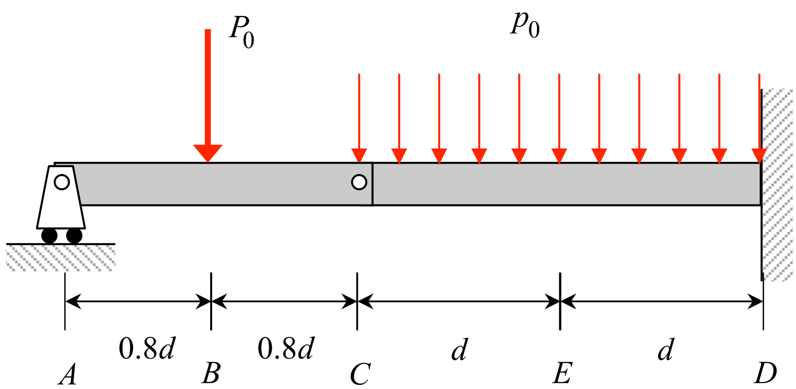
Problem 9.1

Two beam segments, AC and CD, are connected together at C by a frictionless pin. Segment CD is cantilevered from a rigid support at D, and segment AC has a roller support at A.

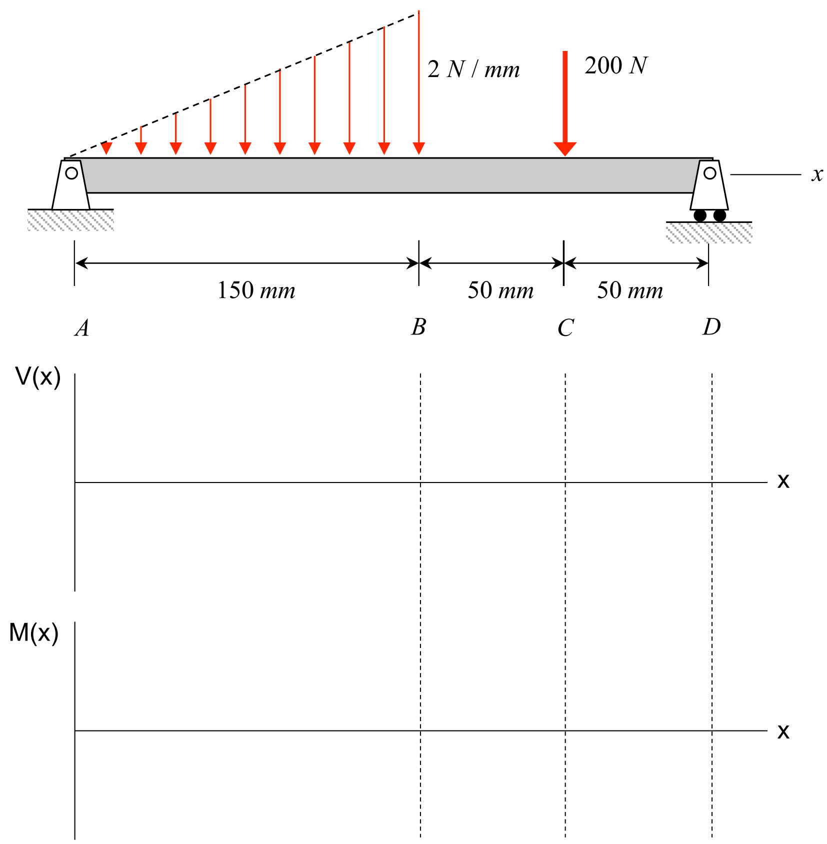
a) Determine the reactions at A and D.

b) Determine the internal reaction force and couple on the left face of a cut through the beam at E.



Example 9.5

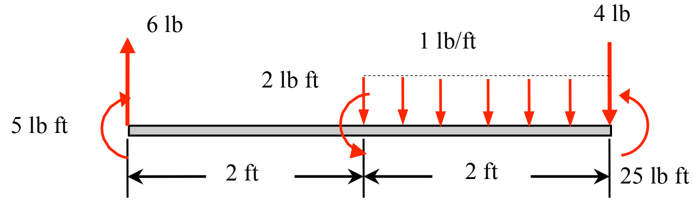
Draw the shear force and bending moment diagrams in the plot axes below for the loaded beam shown.



Example 9.9

The beam is subject to the loading shown.

