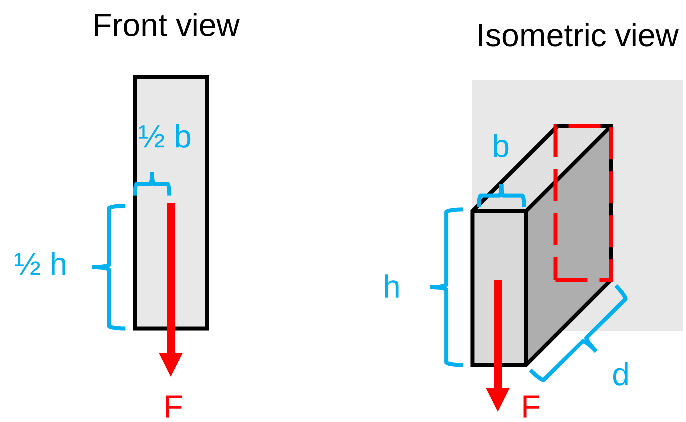
Homework #6

MAE 378

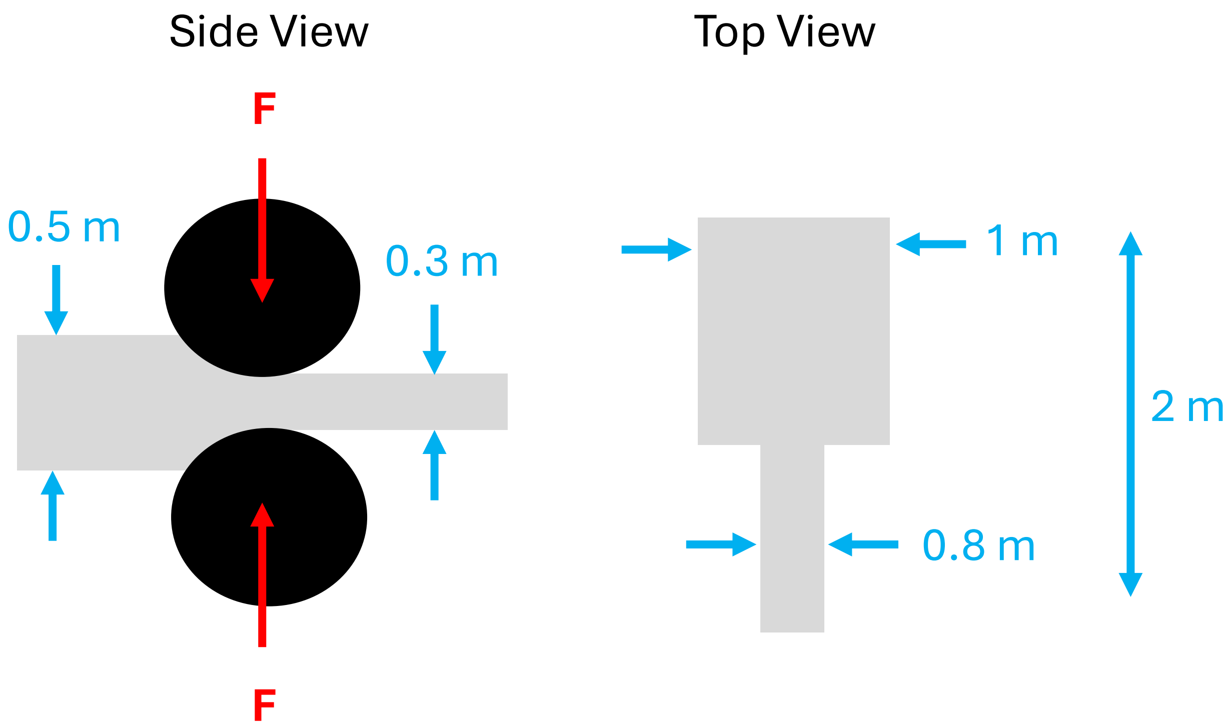
Dr. Natalie Click

Please complete the following problems and submit your solution as a PDF to Canvas. Individual work; no group assignments.

