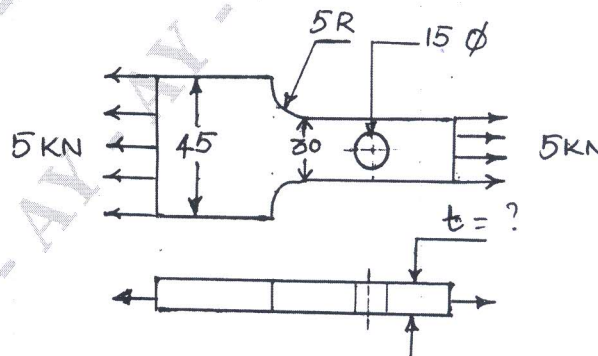


Fig.Q2(c)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-2

- 3 a. What are the differences between low cycle fatigue and high cycle fatigue? (03 Marks)
 b. Explain how surface finish factor affects the endurance limit of a component. (05 Marks)
 c. A rod of a linkage mechanism made of steel 40 cr1 (Ultimate tensile strength, $S_{ut} = 550\text{N/mm}^2$) is subjected to a completely reversed axial load of 100kN. The rod is machined and the expected reliability is 95%. There is no stress concentration. Determine the diameter of the rod for an infinite life condition. Assume surface finish factor, $K_a = 0.78$; size factor = 0.85, and reliability factor, $K_c = 0.868$. (08 Marks)

OR

- 4 a. Explain Soderberg and Goodman lines with a neat graph. (04 Marks)
 b. Using miners equations, explain how the life of a component subjected to different stress levels. (i.e. cumulative damage due to fatigue) is ascertained? (04 Marks)
 c. The work cycle of a component subjected to completely reversed bending stresses consists of the following three elements :
 i) $\pm 350\text{N/mm}^2$ for 85% of time
 ii) $\pm 400\text{N/mm}^2$ for 12% of time
 iii) $\pm 500\text{N/mm}^2$ for 3% of time
 The material for the component is 50C4 (ultimate tensile strength, $S_{ut} = 660\text{N/mm}^2$) and the corrected endurance limit of the component is 280N/mm^2 . Determine the life at the component. (08 Marks)

Module-3

- 5 a. Explain aircraft inertia when subjected angular acceleration. (04 Marks)
 b. What are the advantages and disadvantages of titanium alloy used in aircraft industry? (04 Marks)
 c. An aircraft has a total weight of 45kN, lands on the deck of an aircraft carrier and is brought to rest by means of a cable engaged by an arrestor hook as shown in the Fig.Q5(c). If the deceleration induced by the cable is 39, determine the tension T in the cable, the load on the undercarriage strut, and the shear and axial loads in the fuselage at section AA; the weight of the aircraft aft of AA is 4.5kN. Calculate also the length of the deck covered by the aircraft before it is brought to rest if the touchdown speed is 25m/sec. (08 Marks)

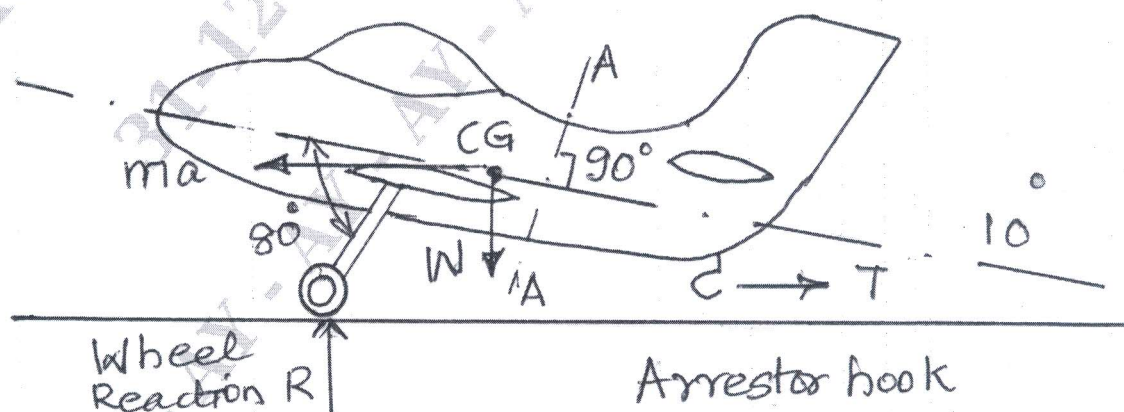


Fig.5(c)
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OR

- 6 a. With a neat sketch explain V-N diagram (velocity load factor). (04 Marks)
 b. Briefly explain advantages and composition of maraging steels. (04 Marks)
 c. An aircraft having a weight of 250kN and a tricycle undercarriage lands with a vertical velocity of 3.7m/sec. Such that the vertical and horizontal reactions on the main wheels are 1200kN and 400kN respectively. At this instant the nose wheel is 1.0m from the ground as shown in the Fig.Q6(c). If the moment of inertia of the aircraft about its CG is $5.65 \times 10^8 \text{NS}^2\text{mm}$, determine the inertia forces on the aircraft, the time taken for its vertical velocity to become zero, and its angular velocity at this instant. (08 Marks)

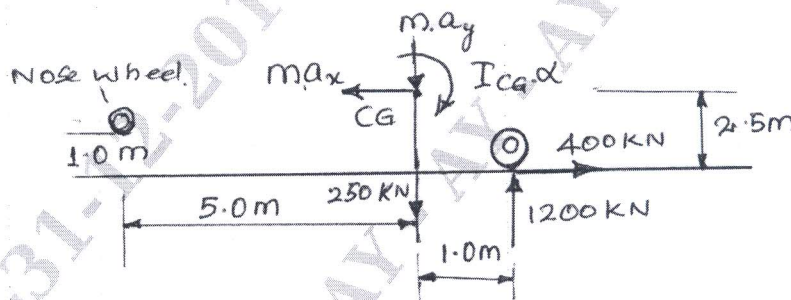


Fig.Q6(c)

Module-4

- 7 a. Derive equations of equilibrium for the stress acting on a 3 dimensional element of an elastic material. (08 Marks)
 b. The state of strain at a point is given by $\epsilon_x = 0.001$, $\epsilon_y = -0.003$, $\epsilon_z = \gamma_{xy} = -0.004$, $\gamma_{yz} = 0.001$. Determine the stress tensor at this point. Take $E = 210 \times 10^6 \text{kN/m}^2$ and Poisson's ratio = 0.28. Find Lamé's constant. (08 Marks)

OR

- 8 a. Write short notes on :
 i) Statically determinate structures
 ii) Statically indeterminate structures. (08 Marks)
 b. Prove Clapeyron's theorem of three moments. (08 Marks)

Module-5

- 9 a. State and prove Castigliano's first theorem in a beam subjected to a load system. (08 Marks)
 b. A cantilever of length 'l' carries a uniformly distributed load of 'W' per unit length over the whole span. Assuming uniform flexural rigidity, find the strain energy stored by the cantilever and deflection at the free end. (08 Marks)

OR

- 10 a. A 2m long pin ended column of square cross section is made of wood. Assuming $E = 12 \text{GPa}$ and allowable stress being limited to 12MPa, determine the size of the column for i) 95kN ii) 200kN. Use factor of safety as 3 and Euler's crippling load for buckling. (08 Marks)
 b. Derive south well plot equation for an elastic buckling load of an imperfect column. (08 Marks)