CBCS SCHEME

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21AE53

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Aero Structures

Time: 3 hrs. Max. Marks: 100

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

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-1

1 a. Explain the following: i) Biaxial stress ii) Triaxial stress iii) Stress tensor iv) Principal stress v) Factor of safety. **(10 Marks)**

b. A circular rod of diameter 50mm is subjected to loads as shown in Fig.Q.1(b). Determine the nature and magnitude of stresses at point A. **(10 Marks)**

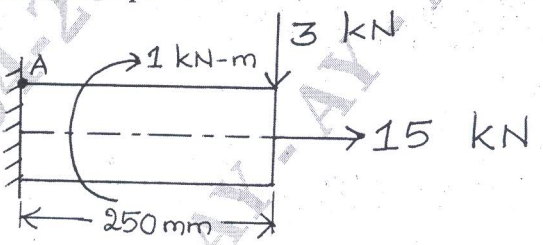

Fig.Q.1(b)

OR

2 a. Explain the following theories of failure:
i) Maximum principal strain theory.
ii) Maximum t shear stress theory.
iii) Maximum strain energy theory.
iv) Distortion energy theory. **(10 Marks)**

b. A steel shaft of yield strength 500MPa in tension and 264MPa in shear is subjected to a bending moment of 100Nm and a twisting moment of 160Nm. Determine the required diameter of shaft based on:
i) Maximum principal stress theory.
ii) Maximum strain energy theory.
iii) Distortion energy theory.
Take E = 210GPa, Poisson's ratio = 0.298 and factor of safety = 2. **(10 Marks)**

Module-2

3 a. Derive an expression for instantaneous stress due to axial impact on vertical bar. **(10 Marks)**

b. A 5kg block is dropped from a height of 200mm on to the centre of a simply supported beam of span 1200mm. The material has an allowable stress of 50MPa. Determine the dimensions of the rectangular cross-section of the beam whose depth is 1.5 times the width. Take E = 70 GPa. **(10 Marks)**

OR

4 a. Explain cumulative fatigue damage. **(08 Marks)**

b. A steel member of circular section is subjected to a torsional stress that varies from 0 to 35MPa and at the same time it is subjected to an axial stress that varies from -14MPa to +28MPa. Neglecting stress concentration and column effect, determine
i) Maximum equivalent shear stress.
ii) Factor of safety based upon yield in shear.
The material has an endurance limit of 206MPa and an yield strength of 480MPa. Assume load, size and surface correction factors as unity. **(12 Marks)**

Module-3

5 a. With neat sketch, explain v-n diagram. **(08 Marks)**

b. An aircraft having a weight of 250kN and a tricycle undercarriage lands at a vertical velocity of 3.7 m/s, such that the vertical and horizontal reactions on the main wheels are 1200kN and 400kN respectively, at this instant, the 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 5.65×10^8 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. **(12 Marks)**

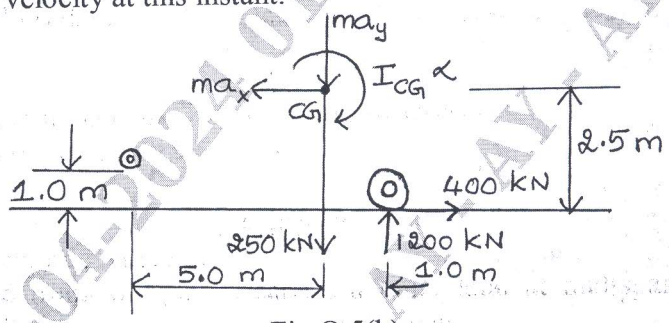

Fig.Q.5(b)

OR

6 a. List and explain the desirable properties of materials used for aircraft applications. **(10 Marks)**

b. List the advantages, limitations and applications of i) Aluminium alloys ii) Stainless steel alloys. **(10 Marks)**

Module-4

7 a. Derive St. Venant's strain compatibility equations. **(10 Marks)**

b. Consider the displacement field $u = [y^2i + 3yzj + (4 + 6x^2)k]10^{-2}$. Determine the rectangular strain components at (1, 0, 2). **(10 Marks)**

OR

8 a. Explain statically determinate and indeterminate structures. **(10 Marks)**

b. Device Clapeyron's three moment equation. **(10 Marks)**

Module-5

9 a. Derive Maxwell's reciprocal theorem. **(10 Marks)**

b. A simply supported beam of span L carries a point load at mid-span. Determine strain energy stored in the beam and deflection at its mid-span. **(10 Marks)**

OR

10 a. Derive Euler's crippling load for a column fixed at one end and hinged at the other end. **(10 Marks)**

b. Design the section of a circular cast iron column that can safely carry a load of 1000kN. The length of the column is 6m. Rankine's constant is 1/1600, factor of safety is 3. One end of the column is fixed and the other end is free. Critical stress is 560MPa. **(10 Marks)**

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