Example 1.3a – The pin-jointed truss structure in Figure 1 carries two vertical forces, 5 kN at joint *D* and 10 kN at joint *E* as shown.

a) Determine the **degree of redundancy** of the structure.
b) Determine the magnitude and sense of the **reaction forces** at both supports.
c) Determine the magnitude and sense of the **internal forces** in each of the 7 members.

$\theta = \text{atan}\left(\frac{1.2}{0.8}\right)$

$\theta \cong 56.3°$

$\cos\theta \cong 0.555$

$\sin\theta \cong 0.832$

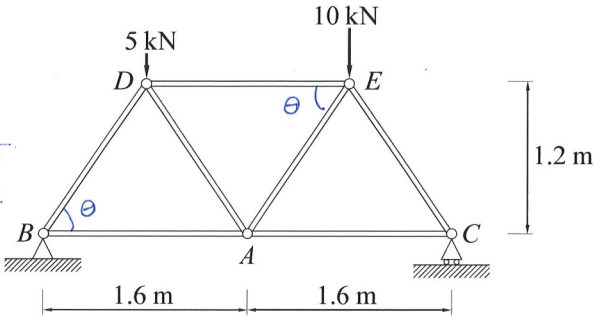


Figure 1: Pin-jointed truss subjected to two vertical forces.

Global FBD

(balance of moments about joint *B*; assuming positive clockwise)

$\Sigma M_B = 0$ ↻

$(5\text{kN})(0.8\text{m}) + (10\text{kN})(2.4\text{m}) - R_{Cy}(3.2\text{m}) = 0$

$\boxed{R_{Cy} = 8.75\text{ kN}}$

$\boxed{R_{Cx} = 0}$ (roller)

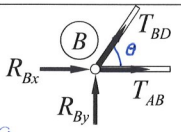
$\Sigma F_y = 0$

$R_{By} + R_{Cy} - (5\text{kN}) - (10\text{kN}) = 0$

$\boxed{R_{By} = 6.25\text{ kN}}$

$\Sigma F_x = 0$

$\boxed{R_{Bx} = 0}$



$\Sigma F_y = 0$

$R_{By} + T_{BD}\sin\theta = 0$

$(6.25) + T_{BD}(0.832) = 0$

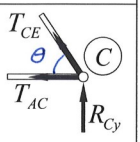
$\boxed{T_{BD} = -7.512\text{ kN}}$

$\Sigma F_x = 0$

$R_{Bx} + T_{AB} + T_{BD}\cos\theta = 0$

$0 + T_{AB} + (-7.512)(0.555) = 0$

$\boxed{T_{AB} = 4.167\text{ kN}}$



$\Sigma F_y = 0$

$R_{Cy} + T_{CE}\sin\theta = 0$

$(8.75) + T_{CE}(0.832) = 0$

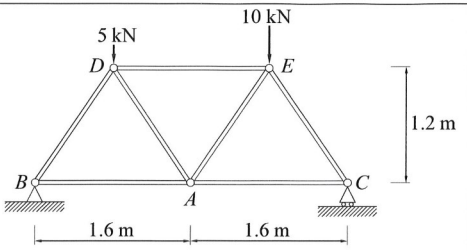
$\boxed{T_{CE} = -10.52\text{ kN}}$

$\Sigma F_x = 0$

$-T_{CE}\cos\theta - T_{AC} = 0$

$-(-10.52)(0.555) - T_{AC} = 0$

$\boxed{T_{AC} = 5.833\text{ kN}}$



$\Sigma F_y = 0$

$(-5) - (T_{BD} + T_{AD}) \sin\theta = 0$

$(-5) - (-7.512 + T_{AD})(0.832) = 0$

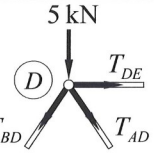
$\boxed{T_{AD} = 1.502 \text{ kN}}$

$\Sigma F_x = 0$

$T_{DE} + (T_{AD} - T_{BD}) \cos\theta = 0$

$T_{DE} + [1.502 - (-7.512)](0.555) = 0$

$\boxed{T_{DE} = -5 \text{ kN}}$



$\Sigma F_y = 0$

$(-5) - (T_{BD} + T_{AD}) \sin\theta = 0$

$(-5) - (-7.512 + T_{AD})(0.832) = 0$

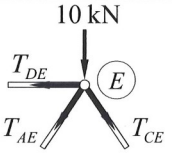
$\boxed{T_{AD} = 1.502 \text{ kN}}$

$\Sigma F_x = 0$

$T_{DE} + (T_{AD} - T_{BD}) \cos\theta = 0$

$T_{DE} + [1.502 - (-7.512)](0.555) = 0$

$\boxed{T_{DE} = -5 \text{ kN}}$



$\Sigma F_y = 0$

$(-10) - (T_{AE} + T_{CE}) \sin\theta = 0$

$(-10) - (T_{AE} - 10.52)(0.832) = 0$

$\boxed{T_{AE} = -1.502 \text{ kN}}$