QUESTION 1 – 4

Use the Method of Joints to calculate the magnitude of the forces in members BC, EC, ED and AE of the shown plane truss in figure 1.

1) **Force in BC:**
   a) - 9 kN  
   b) 7.5 kN  
   c) 4.5 kN  
   d) 2.5 kN  
   e) 0 kN

2) **Force in EC:**
   a) - 9 kN  
   b) 7.5 kN  
   c) 4.5 kN  
   d) 2.5 kN  
   e) 0 kN

3) **Force in ED:**
   a) - 9 kN  
   b) 7.5 kN  
   c) 4.5 kN  
   d) 2.5 kN  
   e) 0 kN

4) **Force in AE:**
   a) - 9 kN  
   b) 7.5 kN  
   c) 4.5 kN  
   d) 2.5 kN  
   e) 0 kN

![Plane Truss](image-url)

**Figure 1: Plane Truss.**
A Beam is loaded and simply supported at A and D as indicated in Figure 2.

5) Determine the reaction forces at $R_L$.
   a) 9.24 kN    b) 7.51 kN    c) 2.03 kN    d) 2.53 kN    e) 2.45 kN

6) Determine the reaction forces at $R_R$.
   a) 3.57 kN    b) 4.28 kN    c) 6.24 kN    d) 2.52 kN    e) 3.84 kN
7) Draw the Shear Force Diagram for Figure 2.
8) Draw the Bending Moment Diagram for Figure 2.
QUESTION 9 - 12

A horizontal profile of a 3 m long cantilever beam has a section as shown in Figure 3.

9) Determine the position of the neutral axis [x-x] measured from the bottom plane.
   a) 150.62 mm  b) 95.43 mm  c) 58.11 mm  d) 43.36 mm  e) 22.25 mm

10) Determine the moment of inertia around the neutral axis [x-x].
    a) $1.02 \times 10^{-6}$ m$^4$  b) $1.96 \times 10^{-6}$ m$^4$  c) $2.31 \times 10^{-6}$ m$^4$  d) $3.73 \times 10^{-6}$ m$^4$  e) $8.35 \times 10^{-6}$ m$^4$

11) Determine the maximum point load applied at the end of the beam furthest to the wall, if the maximum allowable tensile stress is 30 MPa.
    a) 116.8 N  b) 278.9 N  c) 358.9 N  d) 426.5 N  e) **225.2 N**

12) Determine maximum point load applied at the end of the beam furthest to the wall, if the max allowable compressive stress is 90 MPa.
    a) 1927 N  b) 8531 N  c) 3581 N  d) 2121 N  e) 1285 N

**Figure 3:** T-Cross section setup for questions 9 – 12.
QUESTION 13-15
A solid cylinder of 50 mm diameter and 900 mm length is subjected to a tensile force of 120 kN. One part of the cylinder is \( L_1 \) long and is made from steel. The other part fastened to the steel is aluminium and is \( L_2 \) long. Determine the lengths \( L_1 \) en \( L_2 \) so that the two materials elongate an equal amount if \( E_{\text{steel}} = 200 \text{ GPa} \) and \( E_{\text{Al}} = 70 \text{ GPa} \). What is the total elongation of the cylinder?

**Calculate:**

13) The length of \( L_1 \)
   a) 0.28 m  
   b) 0.35 m  
   c) 0.67 m  
   d) 0.43 m  
   e) 0.85 m

14) The length of \( L_2 \)
   a) 0.23 m  
   b) 0.76 m  
   c) 0.53 m  
   d) 0.37 m  
   e) 0.45 m

15) What is the total elongation of the cylinder?
   a) \( 650 \times 10^{-6} \text{ m} \)  
   b) \( 235 \times 10^{-6} \text{ m} \)  
   c) \( 146 \times 10^{-6} \text{ m} \)  
   d) \( 467 \times 10^{-6} \text{ m} \)  
   e) \( 406 \times 10^{-6} \text{ m} \)

QUESTION 16-18
A steel rod, 20 mm in diameter, fits neatly into a brass tube of equal length. The brass tube has an outside diameter of 30 mm. The length of the compound bar is 500 mm as can be seen from Figure 4. If a compressive load of 5 kN is applied to the compound bar and it is given that \( E_{\text{Brass}} = 100 \text{ GPa} \), \( E_{\text{Steel}} = 200 \text{ GPa} \) then, calculate the following:

16) The stress in the Brass:
   a) 4.897 MPa  
   b) 15.652 MPa  
   c) 0.472 MPa  
   d) 9.794 MPa  
   e) 23.75 MPa

17) The stress in the Steel:
   a) 4.897 MPa  
   b) 15.652 MPa  
   c) 0.472 MPa  
   d) 9.794 MPa  
   e) 23.75 MPa

18) The load carried by the Brass:
   a) 2.651 kN  
   b) 5 kN  
   c) 1.932 kN  
   d) 3.794 kN  
   e) 7.523 kN

![Figure 4: Setup for question 16-18.](image)
QUESTION 19
It is necessary to punch a 25 mm diameter hole in a 4.8 mm thick plate.

Calculate the force exerted on the punch if the break-shearing stress is 350 MPa.
a) 221 kN  b) 165 kN  c) 132 kN  d) 70 kN  e) 140 kN

QUESTION 20
Three plates are clinched together by means of a rivet which has a diameter of 20 mm as indicated in Figure 5. If this butt joint is subjected to a load of 22 kN, determine the magnitude of the shear stress in the rivet.

Figure 5: Riveted butt joint setup for question 20.

20) Shear stress in rivet is:

a) 140 MPa  b) 35 MPa  c) 75 MPa  d) 70 MPa  e) 280 MPa
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