CBCS SCHEME

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17AE54

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Aircraft Structures – I

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Explain the machine design. Write down the procedure of machine design. **(05 Marks)**

b. Explain Factor of Safety (FoS) and discuss the factors influencing FoS. **(05 Marks)**

c. A point in a structural member subjected to a plane stress as shown in Fig.Q1(c). Determine the following:

(i) Normal and Tangential stress on a plane inclined at 45°

(ii) Principal stress and their directions

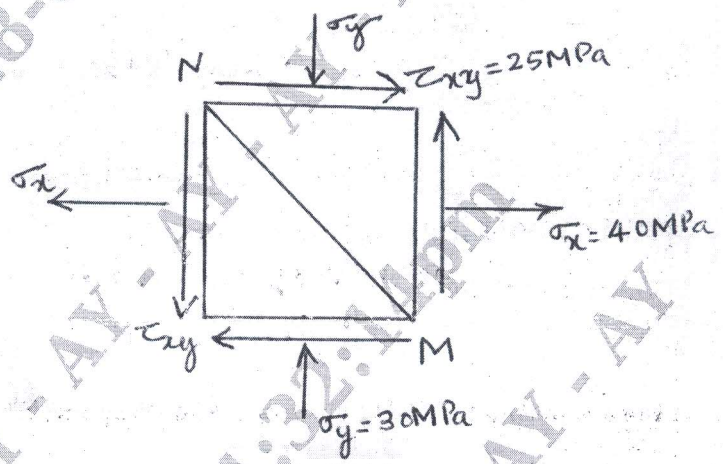

Fig.Q1(c) **(10 Marks)**

OR

2 a. Explain:

(i) Maximum Principal Stress Theory

(ii) Maximum Shear Stress Theory

(iii) Maximum Strain Energy Theory

(iv) Maximum Distortion Energy Theory **(12 Marks)**

b. A bar 50 mm diameter fixed at one end is subjected to a torsional load of 1 kN-m in addition to an axial pull of 15 kN. Determine the principal stress if the length of the shaft is 250 mm. **(08 Marks)**

Module-2

3 a. What is impact stress? Derive an equation for impact stress due to axial impact. **(08 Marks)**

b. A cantilever beam of span 800mm has rectangular cross section of depth 200mm. The free end of the beam is subjected to a transverse load of 1kN that drops on to if from a height of 40mm. Selecting C40 steel, σ_y = 328.6MPa, E = 206.8GPa, Factory of safety = 3. Determine the width of rectangular cross section. **(06 Marks)**

c. What is endurance limit? Briefly discuss the factors affecting the endurance limit. **(06 Marks)**

OR

4 a. Derive Soderberg's criteria for fatigue design. **(08 Marks)**

b. A steel shaft made of SAE1045 steel oil quenched is 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 according to :

i) Maximum principal stress theory
ii) Tresca's criterion
iii) Vonmises criterion.

Take σ_{uit} = 662MPa, σ_{yp} = 425MPa, σ_{en} = 365MPa, τ_{yp} = 241MPa. Load correction factor for bending and Torsion is 0.9 and 0.5 respectively. Take surface correction factor = size correction factor = 0.85. **(12 Marks)**

Module-3

5 a. Explain load factor and different types of loads that acts on the aircraft. **(04 Marks)**

b. Explain V-n diagram. **(06 Marks)**

c. 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, the nose wheel is 1.0m form the ground, as shown in the Fig.Q5(c). If the moment of inertia of the aircraft about its CG is 5.65×10^8 NS^2mm, determine the inertia forces of the aircraft, the time taken for its vertical velocity to become zero and its angular velocity at his instant. **(10 Marks)**

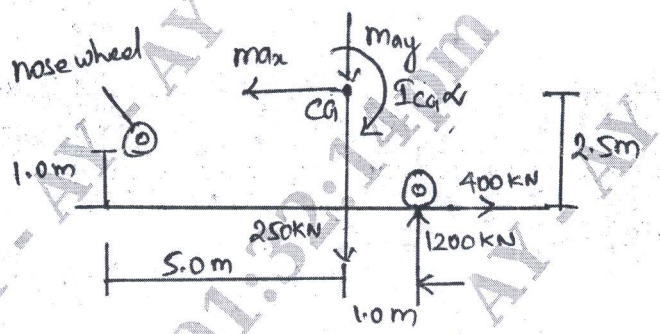

Fig.Q5(c)

OR

6 a. What are the desirable properties materials for aircraft application? **(06 Marks)**

b. Describe the uses of aluminum alloy, titanium alloy stainless steel and composite materials with merits and demerits. **(10 Marks)**

c. Define fracture and fatigue. **(04 Marks)**

Module-4

7 a. Derive the equations of equilibrium in 3-D with a neat sketch. **(12 Marks)**

b. The state of stress at a point is given by

$\sigma_x = x^3yz + x^2y^2 \quad \tau_{xy} = x^2yz$

$\sigma_y = 3y^2z + yz \quad \tau_{yz} = xy^2z$

$\sigma_z = x^2y^2z^2 + xz \quad \tau_{zx} = xyz^2$

In the absence of body forces, determine the equilibrium conditions are satisfied or not at point (3, –4, 2). **(08 Marks)**

OR

8 a. Derive Clapeyron's 3-moment equation. **(10 Marks)**

b. Write notes on:

(i) Statically determinate structures

(ii) Statically indeterminate structures **(10 Marks)**

Module-5

9 a. Derive an expression for strain energy due to torsion with usual notations. **(06 Marks)**

b. State and explain Castiglino's theorem. Determine the total strain energy and free and deflection for the beam shown in Fig.Q9(b).

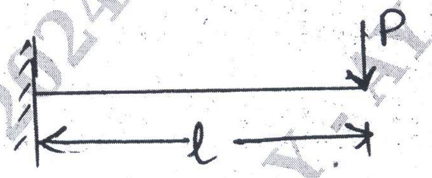

Fig.Q9(b) **(08 Marks)**

c. State and prove Maxwell's reciprocal theorem. **(06 Marks)**

OR

10 a. Drive the expression for Euler's buckling load for a column with both ends hinged. **(08 Marks)**

b. Write a short note on :

i) Limitations of Euler's theory

ii) South-well plot. **(04 Marks)**

c. A hollow cast iron column whose outside diameter is 200mm and thickness of 20mm is 4.5m long and is fixed at both ends. Calculate safe load by Rankine's formula using a factor of safety of 2.5. Find the ratio of Euler's to Rankine's loads. Take $E = 1 \times 10^5$ MPa and Rankine constant $= \frac{1}{1600}$ and crushing stress $\sigma_c = 550$MPa. **(08 Marks)**

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