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This exam measure the following I.Los. a3, a8, a13, a19, b2, b6, b7, b17, c3, c16, d1, and d3  
Answer the following questions

**Question No One (15 mark)**

The horizontal shaft AD is attached to a fixed base at D and is subjected to the torques as shown in Fig. 1. A 44-mm-diameter hole has been drilled into portion CD of the shaft. Knowing that the entire shaft is made of steel for which  $G=77$  GPa, determine the angle of twist at end A.

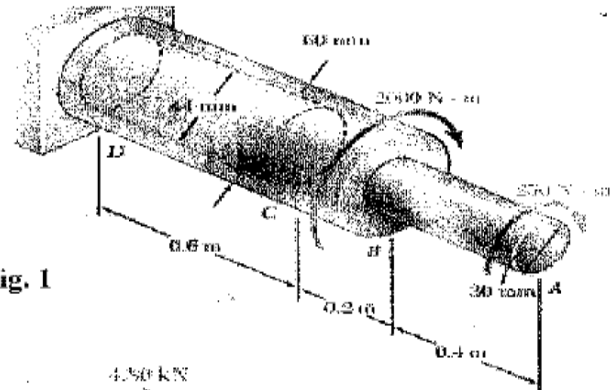


Fig. 1

**Question No Two (15 mark)**

A vertical 4.80 kN load is applied as shown in Fig 2 on a wooden post of rectangular cross section, 80 by 120 mm (a) Determine the stress at points A, B, C, and D. (b) Locate the neutral axis of the cross section

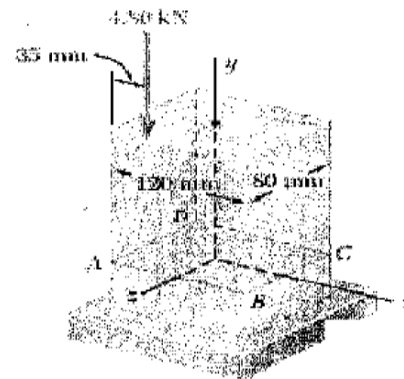


Fig. 2

**Question No Three (20 mark)**

a-) For the state of plane stress shown in Fig. 3, determine by calculation and by Mohr's circle (a) the principal planes, (b) the principal stresses, (c) the maximum shearing stress and the corresponding normal stress.

b-) Prove that  $\sigma = Mc/I$

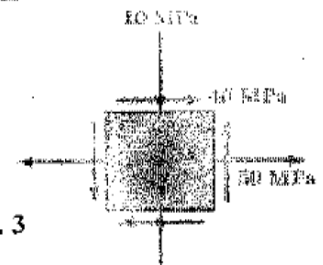


Fig. 3

**Question No Four (20 mark)**

Two forces  $P_1$  and  $P_2$ , of magnitude  $P_1=15$  kN and  $P_2=18$  kN, are applied as shown in Fig. 4 to the end A of bar AB, which is welded to a cylindrical member BD of radius  $c=20$  mm. Knowing that the distance from A to the axis of member BD is  $a=50$  mm and assuming that all stresses remain below the proportional limit of the material, determine (a) the normal and shearing stresses at point K of the transverse section of member BD located at a distance  $b=60$  mm from end B, (b) the principal axes and principal stresses at K, (c) the maximum shearing stress at K.

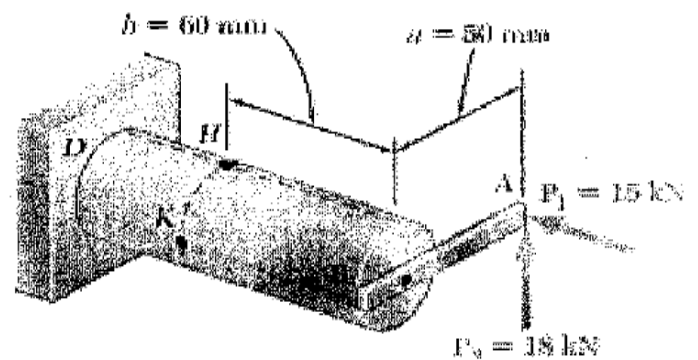


Fig. 4

**Good Luck**  
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