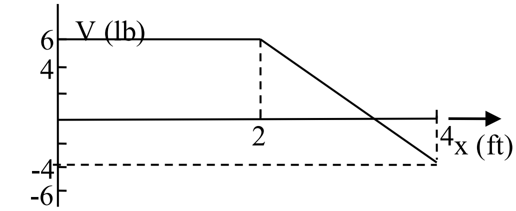
1. Choose the correct shear diagram from the column on the left.
2. Choose the correct moment diagram from the column on the right.



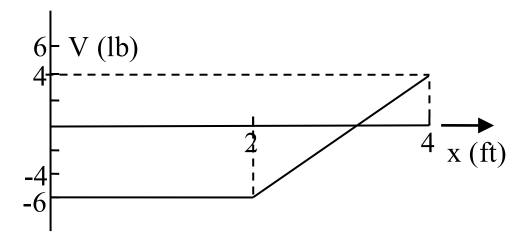
Note: The moment diagrams on the right do not necessarily correspond to the diagrams on the left. Circle answers from following choices.

Shear diagram

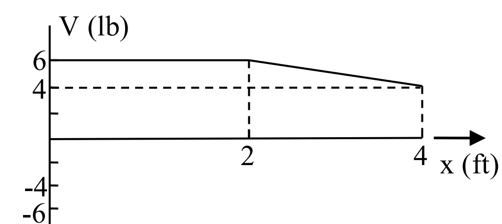
1)



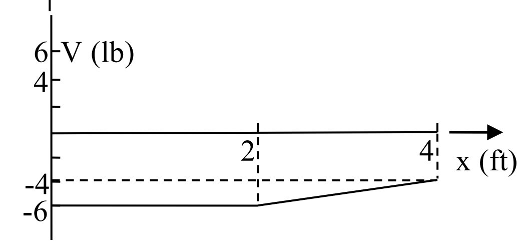
2)



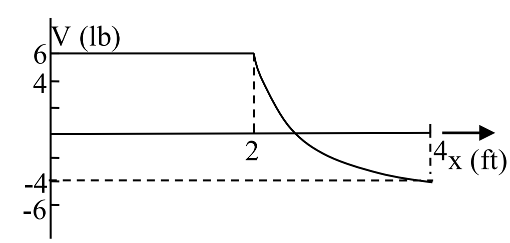
3)



4)



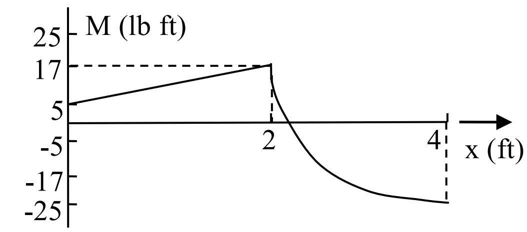
5)



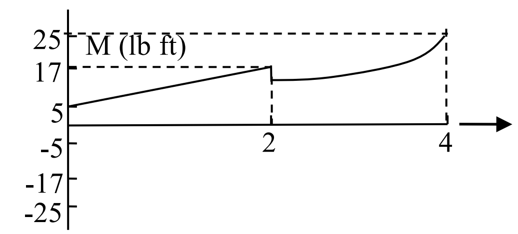
6) None of above

Moment diagram

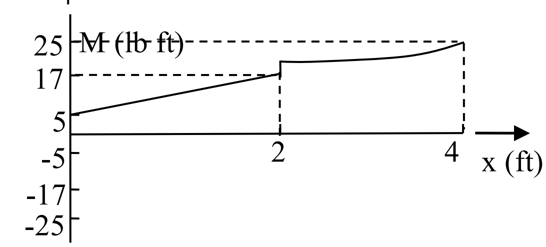
a)



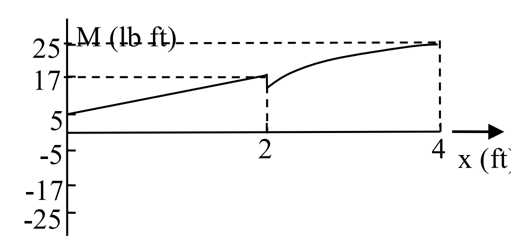
b)



