CBCS SCHEME

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18AE53

# Fifth Semester B.E. Degree Examination, July/August 2022
## 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 briefly about design considerations. **(05 Marks)**

b. Briefly explain about triaxial and biaxial state of stresses. **(05 Marks)**

c. A point in a strained material is subjected to a tensile stress of 500 N/mm$^2$ and 300 N/mm$^2$ in two mutually perpendicular planes. Calculate the normal, tangential, resultant stress and its obliquity on a plane making an angle of 30° with the axis of minor tensile stress. Also find the maximum shear stress. **(10 Marks)**

**OR**

2 a. Explain the following :

(i) Maximum shear stress theory.
(ii) Strain energy theory.
(iii) Maximum normal stress theory.
(iv) Distortion energy theory. **(12 Marks)**

b. The principal stresses at a point in an elastic material are 200 N/mm$^2$ (Tensile), 100 N/mm$^2$(Tensile) and 50 N/mm$^2$(Compressive). If the stress at the elastic limit in simple tension is 200 N/mm$^2$, determine whether the failure of the material will occur according to:

(i) Maximum Principal strain theory.
(ii) Maximum stress theory.
(iii) Maximum strain energy theory.
(iv) Maximum shear strain energy theory.

Take Poisson's ratio as 0.3. **(08 Marks)**

### Module-2

3 a. Derive an expression for impact factor due to axial load. **(10 Marks)**

b. A Cantilever beam of width 50 mm, depth of 150 mm is 1.5 m long. It is stuck by a weight of 1000 N that falls from a height of 10 mm at its free end. Determine impact factor, instantaneous maximum deflection, maximum shear and maximum load. **(10 Marks)**

**OR**

4 a. Derive the equation for Goodman relationship. **(10 Marks)**

b. With a neat sketch, explain the S-N diagram got by the results of fatigue test. **(10 Marks)**

## Module-3

5 a. Explain flight envelope with a neat sketch. **(10 Marks)**

b. An aircraft having a weight of 250 kN and a tricycle undercarriage, lands at a vertical velocity of 3.7 m/s, such that the vertical and horizontal reaction on the main wheels are 1200 kN and 400 kN respectively. At this instant the nose wheel is 1.0 m from the ground as shown in the Fig. Q5 (b) The moment of inertia of the aircraft about its CG is $5.65\times10^8$ NS$^2$mm. Determine the inertia forces on the aircraft, time taken for its vertical velocity to become zero and its angular velocity at this instant.

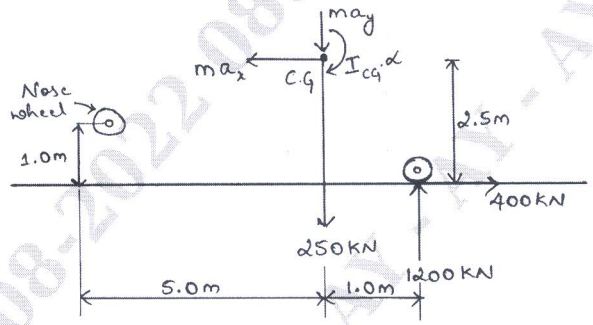


Fig. Q5 (b) **(10 Marks)**

**OR**

6 a. List out the desirable properties of materials for aircraft application. **(10 Marks)**

b. Explain about metallic and non-metallic materials used in aerospace. **(10 Marks)**

## Module-4

7 a. Derive the equilibrium equations for 3-D elastic material and reduce to 2-D plane stress condition. **(10 Marks)**

b. At a particular point in a structural member a 2D stress system exists where $\sigma_x = 60$ N/mm$^2$, $\sigma_y = -40$ N/mm$^2$ and $\tau_{xy} = 50$ N/mm$^2$. If $E = 2\times10^5$ N/mm$^2$ and Poisson's ratio = 0.3, calculate the direct strain in the x and y direction and the shear strain at the point. Also, calculate principal strain at the point and their inclination to the plane on which $\sigma_x$ acts. **(10 Marks)**

**OR**

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

b. Explain the steps involved in the analysis of trusses using method of joints. **(10 Marks)**

## Module-5

9 a. State and explain Maxwell's Reciprocal theorem. **(10 Marks)**

b. State and prove Castigliano's first theorem in a beam subjected to a load system. **(10 Marks)**

**OR**

10 a. Derive an expression for crippling load for a column when one end is fixed and the other end is free. **(12 Marks)**

b. A 2 m long pin ended column of square cross section to be made of wood assuming E = 12 GPa and allowable stress being limited to 12 MPa, determine the size of column to support the following load safety : (i) 96 kN (ii) 200 kN. Use FOS as 3 and Euler's crippling load for buckling. **(08 Marks)**

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