Problems

Machine Design - 2

The yield locus of a material is shown in Fig. (A). A sample with a diameter of 25 mm is manufactured from the above material. Based on this information, answer the following questions:

a) A simple tension test is conducted on the sample as shown in the Fig. (B). What is the tensile force $P$ (in N) that will cause failure? (20 points)

b) A compression test is conducted on a sample as shown in the Fig. (C). What is the compressive force $P$ (in N) that will cause failure? The sample will not buckle. (20 points)

c) A torsion test is conducted on a sample as shown in the Fig. (D). Determine the applied torque $T$ (in N.mm) that will cause failure? Sketch the loading path for the torsion test in Figure A. (30 points)

d) Finally, a four-point bend test is conducted on this sample as shown in the Fig. (E). Determine the applied force $P$ (in N) that will cause failure? (30 points)
Useful info: $d$ is the diameter, $r$ is the radius, $V$ is the shear force, $M$ is the bending moment, $Q$ is the first moment of area about the neutral axis, $t$ is the width of the cross-section

**Geometric properties:**
- Area moment of inertia: $I = \frac{\pi d^4}{64}$
- Polar moment of inertia: $J = \frac{\pi d^4}{32}$

**Bending, torsion, axial and transverse shear:**
- Axial stress: $\sigma = \frac{P}{A}$
- Torsional shear stress: $\tau_{max} = \frac{Tc}{J}$
- Bending stress: $\sigma_{max} = \frac{Mc}{I}$
- Transverse shear: $\tau = \frac{VQ}{It}$