(20%)　1. An aluminum bar AD has a cross sectional area of A = 250 mm^2 and is loaded by forces P_1 = 7560 N, P_2 = 5340 N, and P_3 = 5780 N. The lengths of the segments of the bar are a = 1525 mm, b = 610 mm, and c = 916 mm.

(a) Assuming that the modulus of elasticity E = 72 GPa, calculate the change in length of the bar. Does the bar elongate or shorten? (7%)

(b) By what amount P should the load P_3 be increased so that the bar does not change in length when the three loads are applied? (7%)

(c) If P_3 remains at 5780 N, what revised cross-sectional area for segment AB will result in no change of length when all three loads are applied? (6%)
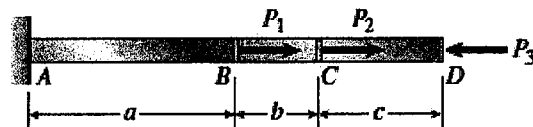
(15%)　2. A propeller shaft of solid circular cross section and diameter d is spliced by a collar of the same material. The collar is securely bonded to both parts of the shaft. What should be the minimum outer diameter d_1 of the collar in order that the splice can transmit the same power as the solid shaft?


(10%)　3. The cantilever beam AB is subjected to a concentrated load P at the midpoint and a counterclockwise couple of moment M_1 = $PL/4$ at the free end. Draw the shear-force and bending-moment diagrams for this beam.
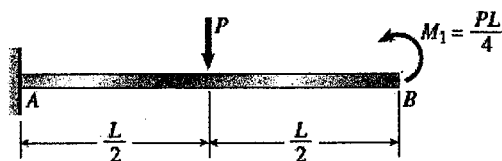

(20%)　4. Determine the maximum tensile stress σ_t and maximum compressive stress σ_c due to the load P acting on the simple beam AB.

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(a) Data are as follows: P = 6.2 kN, L = 3.2 m, d = 1.25 m, b = 80 mm, t = 25 mm, h = 120 mm, and h_1 = 90 mm. (10%)

(b) Find the value of d for which tensile and compressive stresses will be largest. What are these stresses? (10%)
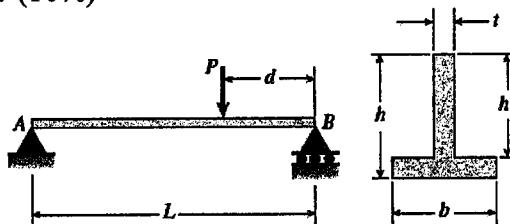
(20%)　5. An element in plane stress is subjected to stresses σ_x = 2150 kPa, σ_y = 375 kPa, τ_{xy} = - 460 kPa

(a) Determine the principal stresses and show them on a sketch of a properly oriented element. (10%)

(b) Determine the maximum shear stresses and associated normal stresses and show them on a sketch of a properly oriented element. (10%)
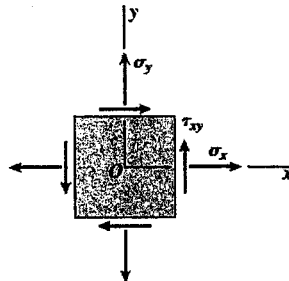
(15%)　6. A hollow pressurized sphere having radius r = 150 mm and wall thickness t = 13 mm is lowered into a lake. The compressed air in the tank is at a pressure of 140 kPa (gage pressure when the tank is out of the water). At what depth D_0 will the wall of the tank be subjected to a compressive stress of 700 kPa?

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