Homework 4

Due Date: November 15, 2025

Problem 1 (15 points):

An overhanding steel beam is subjected to two concentrated forces. Plot the moment diagram, and determine the value of a (distance between A and C) so that the absolute values of the bending moment at cross section C and D are equal. What is the corresponding maximum normal stress due to bending?

(Check the following website for geometric information of $W14 \times 22$:
https://www.engineersedge.com/standard_material/Steel_ibeam_properties_2.htm)
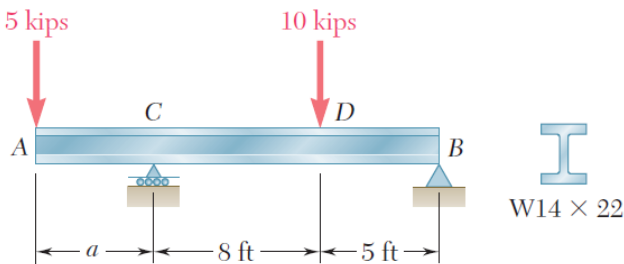
Problem 2 (15 points):

The beam AB supports two concentrated loads P and Q. The normal stress due to bending on the bottom edge of the beam is 55MPa at D and 37.5MPa at F. (a) Determine the value of P and Q; (b). Draw the shear and bending-moment diagrams for the beam, and (c) Determine the maximum normal stress due to bending that occurs in the beam.
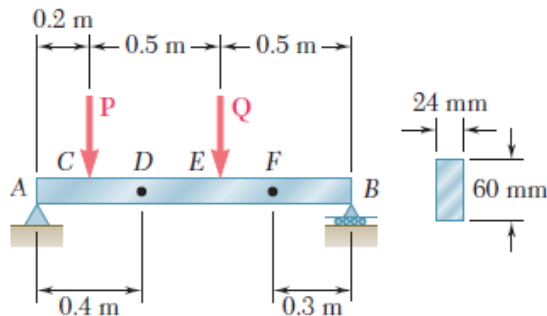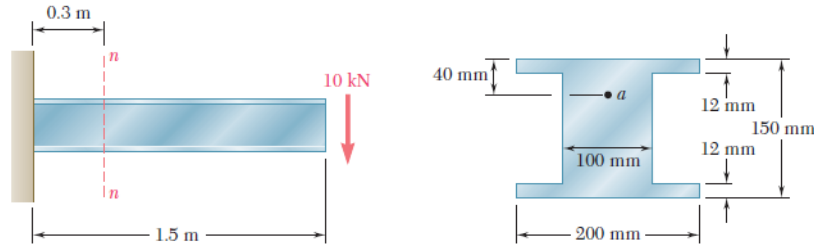

Problem 3 (10 points):

For the beam and loading shown, design the cross section of the beam, knowing that the grade of timber used has an allowable normal stress of 1750 psi.
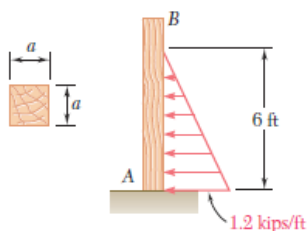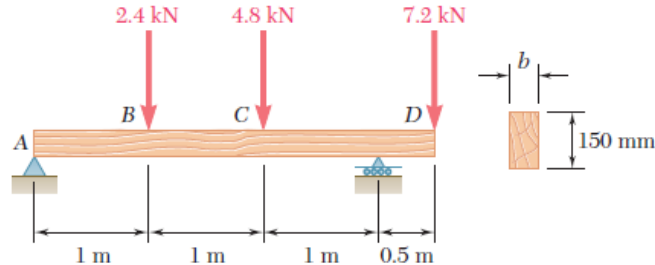
Problem 4 (10 points):

For the beam and loading shown, consider section n-n and determine (a) the largest shearing stress in that section, (b) the shearing stress at point a.
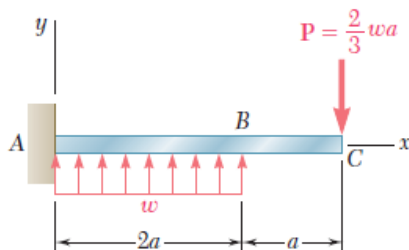

Problem 5 (15 points):

For the beam and loading shown, determine the minimum required width b, knowing that for the grade of timber used, $[\sigma]$=12 MPa and $[\tau]$=825 kPa.
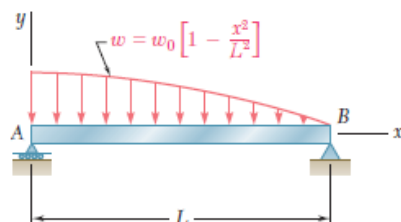

Problem 6 (10 points):

For the cantilever beam and loading shown, determine (a) the equation of the elastic curve for portion AB of the beam, (b) the deflection at B, (c) the slope at B.
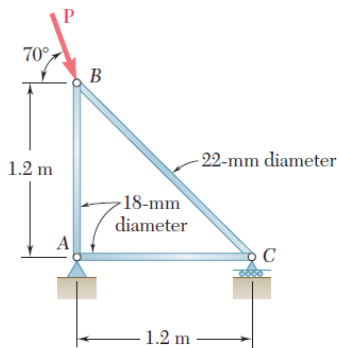

$$P = \frac{2}{3} wa$$

Problem 7 (15 points):

For the beam and loading shown, determine (a) the equation of the elastic curve, (b) the slope at end A, (c) the deflection at the midpoint of the span.

$$w = w_0 \left[1 - \frac{x^2}{L^2}\right]$$

Problem 8 (10 points):

Knowing that P = 5.2 kN, determine the factor of safety for the structure shown. Use E= 200 GPa and consider only buckling in the plane of the structure.

Bonus question (10 points):

Column AB carries a centric load P of magnitude 15 kips. Cables BC and BD are taut and prevent motion of point B in the xz plane. Using Euler's formula and a factor of safety of 2.2, and neglecting the tension in the cables, determine the maximum allowable length L. Use $E=29\times10^6$ psi.