# CHAPTER II- PROBLEMS

1- For each of the stress states listed below, find all three principal normal and shear stresses. Draw a complete Mohr's three-circle diagram and label all points of interest.

(a) $\sigma_x = -80$, $\sigma_y = -30$, $\tau_{xy} = 20$ cw **($\sigma_1$ =0, $\sigma_2$ =-23, $\sigma_3$ =-87)**

(b) $\sigma_x = 30$, $\sigma_y = -60$, $\tau_{xy} = 30$ cw **($\sigma_1$ =39.1, $\sigma_2$ =0, $\sigma_3$ =-69.1)**

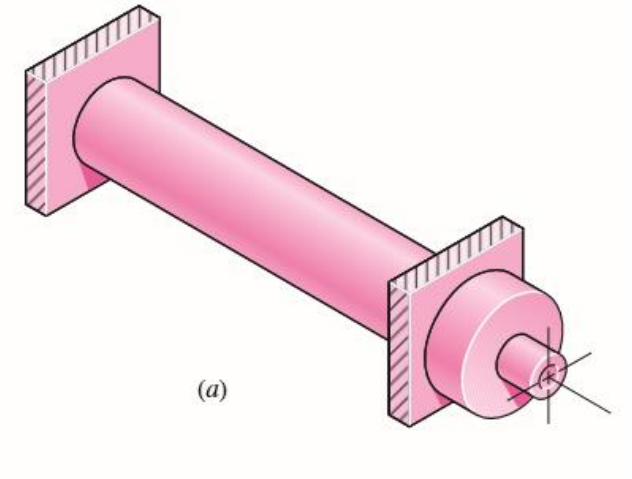
(c) $\sigma_x = 40$, $\sigma_z = -30$, $\tau_{xy} = 20$ ccw **($\sigma_1$ =48.3, $\sigma_2$ =-8.3, $\sigma_3$ =-30)**

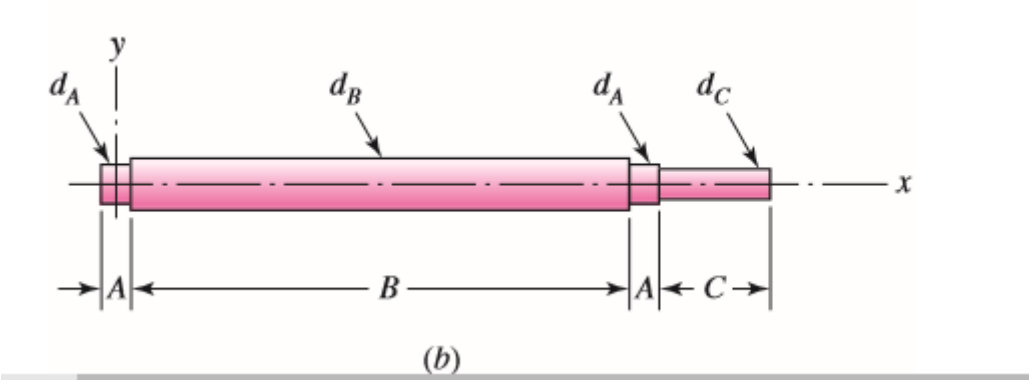
(d) $\sigma_x = 50$, $\sigma_z = -20$, $\tau_{xy} = 30$ cw **($\sigma_1$ =64.1, $\sigma_2$ =-14.1, $\sigma_3$ =-20)**

2- Using a maximum allowable shear stress of 60 MPa, find the shaft diameter needed to transmit 35 kw when (a) The shaft speed is 2000 rev/min. (b) The shaft speed is 200 rev/min. **( a) 24.2 mm, b) 52.2 mm)**

3- A hollow steel shaft is to transmit 5400 N·m of torque and is to be sized so that the torsional stress does not exceed 150 MPa. (a) If the inside diameter is three-fourths of the outside diameter, what size shaft should be used? Use preferred sizes. (b) What is the stress on the inside of the shaft when full torque is applied? **(64.5 mm, 58.9 MPa)**

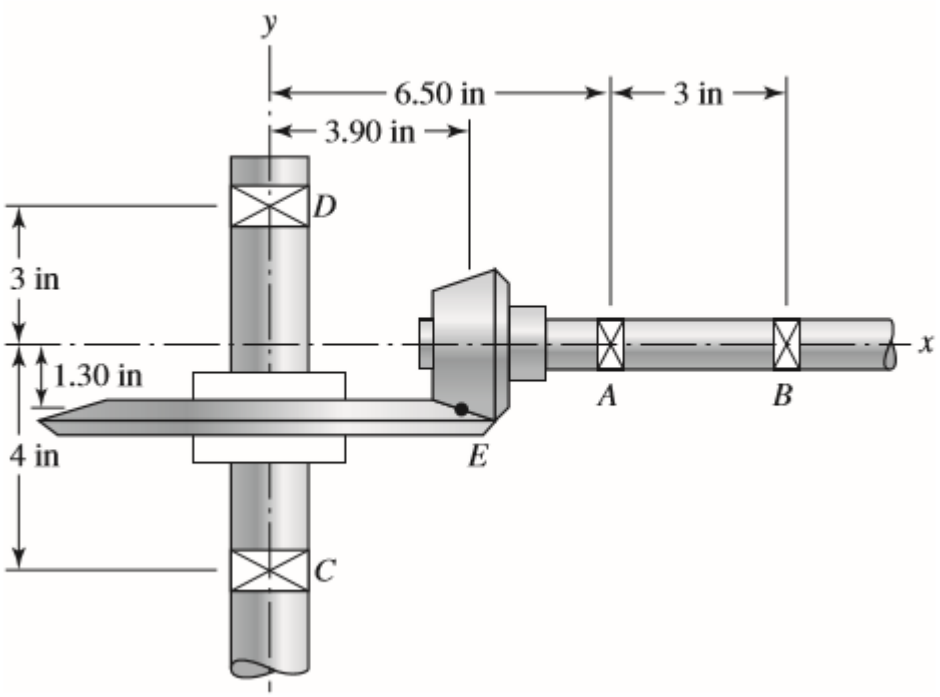
4- The figure shows an endless-belt conveyor drive roll. The roll has a diameter of 6 in and is driven at 5 rev/min by a geared-motor source rated at 1 hp. Determine a suitable shaft diameter $d_c$ for an allowable torsional stress of 14 kpsi. (a) What would be the stress in the shaft you have sized if the motor starting torque is twice the running torque? (b) Is bending stress likely to be a problem? What is the effect of different roll lengths B on bending? **(1.66 in, 23.96 kpsi)**





