

MECHANICAL AND STRUCTURAL ENGINEERING C105
EXAM QUESTIONS 2005 Q1

At a point on the surface of a solid circular –section shaft the principal stresses are found to be 210 MN/m² (tension) and 70 MN/m² (compression). The diameter is 150 mm.

- Determine the values of the shear stress on planes 45° to the principal planes at the point, and show that directions of these stresses on a sketch of the shaft.
- If the shear stress on those planes at 45° are assumed to be the result of an axial torque applied to the shaft, calculate the value of the torque.
- Determine the angles of the planes through the point on which the direct stress is zero and show the directions of these planes on a sketch of the shaft.

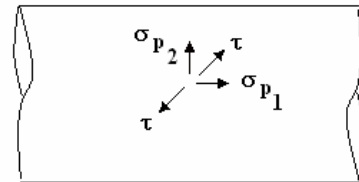
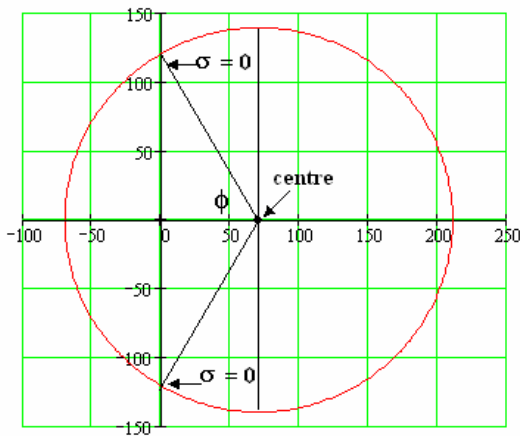
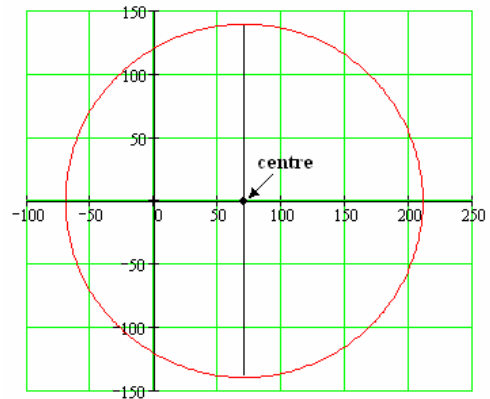
Constructing the circle the centre is at 70. The planes at 45° on the shaft are at 90° on the circle so the shear stress on those planes are ± 140 MN/m²

From the torsion equation

$$T = \tau J/r$$

$$J = \pi D^4/32 = \pi (0.15)^4/32 = 49.7 \times 10^{-6} \text{ m}^4$$

$$T = 140 \times 10^6 \times 49.7 \times 10^{-6} / 0.075 = 92775 \text{ Nm}$$



The stress is zero at the points shown.

The radius is 140 and using the triangle $\phi = \cos^{-1} 70/140 = 60^\circ$

The double angle to the principle planes are $2\theta = 120^\circ$ hence $\theta = 60^\circ$

