Register No: ……

B.E DEGREE EXAMINATIONS: APRIL/MAY 2011

Fourth Semester

AERONAUTICAL ENGINEERING

U07AR403: Aircraft Structures - I

Time: Three Hours **Maximum Marks: 100**

Answer All Questions:-

PART A (10 x 1 = 10 Marks)

1. In the method of joints, a joint is taken for analysis only when there are not more than ……. unknown force(s) acting at that point

   a) one b) three c) two d) four

2. In a plane frame, one of the joint is a horizontal roller joint. For a general loading, the reaction(s) at this joint

   a) is only a horizontal reaction force b) is only a vertical reaction force

   c) are both horizontal and vertical reaction forces d) is a moment only

3. Composite beams (or beams of heterogeneous materials) are otherwise called

   a) continuous beams b) built-in beams c) flitched beams d) beams of uniform strength

4. Moment distribution method was evolved by

   a) Maxwell b) Von Mises c) Hardy Cross d) Rayleigh

5. The strain energy stored by the body within the elastic limit when loaded externally is called

   a) resilience b) proof resilience c) toughness d) modulus of toughness

6. The unit-load method is based on the

   a) principle of virtual work b) Castigliano's theorem

   c) Castigliano's theorem d) Principle of potential energy

7. The ratio of equivalent length of a column (having one end fixed and the other end free), to its actual length is

   a) 2 b) Square root of 2 c) 0.5 d) Inverse of square root of 2

8. The secant formula is used for

   a) long columns under eccentric loading b) long columns under axial loading

   c) short columns under axial loading d) short columns under eccentric loading

9. Shear strain energy theory is also called as

   a) Mises-Henky theory b) Tresca's theory c) Haigh's theory d) Rankine's theory

10. Which of the following theories is suitable for ductile materials?

a) Maximum principal stress theory b) Maximum principal strain theory

c) Maximum shear stress theory d) Distortion energy theory

PART B (10 x 2 = 20 Marks)

11. Differentiate between a truss member and a frame member.
12. Where are plane-frame-type structures found in an aircraft?
13. How do you solve indeterminate structures?
14. State Clayperon's three moment theorem.
15. State Castigliano's first and second theorems.
16. Briefly explain unit load method using a cantilever beam with tip load.
17. The cross-section of a column is rectangular with dimensions 50 mm ×100 mm. Find the second moment of area that must be used for the buckling load calculation.
18. Briefly explain Southwell plot.
19. Differentiate between failure of brittle and ductile materials in axial loading and torsional loading.
20. Define 'von Mises stress'.

PART C (5 x 14 = 70 Marks)

21. a) Determine the magnitude and nature of forces in all members of the truss structure shown in Figure 1.

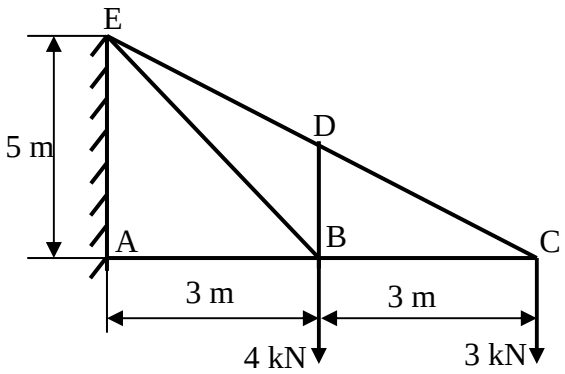

Figure 1.

(OR)

b) A statically determinate rigid-jointed symmetrical portal frame is supported on a roller at A and pinned at support D as shown in Figure 2. For the loading indicate:
(i) determine the support reactions and
(ii) sketch the axial load, shear force and bending moment diagrams.

