Ph.D. Qualifying Exam – Mechanics of Materials (Spring 2010)

Closed books & closed notes Name:_____

(Time: 2 hours) ID #:_____

1. A combined beam, with a constant flexural rigidity *EI*, fixed supports at its ends *A* and *D*, a hinge connection at *B*, and carrying a concentrated force **P** at *C*, is shown in Fig. 1. Determine *(a)* the vertical reaction force $\mathbf{A}_y$ and the reaction moment $\mathbf{M}_A$ at *A*, *(b)* the deflection y_B of the hinge at *B*.
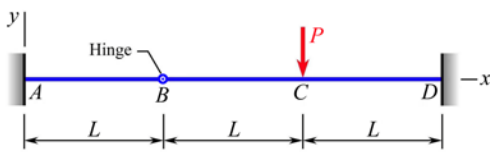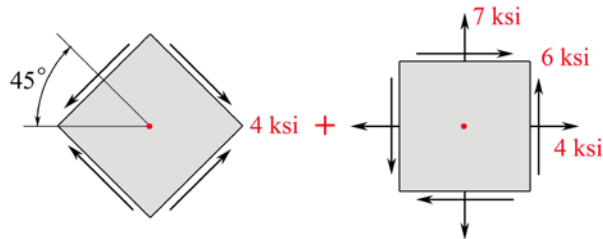

Fig. 1 Fig. 2

2. Using Mohr's circle, determine the *principal planes* and the *principal stresses* for the state of plane stress resulting from the superposition of the two states of stress shown in Fig. 2.

3. A 2-in. solid circular bar is loaded by means of an attached rigid bar as shown. Determine the following:

   a) The internal forces and moments on a section 2 in. away, called section *a-a*, from the support. Draw the appropriate free-body diagram.
   b) Determine the normal stress and shear stress at point *A* on the cross section at section *a-a*.
   c) Determine the normal stress and shear stress at point *B* on the cross section at section *a-a*.
   d) Draw the stress state at point *B* on a differential volume element located at this point.
   e) Plot the distribution of the normal stress on the cross section at section *a-a* in the *x*-direction. Determine the maximum and minimum normal stress values and label their location.

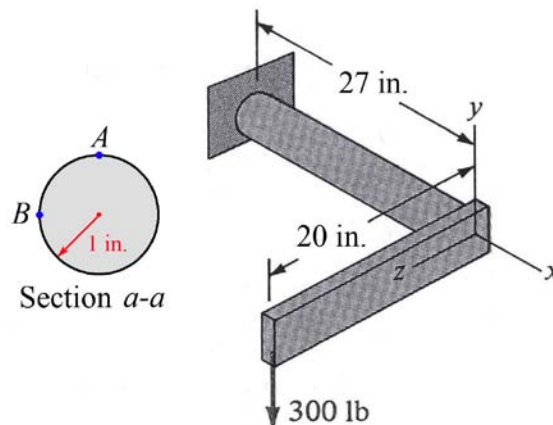*Note:* Be sure to clearly show all work and state units.

Fig. 3