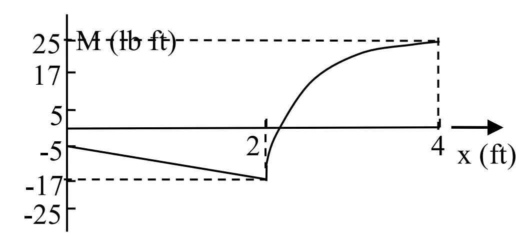
c)



d)



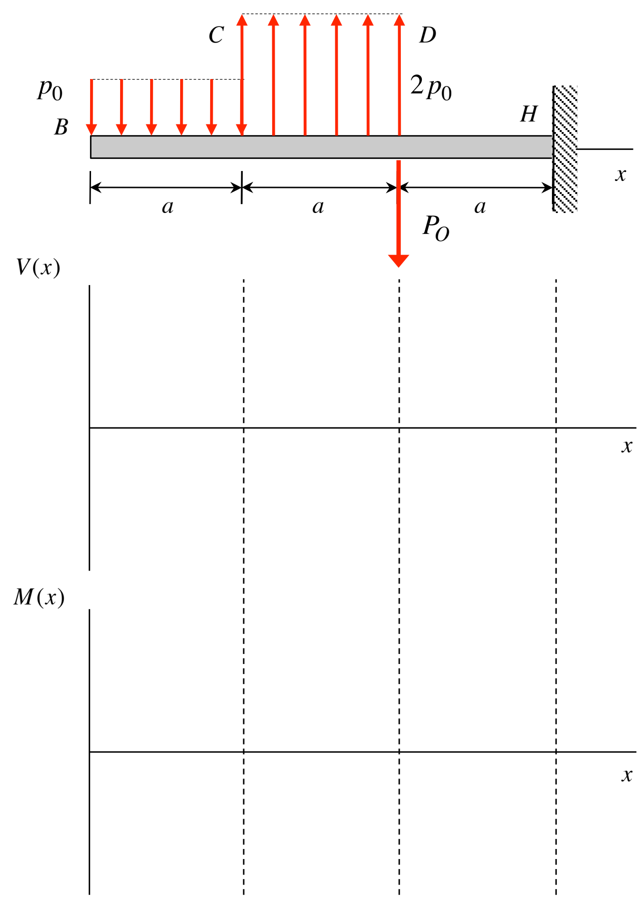
e)



