ME423 – Tutorial 3/ HW 3 – Due 13th Sept 2024 – 11.00 pm

I will be discussing/solving a few of these problems during the tutorial hour on 11/9. You have to submit all the problems by 11.00 pm, 13/9/2024 [Moodle].

1. Derive the material indices for the following cases:
    a. A light truss with stiffness greater than S^*
    b. A light shaft with stiffness greater than S^*

2. Derive the shape factor for annular cross-section with inner radius R_i and outer radius R_o for torsional stiffness.

3. Derive the performance indices for the following cases:
    a. A light beam with maximum stress less than or equal to σ_f (material property)
    b. A light hollow shaft with stiffness greater than S^*

4. Derive the material index to maximize the slenderness ratio (L/r) of a column with circular c/s subject to the constraint that it must not buckle under a given load F.

5. Derive the material index to minimize the cost of a beam with stiffness greater than S^*. Note that the cost of the beam, C, can be assumed to be directly proportional to the mass of the beam, i.e. $C = C_m \rho$ where C_m is the cost per unit mass and is a material property. Your material index will now include E, ρ and C_m.

6. Derive the material index to maximize the energy stored per unit mass in a flywheel of fixed outer radius R, radius t and rotating with angular speed ω. Note that the maximum stress induced in the flywheel should be less than or equal to the failure stress σ_f a material property. Note that at this stress the flywheel bursts. The maximum principal stress in a spinning disk of radius R with uniform thickness is $\sigma_{max} = \dfrac{3+\nu}{8}\rho R^2\omega^2$.