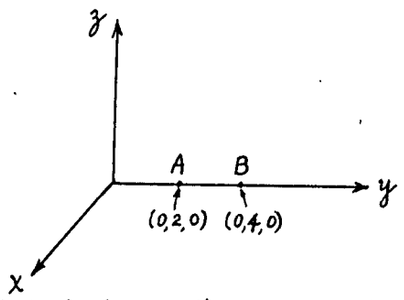
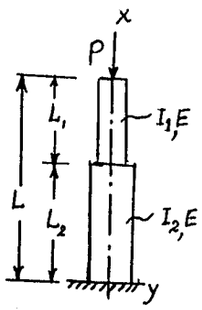
1. The relationship below prevails in a structural member. Calculate the length of the line A-B (as shown in the following figure) after deformation. (10%)

$$\epsilon_{ij} = \begin{pmatrix} x^2+2yx & 3+10zx & z^3+10xy \\ 3+10zx & y+z^2x & x^2+2yz^2 \\ z^3+10xy & x^2+2yz^2 & x^2+y^2 \end{pmatrix} \times 10^{-2}$$



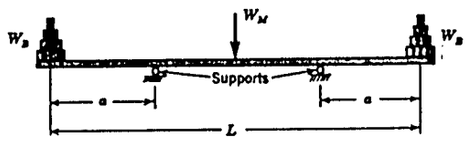
2. At a point in a stressed body (in a plane stress state), there are stresses of 1 MN/m² tension on a vertical plane and 7 MN/m² on a horizontal plane. A positive unknown shearing stress acts on the vertical plane and the maximum shearing stress at the point has a magnitude of 5 MN/m². Determine the shearing stress on the vertical plane and also the principal stresses. (10%)

3. Find the critical load for the column built-in at the bottom and free at the top and consisting of the two prismatical portions with moments of inertia (I_1 and I_2) respectively as shown in the figure. (Hint: for a column of constant cross section, the formula of the critical load is $P_{cr} = \frac{\pi^2 EI}{4L^2}$). (15%)

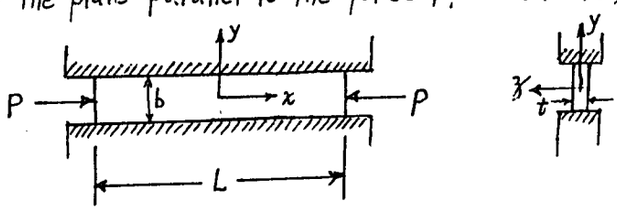


4. A circular shaft, 10 mm diameter, is tested in combined bending and torsion. At a certain cross section the bending moment (M_b) is twice as large as the twisting moment (M_t). Determine the value of M_b and M_t at which yielding will first occur (a) according to Tresca's criterion and (b) according to von Mises' criterion. In a simple tension test, yielding occurs when the longitudinal tension is 340 MN/m². (15%)

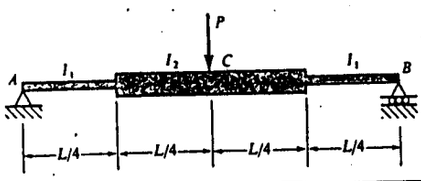
5. A section of a scaffold consists of a plank laid across two supports and extending a distance "a" on either side of the supports. A mason working at the center of the plank thinks that he should stack his supply of bricks on the end of the plank in order to minimize the bending moment in the plank, as shown in the figure. If equal numbers of brick are stacked at each end of the plank, for what weight of bricks, W_B, is the maximum bending moment in the plank a minimum? The man weighs W_M. (13%)



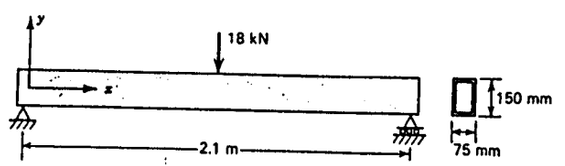
6. A long, thin plate of width b, thickness t, and length L is placed between two rigid walls a distance b apart and is acted on by an axial force P, as shown in the figure. Assuming there is no friction force at the walls, find the deflection of the plate parallel to the force P. (13%)



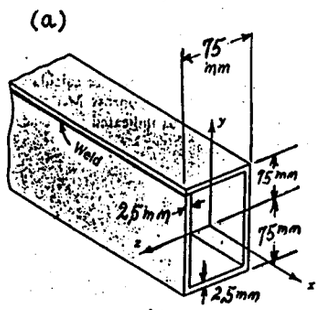
7. The simple beam AB shown in the figure has two different moments of inertia I_1 and I_2. Determine the slope angle θ_a at support A, and deflection δ_c at the midpoint due to the load P. (12%)



8. A strip of steel 450 mm wide, 2.2 m long and 2.5 mm thick is to be bent to form of rectangular cross section 150 mm deep and 75 mm wide. It is to be used to carry a central load of 18 kN on a simple span of 2.1 m as shown in Fig (a). In Fig (b) is shown the location for the longitudinal weld to be made between the edges of the strip after the strip has been bent into the beam of rectangular shape. Calculate the numerical value of the longitudinal shear stress carried by the weld (12%)



(a)



(b)

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