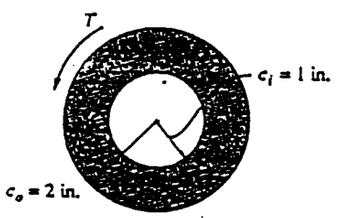
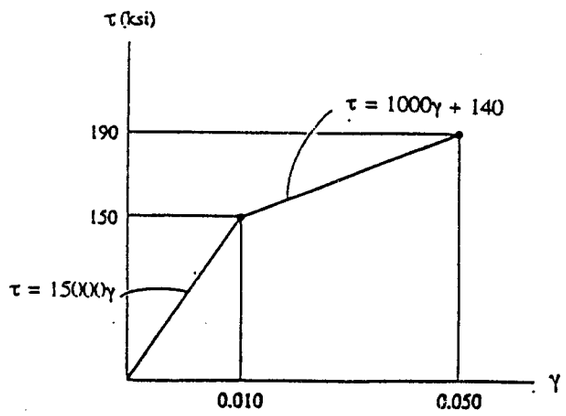
1. (20pts) Select the applicable region (elastic or elastic-plastic or plastic) for the following relations, equations, or theorems :
   (a) Method of superposition.
   (b) The shearing strain in a circular shaft varies linearly with the distance from the axis of the shaft under pure torsion.
   (c) The shearing stress in a circular shaft varies linearly with the distance from the axis of the shaft under pure torsion.
   (d) The angle of twist proportional to the torque applied to the shaft under pure torsion.
   (e) The neutral axis passes through the centroid of the section for pure bending.
   (f) The longitudinal normal strain varies linearly, throughout the member, with the distance from the neutral surface for the case of pure bending.
   (g) Transformation of stress and strain by use of Mohr's circle.
   (h) Bending-moment diagram of a beam.
   (i) Castigliano's Theorem.
   (j) Euler's formula for pin-ended columns.

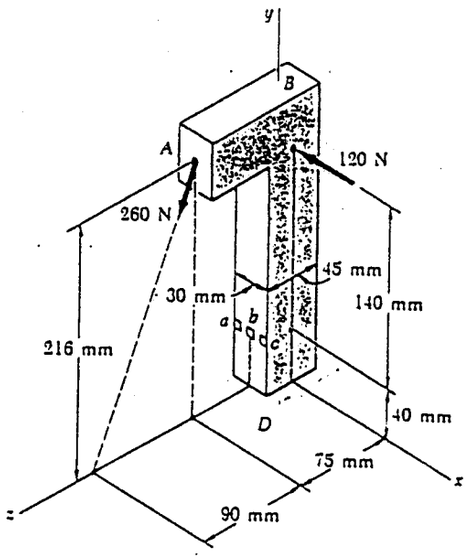
2. (20pts) Please define the following terms :
   (a) yield strength at 0.2% offset,
   (b) bulk modulus,
   (c) residual stresses,
   (d) maximum elastic torque,
   (e) elastic flexure formulas,
   (f) plastic section modulus,
   (g) shear center,
   (h) von Mises yield criterion,
   (i) strain-energy density,
   (j) anisotropic material.

3. (20pts) A tube is made from a brass alloy having a length of 5 ft and a cross-sectional area shown. The material has an elastic-plastic $\tau$-$\gamma$ diagram, as shown. Compute the plastic torque $T_p$. What are the residual-shearing-stress distribution and permanent twist of the tube that remain if $T_p$ is removed just after the tube becomes fully plastic?



4. (20pts) Two forces are applied to the machine components ABD as shown. Knowing that the cross section of the component is a 30 × 45-mm rectangle, determine the principal stresses and maximum shearing stresses at three point indicated.




5. (20pts) For the beam shown, determine (a) the equation of the elastic curve, (b) the maximum deflection of the beam. Also draw the shear and moment diagrams.