(b)

5- In the figure, shaft AB is rotating at 1000 rev/min and transmits 10 hp to shaft CD through a set of bevel gears contacting at point E. The contact force at E on the gear of shaft CD is determined to be $(F_E)_{CD}$ =-92.8**i** -362.8**j**+808.0**k** lbf . For shaft CD: (a) draw a free-body diagram and determine the reactions at C and D assuming simple supports (assume also that bearing C is a thrust bearing), (b) draw the shear-force and bending-moment diagrams, and (c) assuming that the shaft diameter is 1.25 in, determine the maximum tensile and shear stresses in the beam. **(9179 psi, 12845 psi)**



6- A pressure cylinder has a diameter of 150 mm and has a 6-mm wall thickness. What pressure can this vessel carry if the maximum shear stress is not to exceed 25 MPa? **(3.84 MPa)**

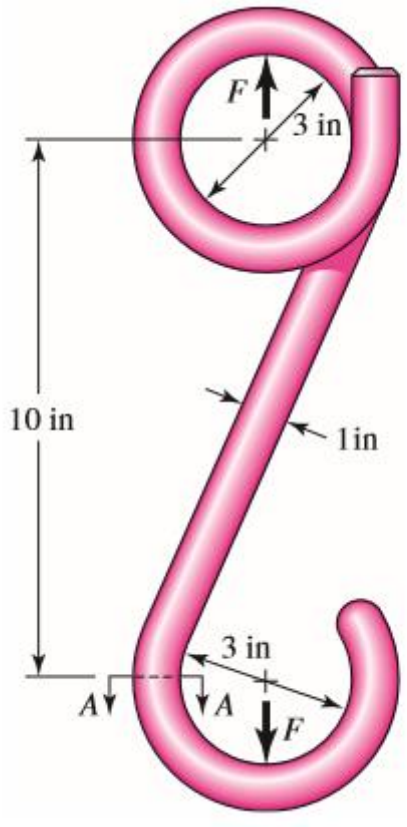
7- An AISI 1020 cold-drawn steel tube has an ID of 1 1/4 in and an OD of 1 3/4 in. What maximum external pressure can this tube take if the largest principal normal stress is not to exceed 80 percent of the minimum yield strength of the material? **(11200 psi)**

8- The table lists the maximum and minimum hole and shaft dimensions for a variety of standard press and shrink fits. The materials are both hot-rolled steel. Find the maximum and minimum values of the radial interference and the corresponding interface pressure. Use a collar diameter of 80 mm for the metric sizes and 3 in for those in inch units.

| Problem Number | Fit Designation* | Basic Size | Hole | | Shaft | |
|---|---|---|---|---|---|---|
| | | | $D_{max}$ | $D_{min}$ | $d_{max}$ | $d_{min}$ |
| 3–62 | 40H7/p6 | 40 mm | 40.025 | 40.000 | 40.042 | 40.026 |
| 3–63 | (1.5 in)H7/p6 | 1.5 in | 1.5010 | 1.5000 | 1.5016 | 1.5010 |
| 3–64 | 40H7/s6 | 40 mm | 40.025 | 40.000 | 40.059 | 40.043 |
| 3–65 | (1.5 in)H7/s6 | 1.5 in | 1.5010 | 1.5000 | 1.5023 | 1.5017 |
| 3–66 | 40H7/u6 | 40 mm | 40.025 | 40.000 | 40.076 | 40.060 |
| 3–67 | (1.5 in)H7/u6 | 1.5 in | 1.5010 | 1.5000 | 1.5030 | 1.5024 |

**(3-62: $p_{max}$=81.5 MPa, $p_{min}$=1.94 MPa, 3.63: $p_{max}$=12000 psi, $p_{min}$=0 psi, 3.64: $p_{max}$=114.5 MPa, $p_{min}$=34.9 MPa.....)**

9- A utility hook was formed from a 1-in-diameter round rod into the geometry shown in the figure. What are the stresses at the inner and outer surfaces at section A-A if the load F is 1000 lbf? **(26300 psi, -15800 psi)**




10- An aluminum alloy roller with diameter 1 in and length 2 in rolls on the inside of a cast-iron ring having an inside radius of 4 in, which is 2 in thick. Find the maximum contact force F that can be used if the shear stress is not to exceed 4000 psi. **(96.1 lbf)**

11- A 6-in-diameter cast-iron wheel, 2 in wide, rolls on a flat steel surface carrying an 800-lbf load. (a) Find the Hertzian stresses , $\sigma_y$ , $\sigma_z$ and $\tau_{2/3}$ (b) What happens to the stresses at a point A that is 0.010 in below the wheel rim surface during a revolution? **(20984 psi)**