f) None of above

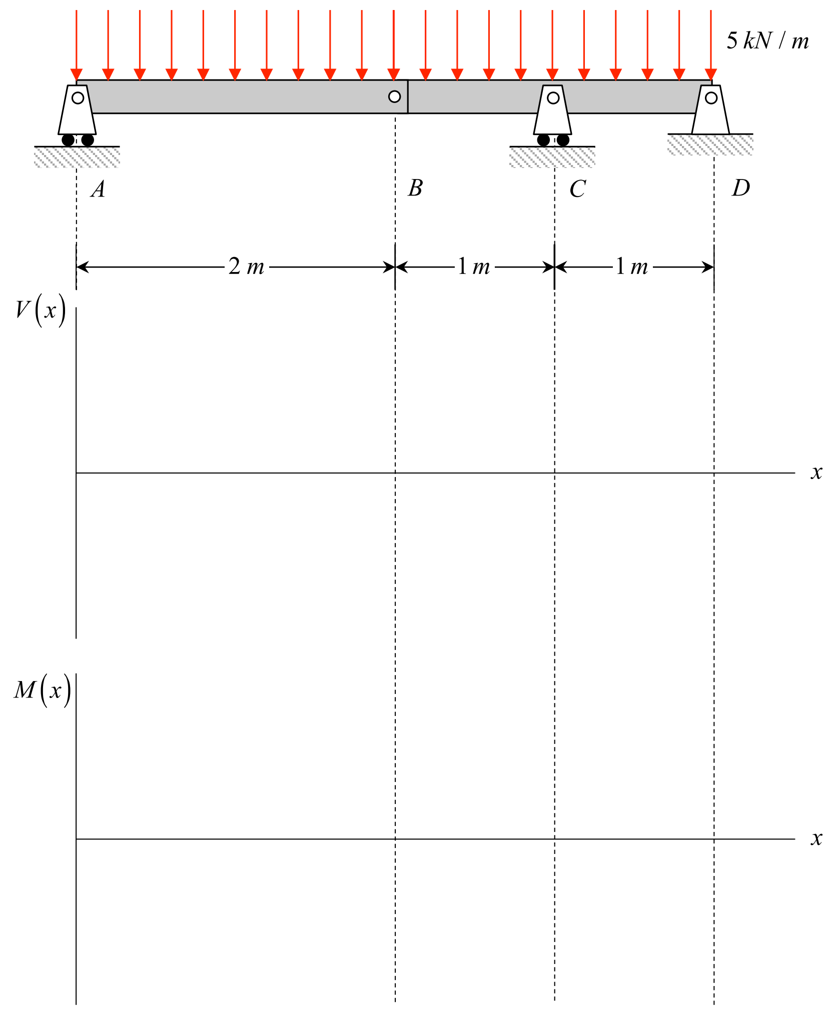
Example 9.12

Determine the shear force and bending moment diagrams in the plot axes below for the loaded beam shown. Clearly indicate the values of V and M at the labeled points as well as any maximum/minimum values. Please provide details on your work. Use $p_0 = 20 lb/in$, $a = 2in$ and $P_0 = 40 lb$.



Example 9.14

Draw the shear force and bending moment diagrams in the plot axes below for the loaded beam shown.



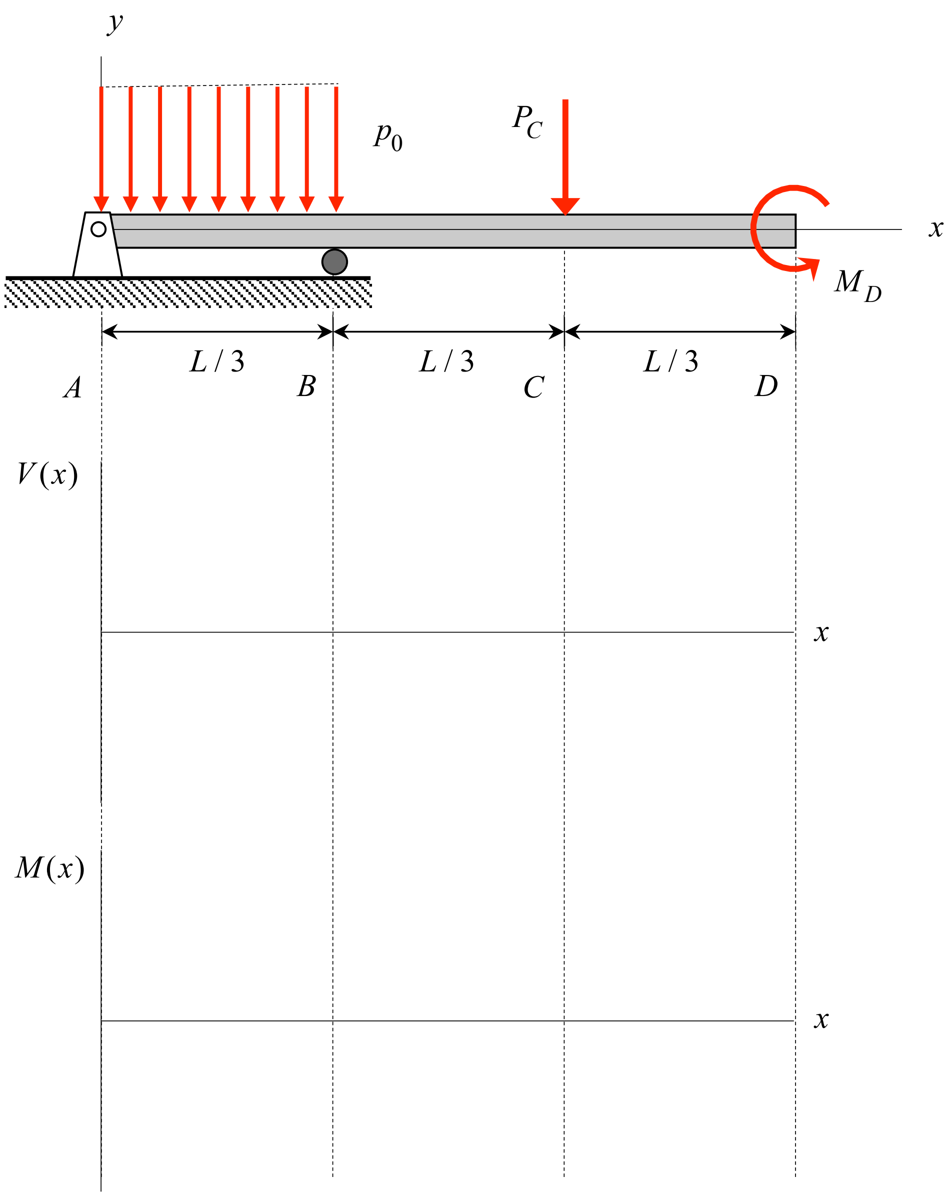
Example 9.15

Consider the loading on the beam shown below.

a) Determine the reactions at supports A and B.

b) Sketch the shear force $V(x)$ and bending moment $M(x)$ distribution on the beam using the axes below. Provide details on your calculations.

