Ph.D. Qualifying Examination

Mechanics of Materials

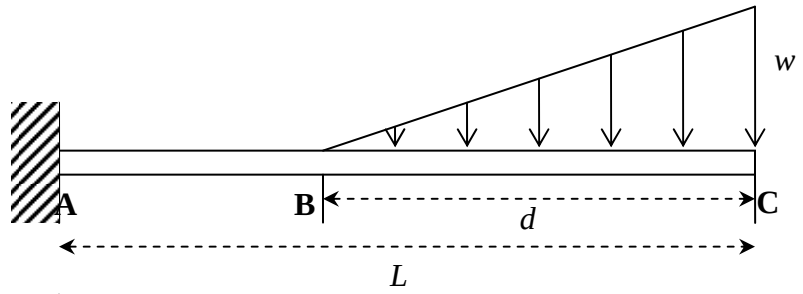
Fall 2011

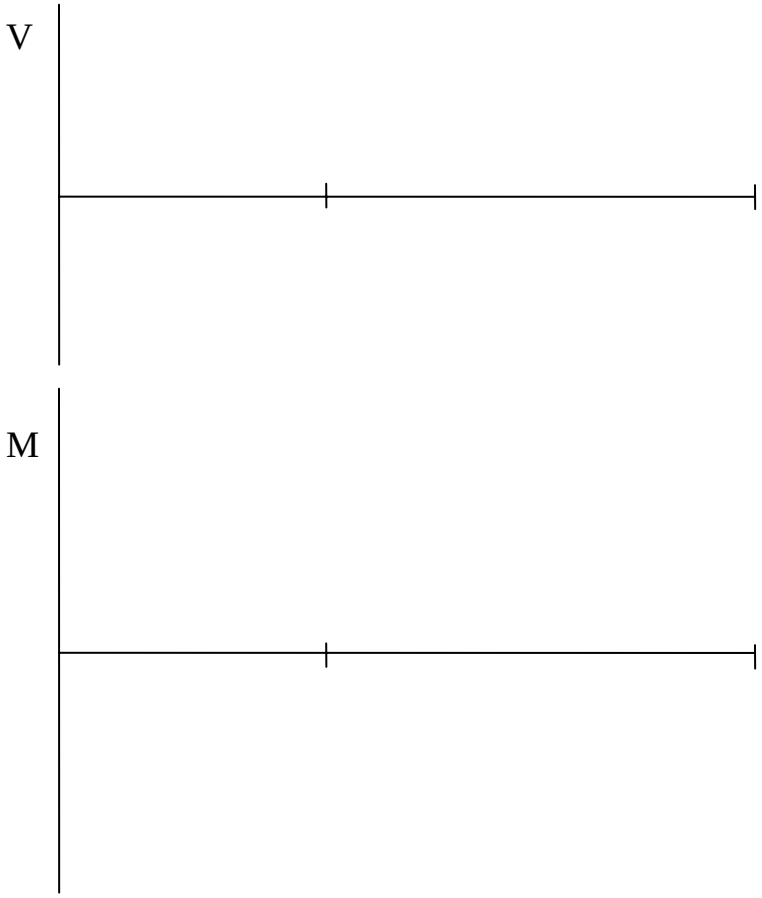
Notes:

- There are a total of 4 problems.
- Time allowed: 2.5 hours.
- Exam is closed book and closed-notes (one sheet of formulas is allowed)
- Problems count 25 points each (total=100 points).
- Show your work on these exam sheets. (Add additional sheets, if needed.)
- You may use a calculator.
- Laptops and cell phones are not allowed.

Problem 1

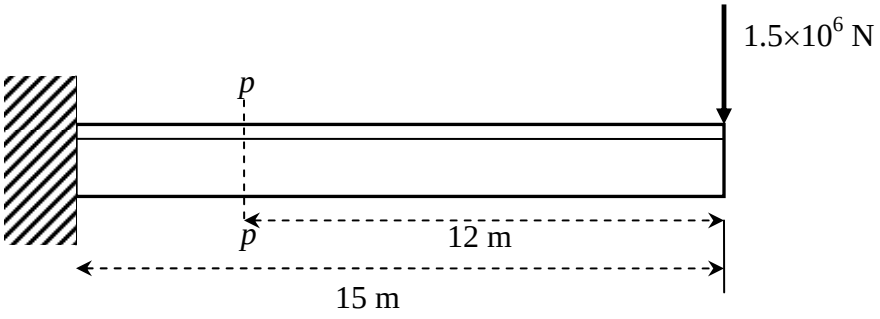
Consider the cantilever beam under a distributed load shown in the figure (the distribution is linear from zero at point B to *w* at point C). Sketch the shear (V) and bending moment (M) diagrams, and label the values of V and M at points A, B and C. Show your work.

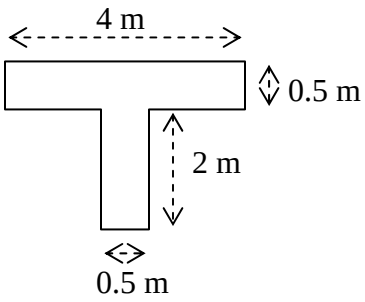




Problem 2

A beam with T-shaped cross section is acted upon in its plane of symmetry by the force 1.5×10^6 N as shown. Determine the maximum compressive stress at section *pp*.





Problem 3

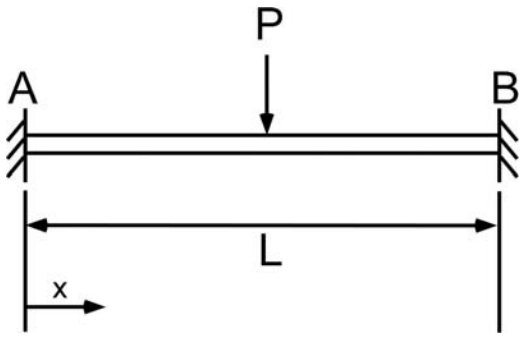
Calculate the average shear stress in a thin-walled tube having a circular cross section of mean radius r_m and thickness t, which is subjected to a torque T. Also, what is the relative angle of twist if the tube has a length L? Please show all work.

Problem 4

The equation relating the force, *P*, and deflection δ for the fix-fix shown below is:

$$P = \frac{192EI}{L^3}\,\delta$$

where *E* is the elastic modulus and *I* is the moment of inertia. This equation shows a linear relationship between these two variables and is valid only for very 'small' deflections and rotations. For 'large' deflections and rotations this equation is no longer valid.



a) Draw a free body diagram that accounts for these large deflections and rotations. (Hint: Consider stretching in the beam.)

b) Set up the new differential equation based on your free body diagram. (Do not solve)

c) Sketch the linear relation given above (indicate slope) and an estimate of the behavior of the beam undergoing large deflections and rotations on the plot to the right: