CBCS SCHEME

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15AE54

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
Aircraft Structures – I

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Design data Hand Book to be issued during examination.

Module-1

1 a. A circular rod of diameter 50mm is subjected to loads as shown in Fig.Q.1(a). Determine the nature and magnitude of stresses at the critical points. **(08 Marks)**

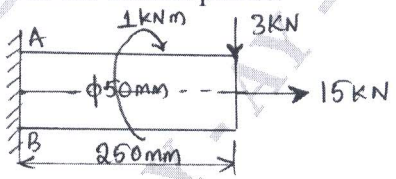

Fig.Q.1(a)

b. An element is subjected to stresses as shown in Fig.Q.1(b). Determine:
i) Normal and shear stresses on a plane whose normal makes an angle of 20° with horizontal axis.
ii) Principal stresses and orientations of principal planes.
iii) Maximum and Minimum shear stresses and orientations of their planes. **(08 Marks)**

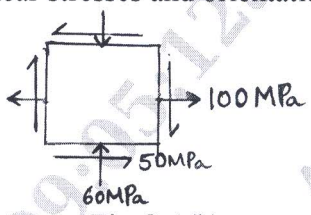

Fig.Q.1(b)

OR

2 a. A round rod of diameter 30mm is to sustain an axial compressive load of 20kN and twisting moment of 1.5kNm. The rod is made of carbon steel (C40) σ_{yt} = 328.6MPa. Determine the factor of safety as per following theories of failure
i) Maximum strain energy theory
ii) Maximum principal strain theory
iii) Distortion energy theory. **(08 Marks)**

b. What is stress concentration? How to mitigate the stress concentration? Determine the maximum stress induced in stepped bar shown in Fig.Q.2(b). **(08 Marks)**

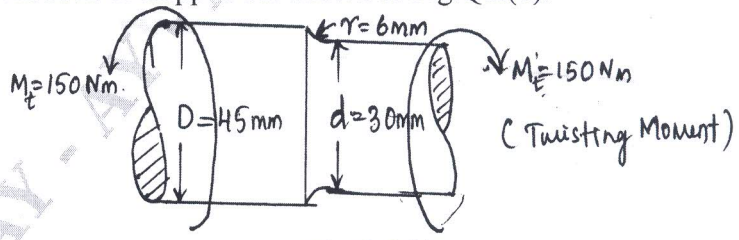

Fig.Q.2(b)

Module-2

3 a. A shaft of 50mm diameter is supported between bearings 300mm apart, the shaft carries a cam at the mid point. There is a slight miss alignment between cam and follower assembly and hence the follower assembly falls through a height of 0.02mm. The mass of the follower is 100kg. Determine:
   i) Impact stress
   ii) Deflection
   iii) Factor of safety if $\sigma_y = 280MPa$. **(08 Marks)**

   b. Briefly explain the stress-life (S-N) diagram for ferrous material. **(08 Marks)**

OR

4 a. What is endurance limit? Briefly explain the factors affecting endurance limit. **(04 Marks)**

   b. A steel shaft made of SAE1045 steel oil quenched subjected to a repeated bending moment of 500Nm and a reversed twisting moment of 600Nm. Determine the diameter of the shaft based on factor of safety 1.8. Take $\sigma_y = 428MPa$, $\sigma_{en} = 365MPa$, $\tau_y = 241MPa$. **(12 Marks)**

Module-3

5 a. Briefly explain different types of loads acting on aircraft. **(08 Marks)**

   b. An aircraft having a weight of 250kN and a tricycle under carriage lands at a vertical velocity of 3.7m/s, such that the vertical and horizontal reactions on the main wheels are 1200kN and 400kN respectively, at this instant nose wheel is 1m from the ground as shown in Fig.Q.5(b). If the moment of inertia of the aircraft about its CG is $5.65 \times 10^8 NS^2mm$. 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)**

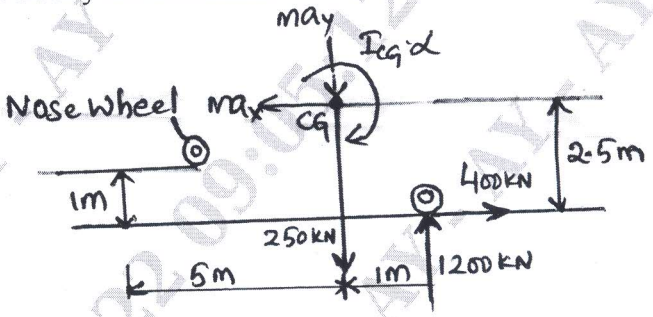

Fig.Q.5(b)

OR

6 a. Briefly explain Aluminium alloys and Titanium alloys used for aircraft structural components. **(08 Marks)**

   b. With neat sketch, explain the basic modes of crack growth and also define stress intensity factor. **(08 Marks)**

Module-4

7 a. Derive Saint-Venants equations of compatability. **(08 Marks)**

   b. Distinguish plane stress and plane strain. Give examples for each. **(08 Marks)**

OR

8 a. Distinguish statically determinate and statically indeterminate structures. Give examples. **(06 Marks)**

b. For the truss shown in Fig.Q.8(b). Determine the magnitude and nature of forces in all members of the structure and tabulate results. **(10 Marks)**

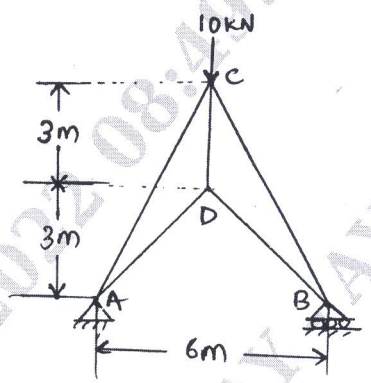

Fig.Q.8(b)

Module-5

9 a. State and prove Maxwell's reciprocal theorem. **(08 Marks)**

b. Determine the critical load for a hollow cast iron rectangular column of external dimensions 150mm × 200mm with the thickness of 25mm. The height of the column is 6m and both ends are fixed. Use Euler's formula and compare the value with the value obtained by Rankine's formula. Take σ_c = 500MPa, $a = \frac{1}{1600}$, E = 120GPa. If allowable stress is 100MPa which of the above formula decides the safe critical load? **(08 Marks)**

OR

10 a. Derive Euler's Buckling load for a column with one end fixed and other end hinged. **(08 Marks)**

b. Briefly explain
   i) Castiglino's theorem
   ii) Southwell plot
   iii) Beam column. **(08 Marks)**

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