Use the following in your calculations: $L = 9\ ft$, $p_0 = 10\ kips/ft$, $P_C = 40\ kips$ and $M_D = 90\ ft \cdot kips$.

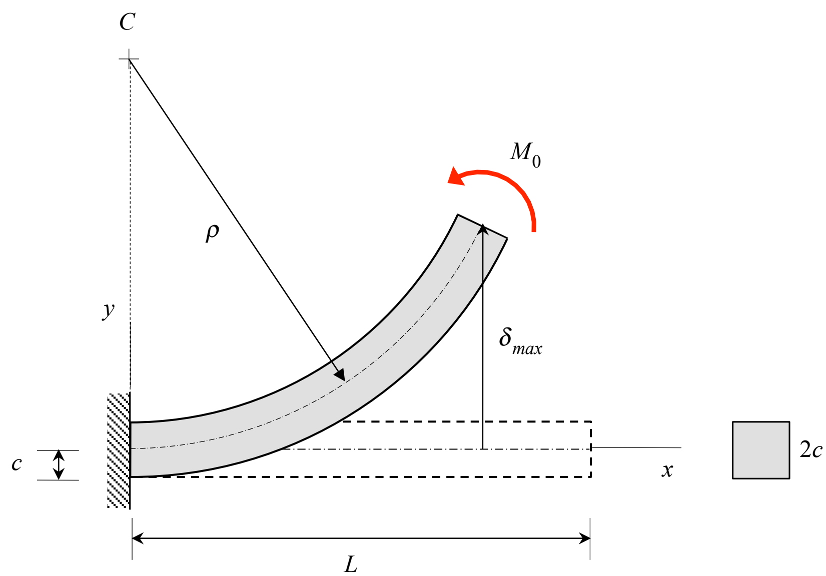


Example 10.3

A couple M_0 acts on the end of a slender cantilever beam as shown below. For this beam, we have $L = 15\ ft$ and $c = 0.5\ ft$.

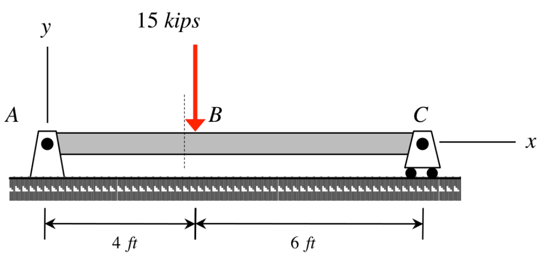
a) Determine an expression for the radius of curvature if the outer fiber of the beam is at the tensile yield strain of the material, $\varepsilon_Y = 0.001$.

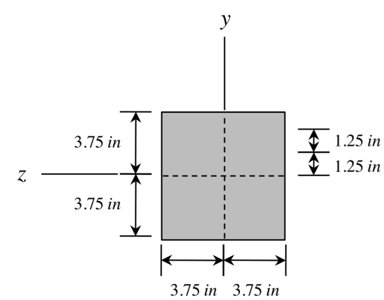
b) Determine the tip deflection δ_{max} at this loading.



Example 10.8

Simply-supported beam AC is loaded as shown. Determine the normal stress and shear stress for levels $y = 0$, $y = 1.25\ in$ and $y = 2.50\ in$ on the cross section just to the left of point B.



