**Homework 5**

**The extra credit questions, Q1 and Q2, are for self-study purposes. You are required to complete them independently without discussion with anyone.**

1) [Extra Credit] The state of stress at a point in a cast-iron structure ($\sigma_u = 290\ MPa$, $\sigma_u' = 650\ MPa$) is described by $\sigma_x = 0$, $\sigma_y = -180\ MPa$, and $\tau_{xy} = 200\ MPa$. Determine whether failure occurs at the point according to the Coulomb–Mohr criterion.

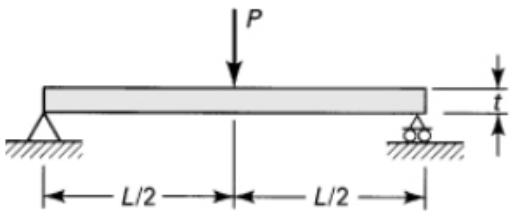
2) [Extra Credit] A material's ultimate strengths in tension and compression are $420$ and $900\ MPa$, respectively. Given the provided stress state at a point within a member made of this material, determine the factor of safety according to the Coulomb–Mohr criterion. (Ans: $1.33$)

$$\begin{bmatrix} 200 & 150 \\ 150 & 20 \end{bmatrix} \text{MPa}$$

3) A long Ti-6Al-6V alloy plate of $130$-$mm$ width is loaded by a $200$-$kN$ tensile force in longitudinal direction with a safety factor of $2.2$. Determine the thickness $t$ required to prevent a central crack to grow to a length of $20\ mm$ (Case A, Table 4.2). (Ans: $9.27\ mm$)

4) An AISI-4340 steel pressure vessel (having closed ends) of $60$-$mm$ diameter and $5$-$mm$ wall thickness contains a $12$-$mm$-long crack. Using the thin-wall assumption, calculate the pressure that will cause fracture when (a) the crack is longitudinal; (b) the crack is circumferential. Assumption: Use a factor of safety $n = 2$ and geometry factor $\lambda = 1.01$ (Table 4.2).


5) A small leaf spring $b = 10\ mm$ wide by $L = 125\ mm$ long by $t\ mm$ thick is simply supported at its ends and subjected to a center load $P$ that varies continuously from $0$ to $20\ N$. Using the Modified Goodman criterion, determine the value of $t$, given a fatigue strength $\sigma_{cr} = 740\ MPa$, ultimate tensile strength $\sigma_u = 1500\ MPa$, and safety factor of $n = 2.5$. (Ans: $0.973\ mm$)




6) Determine the fatigue life of a machine element subjected to the following respective maximum and minimum stresses (in megapascals):

$$\begin{bmatrix} 800 & 200 \\ 200 & 500 \end{bmatrix}, \quad \begin{bmatrix} -600 & -150 \\ -150 & -300 \end{bmatrix}$$

Use the maximum energy of distortion theory of failure together with the (a) modified Goodman criterion and (b) Soderberg criterion. Let $\sigma_u = 1600\ MPa$, $\sigma_{yp} = 1000\ MPa$, and $K = 1$.