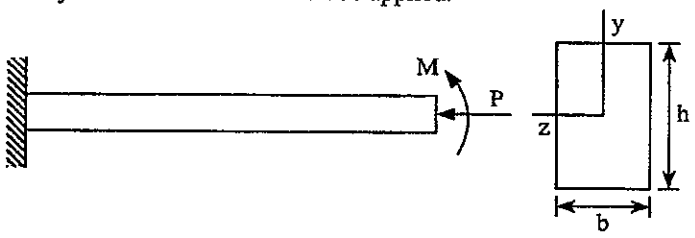
**Question 1 (20%)**

A cantilever beam is subjected to an axial compressive force P and a moment M at the free end. Assume that the force P can only applied along the y axis. If the beam can not resist any tensile stress, determine the lowest and the highest positions on y axis that the force P can be applied.



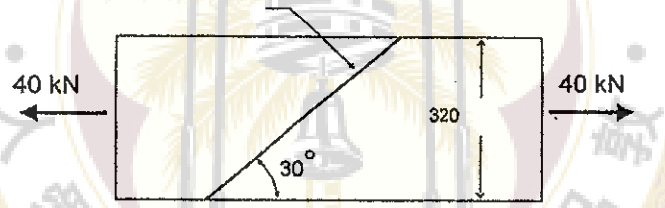

**Question 2 (20%)**

Two wood plates 320 mm wide and 25 mm thick are glued together at an angle of 30 degrees to the horizontal axis as shown. The glued plate assembly resists an axial load of 40 kN. Use the Mohr's circle solution (**Not** the transformation equations) to determine the following:

a) The normal and shear stress acting on the glued joint. Make sure to show your answer on a properly oriented element.

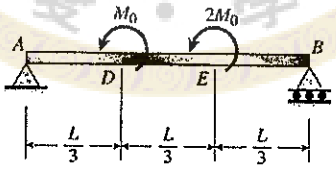
b) The maximum in-plane shear stress (and associated normal stresses) acting on the wood plates. Once again, show your answer on a sketch of a properly oriented element.

**Note:** the credit will only be given for a solution using Mohr's circle. This mean that you need to draw a Mohr's circle based on the stress components given in this problem. Remember to show numbers on your circle. Your calculations must be based on the geometry of your circle. In other words, you are expected to use trigonometry to construct your Mohr's circle.



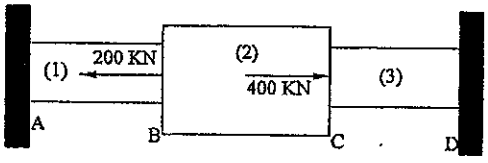

**Question 3 (20%)**

A simple beam AB is subjected to couples $M_0$ and $2M_0$ acting as shown in the figure. Determine the deflection δ at points D and E. (use the moment-area method)




**Question 4 (20%)**

The rods 1, 2, and 3 shown below are welded together, mounted between two rigid walls and subjected to the forces shown at **joints** B and C. Rods 1 and 3 are of the same length, $L_1 = L_3 = 2$ m and $L_2 = 2.5$ m. Rods 1 and 3 are made from a material with Young's modulus E = 160 GPa. Rod 2 is made from a materials with Young's modulus E = 70 GPa. The cross sections are given by: $A_1 = A_3 = 10\times10^3$ mm$^2$ and $A_2 = 22\times10^3$ mm$^2$. Determine the displacements of joints B and C.

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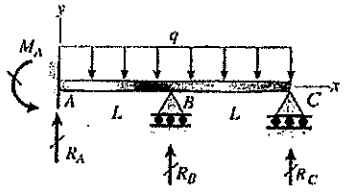
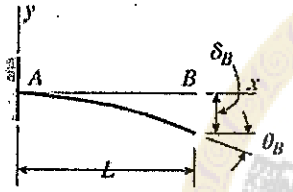
**Question 5 (20%)**

A propped cantilever beam of length 2L with supports at B and C is loaded by a uniformly distributed load with intensity q. (Use the attached tables and the method of superposition to solve for **all** reactions)



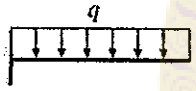

$v$ = deflection in the $y$ direction (positive upward)

$v' = dv/dx$ = slope of the deflection curve

$\delta_B = -v(L)$ = deflection at end $B$ of the beam (positive downward)

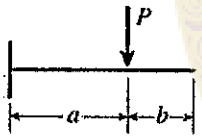
$\theta_B = -v'(L)$ = angle of rotation at end $B$ of the beam (positive clockwise)

$EI$ = constant




$$v = -\frac{qx^2}{24EI}(6L^2 - 4Lx + x^2) \qquad v' = -\frac{qx}{6EI}(3L^2 - 3Lx + x^2)$$

$$\delta_B = \frac{qL^4}{8EI} \qquad \theta_B = \frac{qL^3}{6EI}$$




$$v = -\frac{Px^2}{6EI}(3a - x) \qquad v' = -\frac{Px}{2EI}(2a - x) \qquad (0 \le x \le a)$$

$$v = -\frac{Pa^2}{6EI}(3x - a) \qquad v' = -\frac{Pa^2}{2EI} \qquad (a \le x \le L)$$

$$\text{At } x = a: \quad v = -\frac{Pa^3}{3EI} \qquad v' = -\frac{Pa^2}{2EI}$$

$$\delta_B = \frac{Pa^2}{6EI}(3L - a) \qquad \theta_B = \frac{Pa^2}{2EI}$$

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