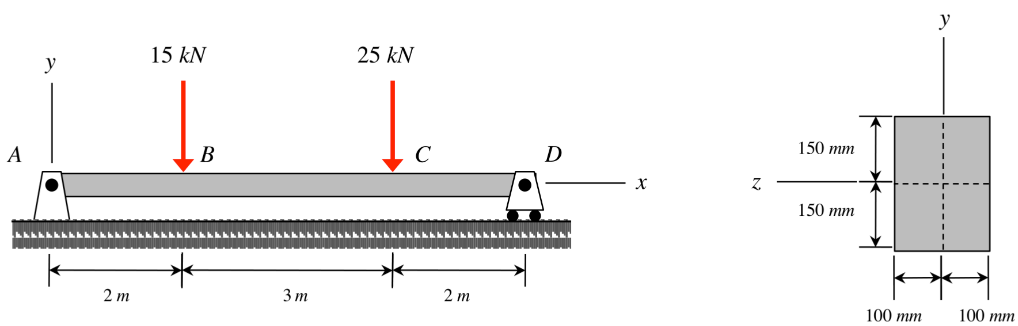


Example 10.9

Beam AD is loaded as shown.

a) Determine the maximum magnitude normal stress in the beam and the location on the beam where it occurs.

b) Determine the maximum magnitude shear stress in the beam.

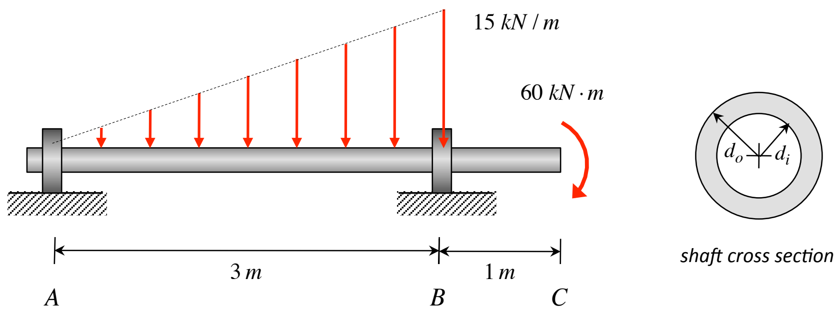


Example 10.12

A tubular shaft has a cross section as shown in the figure. The inner and outer diameter are related by $d_i = 0.5d_o$. (Assume that A is a simply supported joint while B is a roller joint)

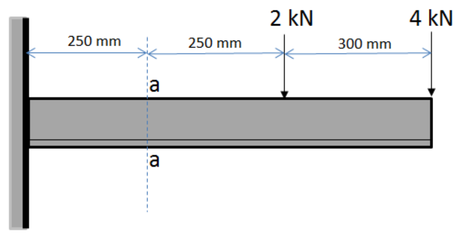
(a) Determine the absolute maximum flexural stress in the shaft if d_o =200 mm and its location.

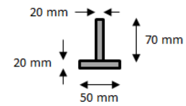
(b) Determine the required dimensions of inner and outer diameter if the bending stress to cause failure is 300 MPa. Consider a F.S. of 3.



Example 10.14

Determine the maximum shear stress acting on the section a-a of the cantilevered beam below.





Solution:

Example 10.15

Consider the loading on the cantilevered beam shown below.

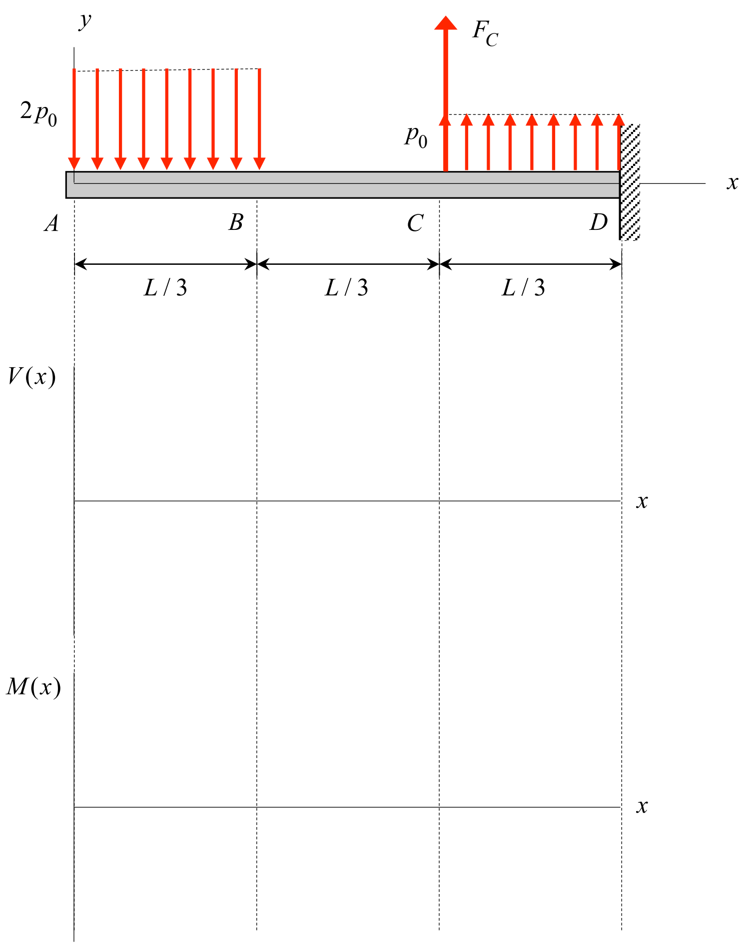
c) Sketch the shear force $V(x)$ and bending moment $M(x)$ distribution on the beam using the axes below. Provide details on your calculations.

