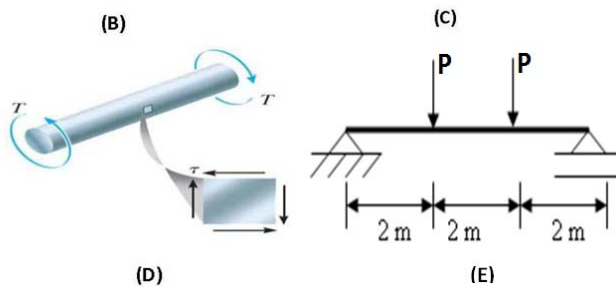
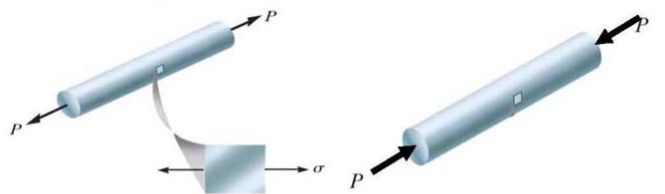
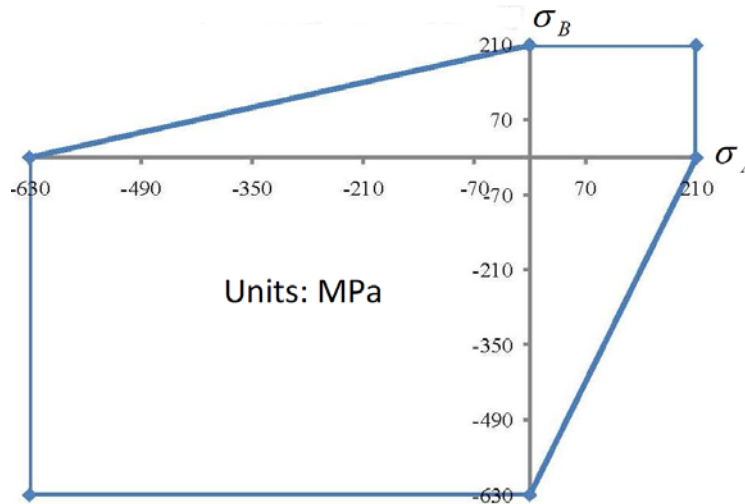


Machine Design - 2

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 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)**
- 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)**
- 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)**
- 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)**



Problems

Useful info: d is the diameter, c 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: $\tau = \frac{VQ}{It}$