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CHEMICAL ENGINEERING REFRESHER COURSE

ENGINEERING MECHANICS & STRENGTH OF MATERIALS PART 2

1. Which of the following is NOT a type of support condition in engineering mechanics?
   a. Fixed support
   b. Roller support
   c. Hinged support
   d. Sliding support

2. Which of the following is a necessary condition for a body to be in equilibrium under the action of a system of forces?
   a. The sum of all forces in the x-direction is zero
   b. The sum of all forces in the y-direction is zer
   c. The sum of all moments about any point is zero
   d. All of the above

3. Which of the following is true about the centroid of an area?
   a. It is the point of intersection of the medians
   b. It is the point through which the entire area can be assumed to be concentrated
   c. It is the point through which the line of action of the resultant force passes
   d. It is the point of intersection of the diagonals of a rectangle

4. Which type of stress is induced in a material subjected to a twisting force or torque?
   a. Normal stress
   b. Shear stress
   c. Tensile stress
   d. Comprehensive stress

5. What is the term used to describe the maximum stress a material can withstand before failure in a uniaxial tension test?
   a. Yield strength
   b. Elastic modulus
   c. Ultimate tensile strength
   d. Resilience

6. Which of the following is a measure of a material's ability to deform plastically before fracture?
   a. Ductility
   b. Elastic modulus
   c. Toughness
   d. Resilience

7. A semicircle of radius 3 inches is drawn on the base of an inverted right triangle with a height of 9 inches. Determine the coordinates of the centroid of the composite area formed. Assume that the leg of the right triangle corresponding with the height coincide with the y – axis.
   a. (3.24, 7.74)
   b. (3.24, 7.47)
   c. (2.34, 7.74)
   d. (2.34, 7.47)

8. A block R of mass 100 kg is placed on a block S of mass 150 kg as shown in the figure. Block R is tied to the wall by a massless and inextensible string PQ. If the coefficient of static friction for all surfaces is 0.4, determine the minimum force F (in kN) needed to move the block S.
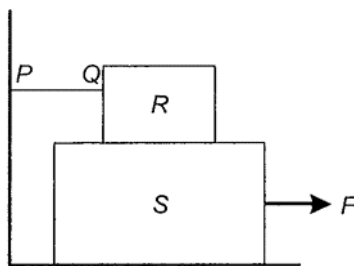
    a. 0.69
    b. 0.88

    c. 0.98
    d. 1.37

9. Determine the force P that will keep the pulley system in equilibrium. Neglect the weights of the pulley.


9000 N
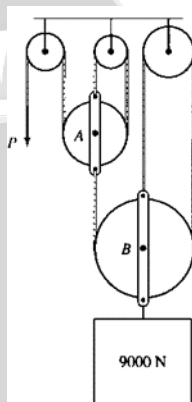
    a. 1000 N
    b. 2000 N

    c. 3000 N
    d. 4000 N

10. If point A is in equilibrium under the action of the applied forces, the values of tensions T_{AB} and T_{AC} are _____ and _____ respectively.

T_{AB}

T_{AC}

60°   A   30°

600 N
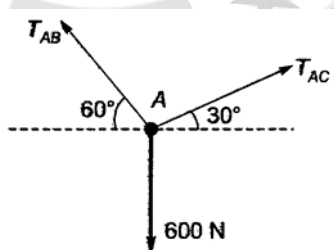
    a. 150 N; 450 N
    b. 300 N; 520 N

    c. 450 N; 150 N
    d. 520 N; 300 N

11. Assume that a 20-mm-diameter rivet joins two plates that are each 110 mm wide. The allowable stresses are 120 MPa for bearing in the plate material and 60 MPa for shearing of rivet. Determine the minimum thickness of each plate.

    a. 8.75 mm
    b. 7.85 mm

    c. 8.57 mm
    d. 7.58 mm

12. A solid steel shaft 5 m long is stressed to 80 MPa when twisted through 4 degrees. Using G = 83 GPa, compute the shaft diameter.

    a. 14 mm
    b. 138 mm

    c. 148 mm
    d. 160 mm

13. An aluminum bar having a cross-sectional area of 0.5 in² carries the axial loads applied at the positions shown in the figure. Compute the total change in length of the bar if E = 10 × 10⁶ psi. Assume the bar is suitably braced to prevent lateral buckling.
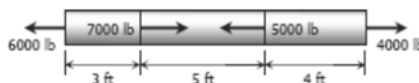
    a. 0.0696 in (lengthening)   c. 0.1925 in (shortening)
    b. 0.0696 in (shortening)   d. 0.1925 in (lengthening)

14. Two bodies of the same mass are moving with the same speed, but in different directions in a plane. They have a completely inelastic collision and move together thereafter with a final speed which is half of their initial speed. The angle between the initial velocities of the two bodies (in degree) is
    a. 30°   c. 90°
    b. 60°   d. 120°

15. A person pushes a box on a rough horizontal platform surface. He applies a force of 200 N over 15 m. Thereafter, he gets progressively tired, and his applied force reduces linearly with distance to 100 N. The total distance through which the box has been moved is 30 m. What is the work done by the person during the total movement of the box?
    a. 3280 J   c. 5690 J
    b. 2780 J   d. 5250 J

16. A 100 kg body moves to the right at 5 m/s and another body of mass W moves to the left at 3 m/s. They meet each other and after impact the 100 kg body rebounded to the left at 2 m/s. Determine the mass of the other body if coefficient of restitution is 0.5.
    a. 130 kg   c. 140 kg
    b. 150 kg   d. 120 kg

17. A 40 g bullet with a speed of 300 m/s is fired into a ballistic pendulum of mass 5 kg suspended from a chord 1 m long. Compute the vertical height through which the pendulum rises.
    a. 28.87 cm   c. 29.36 cm
    b. 35.67 cm   d. 30.10 cm

18. A steel shaft 3 ft long that has a diameter of 4 in. is subjected to a torque of 15 kip-ft. Determine the maximum shearing stress and the angle of twist. Use G = 12 × 10⁶ psi.
    a. τ_{max} = 13.4 ksi; θ = 2.21°   c. τ_{max} = 13.4 ksi; θ = 1.23°
    b. τ_{max} = 14.3 ksi; θ = 2.21°   d. τ_{max} = 14.3 ksi; θ = 1.23°

19. A steel rod, having a diameter of 40 mm is loaded as shown in the figure. Taking E = 200 GPa, determine the distance x from the left-hand support to a point at which the deformation is zero.
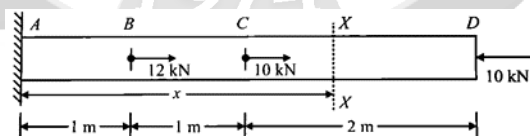
    a. 2.5 m   c. 3.6 m
    b. 3.2 m   d. 2.9 m

20. Determine the outside diameter of a hollow steel tube that will carry a tensile load of 600 kN at a stress of 150 MPa. Assume a wall thickness to be one – tenth of the outside diameter.
    a. 112 mm   c. 119 mm
    b. 113 mm   d. 114 mm

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