

Qualifying Exam, Fall 2020
Solid Mechanics

* This is a closed-book test (with a cheat sheet provided), and no calculator is allowed.

* Work THREE out of the four problems, and clarify which three you want graded.

I want problems #_____ , #_____ , and #_____ to be graded.

Problem 1. Obtain the relationship between the twisting moment M and the twist angle per unit

length θ for a rectangular bar under torsion.

Note: $1 + \frac{1}{3^4} + \frac{1}{5^4} + \dots = \frac{\pi^4}{96}$

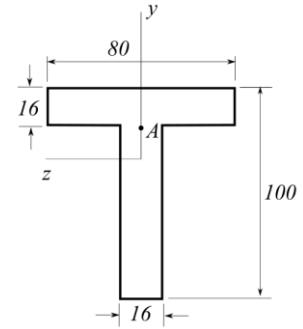
Problem 2. For the state of stress in coordinate system $\{e_1, e_2, e_3\}$

$$[\sigma] = \begin{bmatrix} 10 & 50 & -50 \\ 50 & 0 & 0 \\ -50 & 0 & 0 \end{bmatrix} MPa$$

find stresses σ_{11}^* and σ_{13}^* in the coordinate system $\{e_1^*, e_2^*, e_3^*\}$ if e_1^* is in the direction of $e_1 + 2e_2 + 3e_3$ and e_2^* is in the direction of $e_1 + e_2 - e_3$

Problem 3

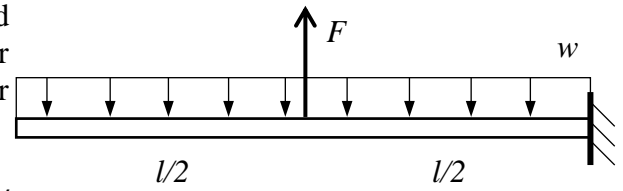
A beam with a T cross section shown on the right has internal bending moment $M_z = 1.5 \text{ kN} \cdot \text{m}$ and shear force $V_y = 30 \text{ kN}$. Calculate principal stresses and maximum shear stress at point A located immediately below the transition from the 80-mm to the 16-mm portion.



Dimensions are in mm

Problem 4

Using Castigliano's theorem, find deflection and angle of rotation of the free end of the cantilever beam shown. Neglect the transverse shear effects.



Assume: $l = 40 \text{ in}$, $F = 2000 \text{ lb}$, $w = 50 \text{ lb/in}$, $E = 30 \cdot 10^6 \text{ psi}$, $I = 1.2 \cdot \text{in}^4$