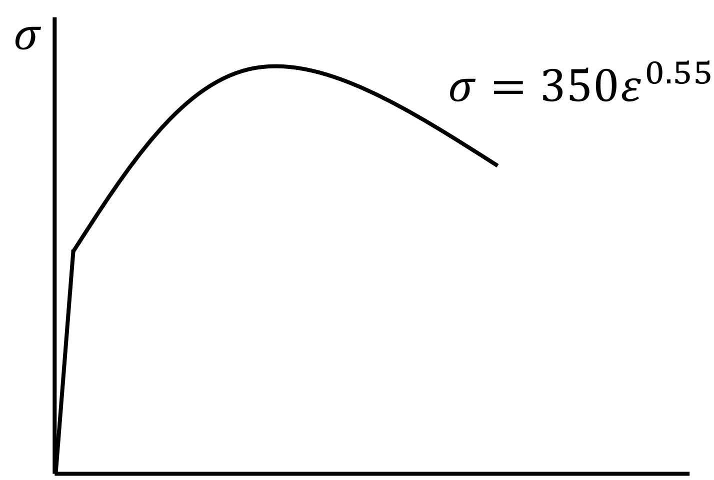
1. Suppose we weld a rectangular peg (h = 100 mm, b = 25 mm, d = 250 mm) to a metal plate, and then apply a force (150 N) on the end of the peg as shown in the figure below (the red rectangle is the weld area). Using your knowledge from mechanics of materials, **find the maximum bending stress σ_b and maximum shear stress τ_s in the weld area.**



2. For the following rolling process, determine **a) the draft (m) and b) the force (N) required to maintain a certain separation between two rollers.**



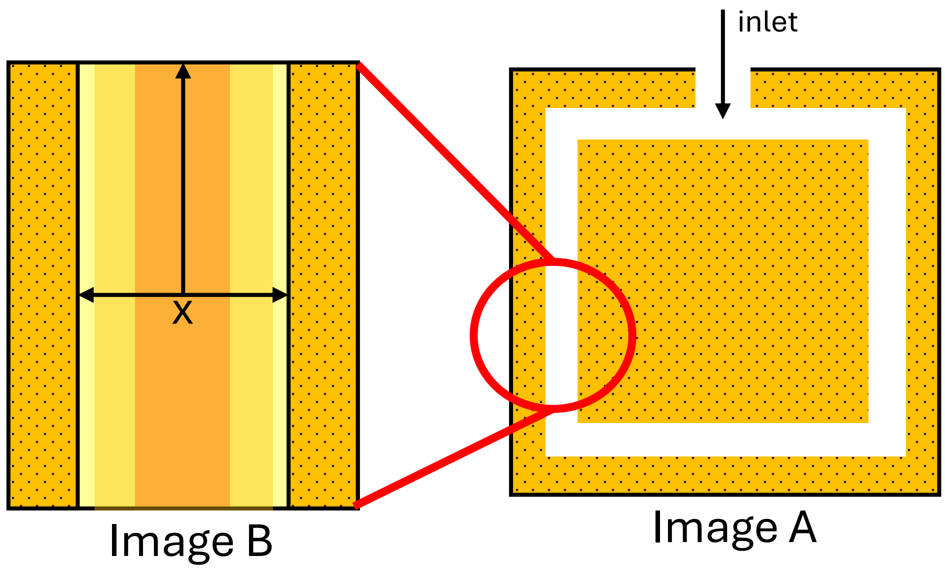
Stress-Strain curve for the material:



3. Imagine you are casting a mold that has the following cross sectional shape (Image A). If we focus on a zoom in of the cross sectional area (Image B), we can develop a simple model to describe the change in temperature of the liquid metal as a function of position (x) inside the mold cavity at various time stamps (t). Let us use a parabolic model in this case.

In the center of the mold (x = 0 cm), the temperature will initially be the temperature of the molten metal being poured in, 660ºC. Simultaneously at the outer edge where the metal meets the sand, the temperature will be 400ºC. As time goes on (t = 5 sec), the temperature in the center remains at 660ºC while the temperature at the edge cools to 200ºC. Finally after 10 seconds, the edge of the mold has cooled to room temperature (25ºC) while the middle remains at 660ºC.

For each of the time stamps (t = 0, 5, and 10 seconds), **a) derive the equation for temperature as a function of distance inside the mold cavity (in other words, solve for the quadratic coefficients).** Assume the cooling profile is a parabolic curve as a function of distance (x) with a peak at x = 0 cm. **b) Plot the functions for all three time cases (t = 0 red; t = 5 green; t = 10 blue).** Make sure to label your axes!



4. Face milling is another type of basic machining process. A schematic of the process is shown below. The table feed rate is $f_m = f_t n N_s$ for a cutter with n teeth and a feed per tooth rate f_t. The equation for the cutting time is given:

$$T_m = \frac{L + L_A + L_O}{f_m}$$

where $L_o = L_A = \sqrt{W(D-W)}$ for $W < D/2$ and $L_o = L_A = D/2$ for $W \geq D/2$

The material removal rate for the cutting process is expressed as: $MRR = Wdf_m$

where d is the depth of the cut.

If the length of the cut is 100 mm, the cutting speed is 3 m/min for a cutting tool with 26 teeth, the cutter diameter is 25 mm, the width of the cut is 12.5 mm, the depth of the cut is 0.005 mm, and the feed per tooth is 0.05 mm/tooth, **calculate the total time for machining and the material removal rate.**