Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 80007

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fourth Semester

Aeronautical Engineering

AE 8403 — AIRCRAFT STRUCTURES – I

(Regulation 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Members of a planar truss are connected by _____ while the members of a space truss are connected by _____.

2. What is a two force member?

3. Basis for the dummy and unit load methods are (the principle of superposition/ Castigliano's theorems / the principle of virtual work and Maxwell's reciprocal theorem)

4. The strain energy in a member subject to axial loading can be expressed as _____.

5. Solid and slender columns fail primarily by (primary buckling / local buckling / combination of local buckling and material crushing).

6. What is a beam-column?

7. Define the hydrostatic state of stress.

8. When does a stressed material break according to the maximum principal stress failure criterion?

9. Briefly define fatigue of materials.

10. In structural mechanics, what does the term creep refer to?

PART B — (5 × 13 = 65 marks)

11. (a) (i) What is the most elementary 3-D space truss structure? In the context of a space truss, explain the method of joints. (3)

(ii) Determine the forces in members AB, AC and AE of the space truss given in Figure 1. (10)

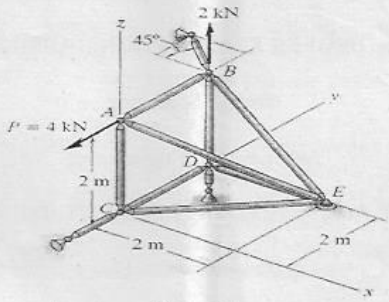

Figure 1

Or

(b) Calculate the member force in member DJ of the planar truss given in Figure 2 using the method of sections.

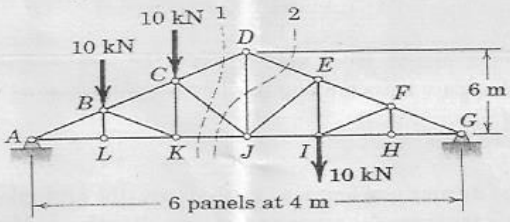

Figure 2

12. (a) Refer Figure 3 where a bar of uniform cross-section is bent into a quadrant of circle of radius R. One end of the bent is fixed and other is free. At the free end it carries a vertical load W. Determine expressions for the vertical and horizontal deflections at A using energy methods.

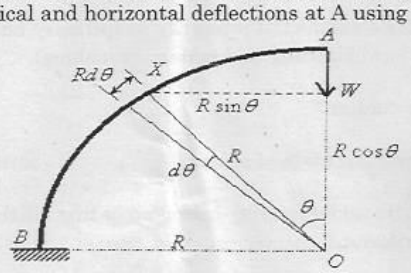

Figure 3

Or

(b) Consider a cantilever beam of length L and flexural rigidity EI subject to uniformly distributed load q_0 N/m throughout its length. Determine an expression for the tip deflection using the dummy load method.

13. (a) (i) What are the limitations of the Euler buckling theory? (3)

(ii) Compare the critical loads, effective lengths, and effective length factors for ideal columns with different end conditions. Use a tabular chart. Neatly sketch the first buckled mode shape for each end condition. (10)

Or

(b) How can the critical load of a fixed-pinned column be obtained? Derive and obtain the governing differential equation and the buckling equation. How can the critical load be calculated?

14. (a) A steel machine part is statically loaded and has a yield strength of 320 MPa. At a certain critical point, the following state of stress exists: $\sigma_x = 60$ MPa, $\sigma_y = -30$ MPa, and $\sigma_z = -20$ MPa, with $T_{xy} = 40$ MPa.

Check if failure will occur and determine the safety factor according to the following failure theories:

(i) Maximum normal stress failure theory. (4)

(ii) Maximum shear stress failure theory (4)

(iii) Distortion energy failure theory (5)

Or

(b) (i) What the differences in the physical aspects of ductile failure and brittle failure? (6½)

(ii) Explain the maximum shear stress failure theory and indicate the failure envelope. (6½)

15. (a) A rod consists of two parts made of steel and aluminum as shown in Figure 4. Elastic modulus and coefficient of thermal expansion for steel are 200 GPa and 11.7×10^{-6} per °C respectively and for aluminum the values are 70 GPa and 21.6×10^{-6} per °C respectively. If the temperature of the rod is raised by 50 °C, determine the forces and stresses acting on the rod. Rod diameters are 5 cm (steel) and 3 cm (aluminium).

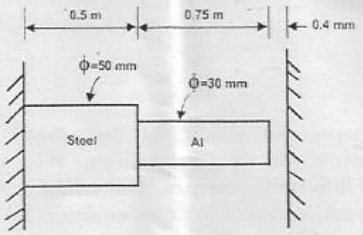

Figure 4

Or

(b) Write notes and explain fatigue of materials due to repeated loading cycles. Explain the physical meaning and significance of the S-N curve. Define the endurance limit.

PART C — (1 × 15 = 15 marks)

16. (a) (i) Name a few failure theories suitable for ductile material and a few failure theories suitable for brittle material. Which is the characteristic failure stress for ductile material and for brittle material? Write down an approximate value for the yield stress of pure aluminium. (5)

(ii) Consider a prismatic bar of cross-section area A and tensile modulus E. The bar is in a vertical position hung from a support. Determine the strain energy in the bar first due to self-weight alone and next, due to self-weight and an axial load P at the free end. Is the total strain energy the sum of strain energy due to self-weight and the strain energy due to the axial load P? (10)

Or

(b) Answer the following questions:

(i) Suggest methods by which critical buckling loads of columns can be increased. In which plane will a practical column buckle? (5)

(ii) Consider the spring supported rigid bar linkage system indicated in Figure 5. Determine the critical buckling load for the given system. (5)

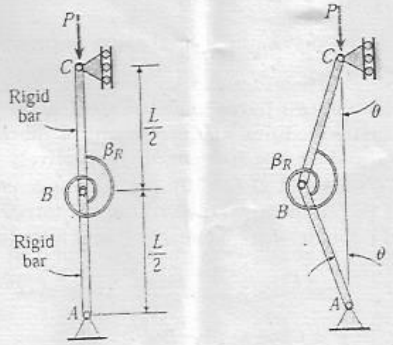

Figure 5

(iii) Summarize the conditions for stable, neutral, and unstable equilibrium for an ideal column. Why does a practical column behave differently from an ideal column? Why are 3rd 4th and higher order buckling loads often insignificant in column analysis? (5)