Problem 1 (25%)

A steel shaft with the left portion solid and the right portion hollow is loaded as shown in Fig. 3. If the maximum shearing stress in the shaft must not exceed 90 MPa and the maximum tensile stress in the shaft must not exceed 130 MPa, please determine,

a. The maximum axial load P that can be applied to the shaft. (15%)

b. The principal stresses and the maximum shearing stress at a point on the outside surface of midway BC. (10%)

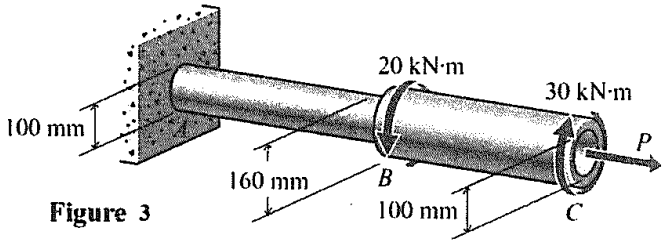


Figure 3

Problem 2 (25%)

A beam is loaded and supported as shown in Fig 4 below.

(a) Write equations for the shear and the bending moment for any section of the beam in the interval CD. (10%)

(b) Draw complete shear and bending moment diagrams for the beam. (15%)

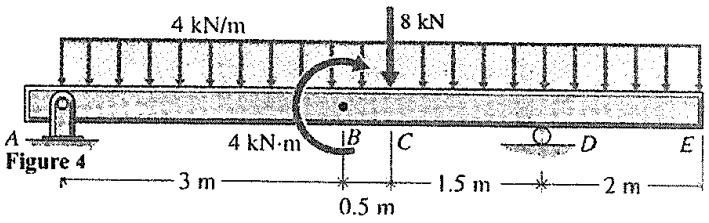
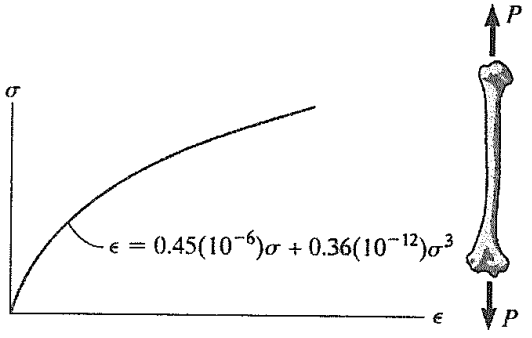


Figure 4

Problem 3 (25%)

The stress–strain diagram for a bone is shown as the right figure and can be described by the equation $\epsilon = 0.45(10^{-6})\sigma + 0.36(10^{-12})\sigma^3$, where σ is in kPa. Determine the modulus of toughness and the amount of elongation of a 200-mm-long region just before it fractures if failure occurs at $\sigma = 6873.52$ kPa.



Problem 4 (25%)

The bone shown as the right figure can be modeled as a tube having an inner diameter of 9.5 mm and an outer diameter of 32 mm. Determine the maximum elastic static force **P** that can be applied to its center. Assume the bone to be roller supported at its ends. The stress-strain diagram for the bone is shown as the figure below, and is the same in tension as in compression.