(20%)   1. A plastic rod AB of length $L = 0.5$ m has a diameter $d_1 = 30$ mm. A plastic sleeve CD of length $c = 0.3$ m and outer diameter $d_2 = 45$ mm is securely bonded to the rod so that no slippage can occur between the rod and the sleeve. The rod is made of an acrylic with modulus of elasticity $E_1 = 3.1$ GPa and the sleeve is made of a polyamide with $E_2 = 2.5$ GPa.

(a) Calculate the elongation δ of the rod when it is pulled by axial forces $P = 12$ kN. (10%)
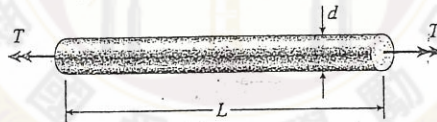
(b) If the sleeve is extended for the full length of the rod, what is the elongation? (10%)
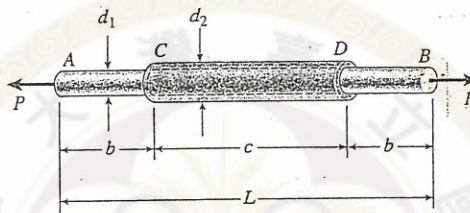

(15%)   2. A copper rod of length $L = 610$ mm is to be twisted by torques T until the angle of rotation between the ends of the rod is $4.0°$. If the allowable shear strain in the copper is 0.0008 rad, what is the maximum permissible diameter of the rod?

(15%)   3. The simple beam AB is subjected to a concentrated load P and a clockwise couple $M_1 = PL/3$ acting at the points shown in the figure. Draw the shear-force and bending-moment diagrams for this beam.
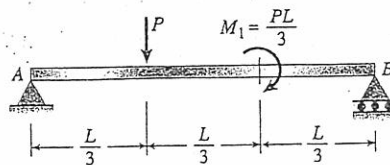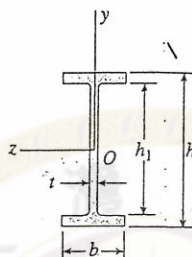

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(15%)   4. A wide flange beam having the dimension of cross section: $b = 150$mm, $t = 12$ mm, $h = 300$ mm, and $h_1 = 270$ mm is subjected to a shear force $V = 130$kN. Determine
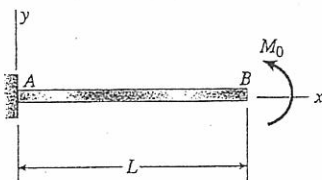
(a) the maximum shear stress τ_{max} in the web and

(b) the minimum shear stress τ_{min} in the web.

(15%)   5. The surface of an airplane wing is subjected to plane stress with normal stresses σ_x and σ_y, and the shear stress τ_{xy}. At a counterclockwise angle $\theta = 32°$ from the x axis, the normal stress is 37 MPa tension, and at an angle $\theta = 48°$, it is 12 MPa compression. If the stress σ_x equals 110 MPa tension, what are the stresses σ_y and τ_{xy}?
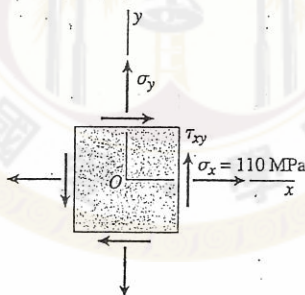
(20%)   6. Derive the equation of the deflection curve for a cantilever beam AB when a couple M_0 acts counterclockwise at the free end. Also, determine the deflection δ_B and slope θ_B at the free end.

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