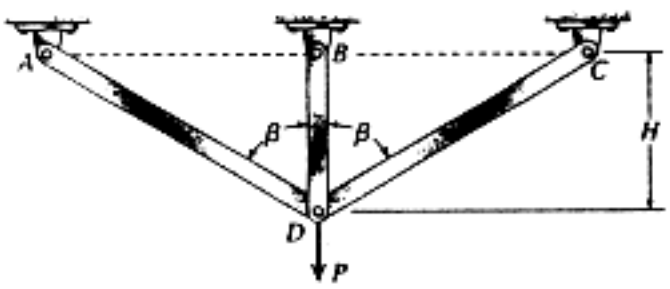
(25%) 1. A vertical load P is supported by a statically indeterminate truss $ABCD$ (see figure). All bars are made of the same material (modulus of elasticity E) and have the same cross-sectional area A.

(a) Determine the strain energy U of the truss in terms of the vertical displacement δ_D of joint D.

(b) Determine the vertical displacement δ_D of joint D.

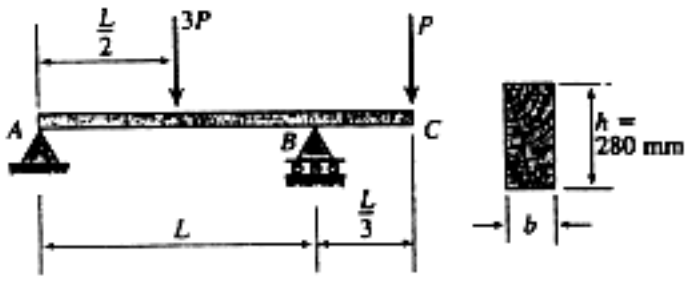
(c) Find the forces in the bars of the truss.



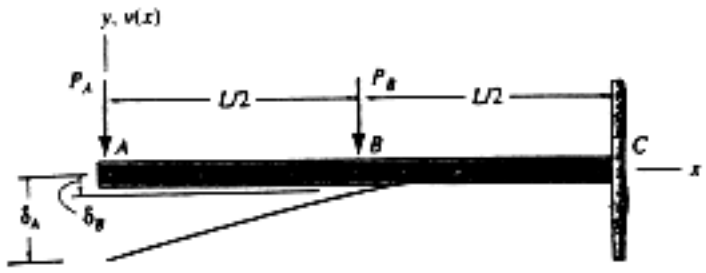
(25%) 2. A beam ABC has height $h = 280$ mm and main-span length $L = 3.6$ m (see figure). The beam supports a concentrated load $3P = 15$ kN at the midpoint of the main span and a load $P = 5$ kN at the free end of the overhang. The beam material has weight density $\gamma = 5.5\,kN/m^3$.

(a) Draw the diagrams for the distribution of the shear force and the bending moment in the beam.

(b) Determine the required width b of the beam based upon an allowable bending stress of 8.2 MPa and an allowable shear stress of 0.7 MPa.



(25%) (3) Loads P_A and P_B are applied to an uniform cantilever beam AC, as shown in the following figure, causing deflection δ_A and δ_B at A and B, respectively. Determine expressions for P_A and P_B in terms of E, I, L, δ_A and δ_B.



(25%) (4) Determine the critical load P_{cr} for the bar-spring system shown in the following figure. The load P remains horizontal. End A is free to move horizontally, and point B moves in a circular arc about C. A frictionless pin connects bars AB and BC at point B. The rotational spring at C exerts a restoring moment $(M_C)_r = k_\theta\theta$ when bar BC rotates away from the horizontal position.