Faculty of Engineering & Technology
Fourth Semester B.E. (Aeronautical Engg.) (CBS) Examination
AIRCRAFT STRUCTURES—I

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) All questions are compulsory.

(3) Due credit will be given to neatness and adequate dimensions.

(4) Assume suitable data wherever necessary.

(5) Illustrate your answers wherever necessary with the help of neat sketches.

1. (a) Draw stress-strain diagram for ductile materials and also explain it in detail. 6

(b) A solid shaft is 100 mm in diameter, transmits 120 kN at 200 rpm. Find the maximum intensity of shear stress induced and the angle of twist (θ) for a length of 6m. Take $C = 8 \times 10^4$ N/mm^2. 8

OR

2. (a) Consider a shaft which is fixed from one end and subjected to a torsion on other end. Derive a relation where the twisting moment is proportional to the modulus of rigidity, shear stress, angle of twist and polar modulus of the material. 6

(b) A member ABCD is subjected to a point load, P_1, P_2, P_3 and P_4 as shown in fig. 1 calculate the force P_3 necessary for equilibrium if P_1 = 120 kN, P_2 = 220 kN and P_4 = 160 kN. Determine also the net change in the length of the member.
Take $E = 2 \times 10^5$ N/mm^2. 8

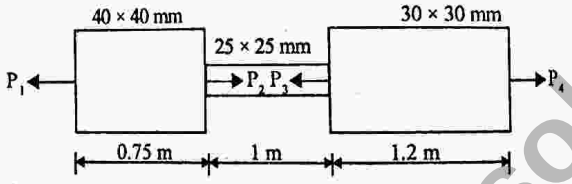

Fig. 1

3. (a) Find the reactions at the fixed end of the cantilever loaded as shown in figure. 2. Also draw SF and BM diagram. 8

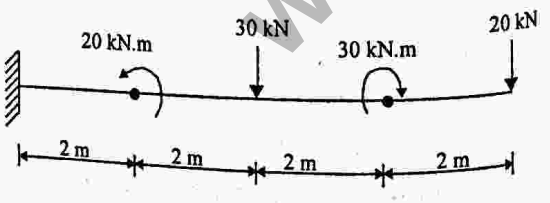

Fig. 2

(b) Derive an equation for bending when the beam is subjected to pure bending. 5

OR

4. (a) Draw SF and BM diagrams for the beam shown in the figure 3. Locate point of zero shear and contra flexure if any. 8

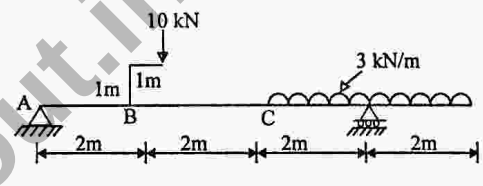

Fig. 3

(b) Explain the classification of beams in detail. 5

5. (a) Derive Castigliano's theorem. 6

(b) The external diameter of a hollow shaft is twice the internal diameter. It is subjected to pure torque and it attains a maximum shear stress (z). Show that the strain energy stored per unit volume of the shaft is $\frac{5\tau^2}{16C}$. Such a shaft is required to transmit 5400 KW at 110 rpm with uniform torque, the maximum stress not exceeding 84 MN/m^2. Determine :

(i) The shaft diameter

(ii) The energy stored per m^3.

Take C = 90 GN/m^2. 7

OR

6. (a) Define the following :

(i) Resilience

(ii) Proof resilience

(iii) Modulus of resilience. 6

(b) A bar 100 cm in length is subjected to an axial pull, such that the maximum stress is equal to 150 MN/m^2. Its area of cross section is 2 cm^2 over a length of 95 cm and for the middle 5 cm length it is only 1 cm^2. If E = 200 GN/m^2 calculate the strain energy stored in bar. Shown in figure 4. 7

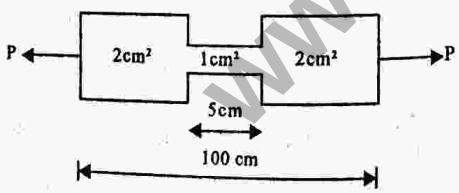

Fig. 4

7. (a) Derive an expression for Euler's equation for a column which is subjected to a crippling load and whose effective length is equal to the half of its original length. 7

(b) A hollow CI column whose outside diameter is 250 mm has a thickness of 25 mm. It is 5 m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 4. Calculate the slenderness ratio and the ratio to Euler's and Rankine's critical loads. For cast iron σ_C = 550 N/mm^2, a = $\frac{1}{1600}$ and E = 8×10^4 N/mm^2. 7

OR

8. (a) Derive an expression for the Eulers critical load of the beam columns with transverse loading at the centre. 7

(b) A slender pin ended aluminium column 1.8 m long and of circular cross-section to have an outside diameter of 50 mm. Calculate the necessary internal diameter to prevent failure by buckling if the actual load applied is 13.6 kN and the critical load applied is twice the actual load. E = 70 GN/m^2. 7

9. (a) A point is subjected to perpendicular stresses of 50 MN/m^2 and 30 MN/m^2, both tensile. Calculate the normal, tangential stresses and resultant stress and its obiquity on a plane making an angle of 30° with the axis of second stress. Solve by analytical and graphical method. 8

(b) Explain in detail about principal planes and principal stresses. 5

OR

10. (a) At a point in a bracket the stresses on two mutually perpendicular planes are 400 MN/m^2 tensile and 300 MN/m^2 tensile. The shear stress across these planes is 200 MN/m^2. Determine the magnitude and directions of principal stresses and maximum shear stress. 7

(b) Derive an expression of maximum and minimum principal stresses and maximum shear stress when a member is subjected to combined stress. 6

11. (a) Derive an equation for a combined bending and torsion considering maximum and minimum principal stresses. 7

(b) A circular shaft 25 mm diameter has a tensile yield strength of 620 MPa and a compressive yield strength of 820 MPa. Determine the twisting moment required to produce yielding based on :

(i) Maximum principal stress theory

(ii) Maximum shear stress theory. 6

OR

12. (a) A solid shaft is subjected to a bending moment of 300 MN and a twisting moment of 225 Nm. Find the diameter of the shaft with a factor of safety of 2 according to the maximum principal strain theory.

Take $\sigma_y = 210\ N/mm^2$ and $\frac{1}{m} = 0.25$. 7

(b) State and explain maximum distortion theory. 4

(c) Define :

(i) Notch sensitivity

(ii) Stress raisers. 2