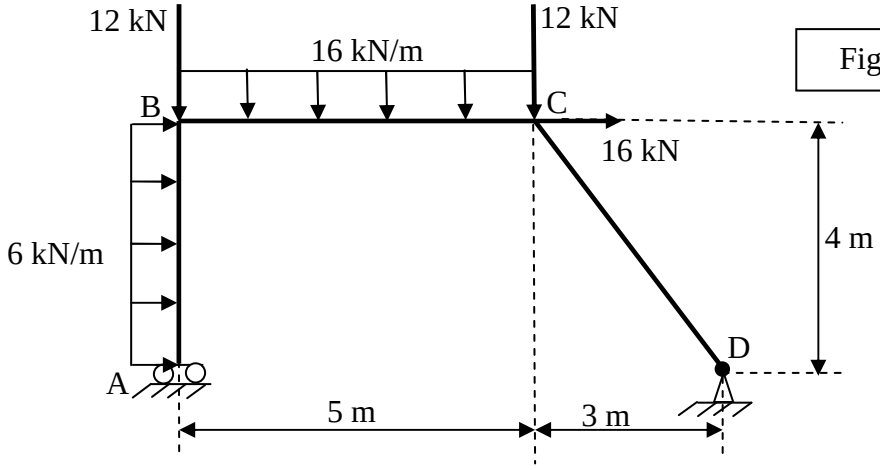

Figure 2

22. a) A continuous beam ABC is simply supported at the extreme ends A and C and also at the intermediate support B. The span AB = 3.6 m and the span BC = 2.4m. A concentrated downward load of 2 kN acts at a distance of 1.8 m from A and another concentrated downward load of 4 kN acts at a distance 1.8 m from C. Assuming *EI* is constant, find the shear force and bending moments at the supports and draw the shear force and bending moment diagrams. **Use Clayperon's three moment theorem**.

(OR)

b) A continuous beam ABC is fixed at the left extreme end A and simply supported at the right extreme end C and is also simply supported at an intermediate point B. The span AB = 4 m and the span BC = 3 m. A concentrated downward load of 80 kN acts at a distance of 1.0 m from A while another concentrated downward load of 60 kN acts at a distance 1.0 m from C. $I_{AB} : I_{BC} = 2:1$. Find the support moments and draw the bending moment diagram. **Use moment distribution method**.

23. a) A cantilever beam of span 10 m is subjected to a tip load of 3 kN. Determine the slope at mid-span of the beam using any one of the energy methods. Take E = 200 GPa and $I = 60\times10^6$ mm^4.

(OR)

b) A triangular plane truss structure ABC consists of three members AB, AC and BC of joint coordinates A, B and C with (0,0) m, (8,0) m and (4,3) m, respectively. The

joints A and B are simply supported. A horizontal load of 4 kN acts in the positive *x*-direction at joint C. Find the vertical displacement of point C of the truss. The cross-sectional area of each member is 400 mm2 and E = 200 GPa. Use any one of the energy methods.

24. a) A column AB of length *l* with both ends hinged has an initial curvature. It is subjected to an axial loading which produces a maximum deflection at the mid-span of the column. Derive the expressions for the maximum deflection, maximum bending moment and maximum bending stress.

(OR)

b) A beam column of length *l* is pinned at both ends and is subjected to an axial thrust P and a lateral uniformly distributed load of intensity of *q* per unit run. Derive the expressions for the deflection at the mid-span, maximum bending moment and maximum bending stress in the beam column.

25. a) A cylindrical shell made of mild steel plate and 1.2 m in diameter is to be subjected to an internal pressure of 1.5 MPa. If the material yields at 200 MPa, calculate the thickness of the plate on the basis of the following three theories, assuming a factor of safety 3.0 in each case.

(i) Maximum principal stress theory

(ii) Maximum shear stress theory

(iii) Maximum shear strain energy theory

(OR)

b) The direct stresses on two mutually perpendicular planes, in a two-dimensional stress system, are σ and 144 MPa. In addition, these planes carry a shear stress of 48 MPa. Assuming the factor of safety on elastic limit as 3.0

(i) Find the value of σ at which the shear strain energy is least.

(ii) If failure occurs at this value of shear strain energy, estimate the elastic limit of the material in simple tension.

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