SE104 Homework 11

1. We need to design a flywheel that must be able to store a certain amount of kinetic energy, U_0, without permanent damage of the material. The thickness, t, must be close to 10 cm. What can we do to minimize the radius of the flywheel, R? (Hint: the kinetic energy of a flywheel is $U = \pi\rho t\omega^2 R^4/4$, with ρ being the material mass density and ω the spinning rate).

2. (a) Derive the performance index of material selection, for a helical spring that can store as much energy as possible without plastic damage. The spring is subjected to a load (F_0) varying from 1000 N to 2000 N. The coil radius, R, must be around 10 cm. There should not be more than 100 turns of coils. (b) List top 3 candidates.

3. (a) Derive the design index, M, for a beam that should be as lightweight as possible. The two ends of the beam are simply supported, and a concentrated force is applied at the middle point. The beam must not yield when it is subjected to a specified load, F^*. The cross section must be square, and the beam length must be close to a given value, L_0. (b) List top 3 candidates of material.

4. A plate is 10 m long, 1 m wide, and 1 mm thick. A tensile force 1000 N is applied along the length direction. A small through-thickness slit is found at its center, with the slit length of 1 cm and the curvature of the slit tip of 1 mm. What is the maximum stress in the plate? (Hint: the geometric factor $\alpha = 1$)