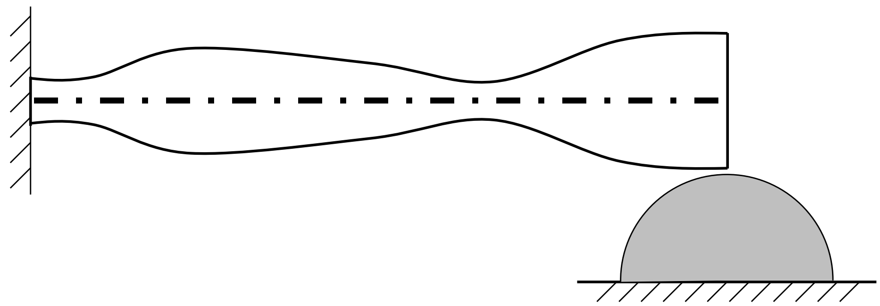
ME 260: Structural Optimization: Size, Shape, and Topology		
Assigned: Nov. 17, 2020	Homework 4	Due: Nov. 27, 2020

Problem 1 (10 points)

Consider a beam of length l fixed at the left end and free at the right end. It is under uniformly distributed transverse load of q_0. There is a fixed semicircular disc of radius r right below but not quite touching the beam. Assuming circular cross section, find $R(x)$, the radius along the length of the beam for maximizing the contact force at the right end for a given volume of material, V^*. Denote Young's modulus as E and assume any other symbols you may need. Present your problem formulation, Euler-Lagrange equations with boundary conditions, and an outline of how you would solve the equations.



Extra credit of 10 points for solving it completely either analytically or numerically by assuming some numbers.

Problem 2 (10 points)

Formulate a structural optimization problem that involves variable-end conditions and solve it. If your problem has broken extremals, comment on that aspect as well.

It should be a new problem to the extent that you cannot find it in books, research papers, or on the internet. It is purely a test for your creative thinking about how you would apply what you have learnt about variable-end conditions.

Problem 3 (10 points)

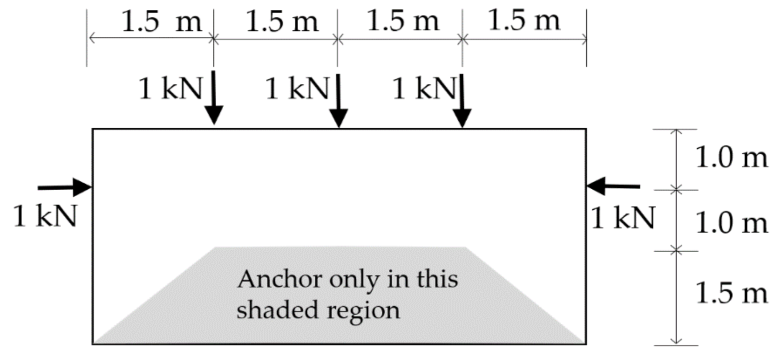
[You need Matlab codes for bars, beams, and columns to solve this problem.]

Write a general-purpose code for maximization of the first natural frequency of a beam for any boundary condition (fixed, hinged, guided vertically, free) at either end. There is an upper bound on the volume of material, V^*; and there are lower and upper bounds on the area of cross section. Assume rectangular cross section of fixed depth, d, but variable breadth, $b(x)$. Numerical values need to be assumed for all quantities that you need in your code. The strongest column code is the closest to this problem.

Start early! Do not wait until a day before the deadline.

Problem 4 (10 points) [You need to download *YinSyn* code for this problem.]

Using *YinSyn* topology optimization code, minimize the mean compliance of the structure for the specifications shown in the adjacent figure. You may fix the structure anywhere only in the shaded region while the structure itself must fit within the given rectangular domain including the shaded region. Additionally, the total length of the fixed (anchored) edge cannot exceed 2 m. Use E = 68 GPa.



Problem 5 (10 points) [You need to download YinSyn code for this problem.]

Using YinSyn topology optimization code, obtain the best topology of a compliant mechanism for maximum output displacement for the specifications shown in the adjacent figure. You may fix the structure anywhere only in the shaded region while the mechanism itself must fit within the given rectangular domain including the shaded region. Additionally, the total length of the fixed edge cannot exceed 2 m units. Use E = 68 GPa. Note that output load, 100 N, acts opposite to the desired displacement.