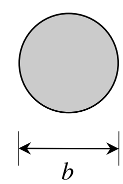
d) Determine the location(s) along the beam at which the maximum magnitude normal stress exists and location(s) along the beam at which the maximum magnitude shear stress exists.

e) Consider a circular beam cross-section “A” shown. For this cross section, determine the maximum magnitude normal stress and its location on the cross section. Also, what is the shear stress at the neutral axis? Feel free to use the results from Example 10.11 of the lecture book in finding the neutral axis shear stress.

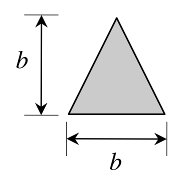
f) Consider a triangular beam cross-section “B” shown. For this cross section, determine the maximum magnitude normal stress and its location on the cross section. Also, what is the shear stress at the neutral axis?

Use the following in your calculations: $L = 3\ m$, $p_0 = 20\ kN/m$, $F_C = 50\ kN$ and $b = 0.1\ m$.





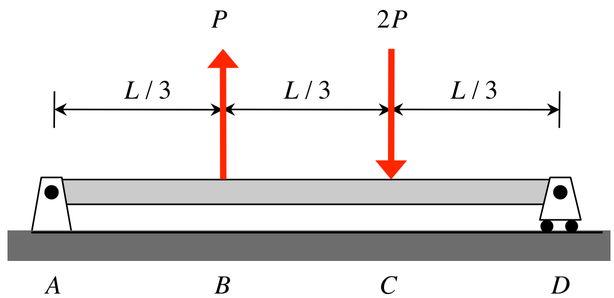
beam cross section A



beam cross section B

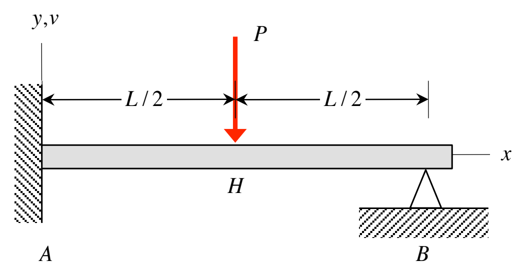
Example 11.18

Determine the deflection of the beam loaded as below using superposition.



Example 11.22

Consider the indeterminate beam shown below, where the beam is made up of a material having a Young's modulus of E and a cross-sectional second area moment of I. For this beam, determine its deflection at the midpoint H. Use the superposition approach with known beam deflection solutions.

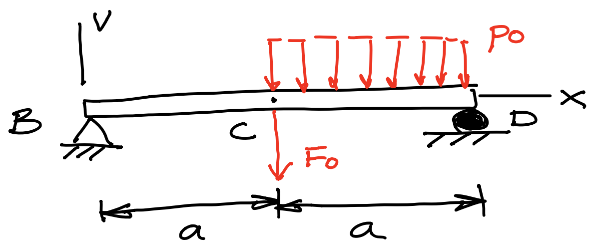


Example 11.23

Consider the simply-supported beam shown below with a line load of p_0 over $a < x < 2a$ and a concentrated force at $x = a$. The cross section of the beam has a second order area moment of I and is made of a material with a Young's modulus of E.

(a) Make a sketch of the deflection of the beam, $v(x)$. In your sketch, pay close attention to displacements and slopes at supports.

(b) Using the second-order integration method, determine the slope at end D, θ_D, and the displacement at the beam midpoint, v_C.



Example 11.24

Consider the loading on the propped-cantilevered beam shown below.

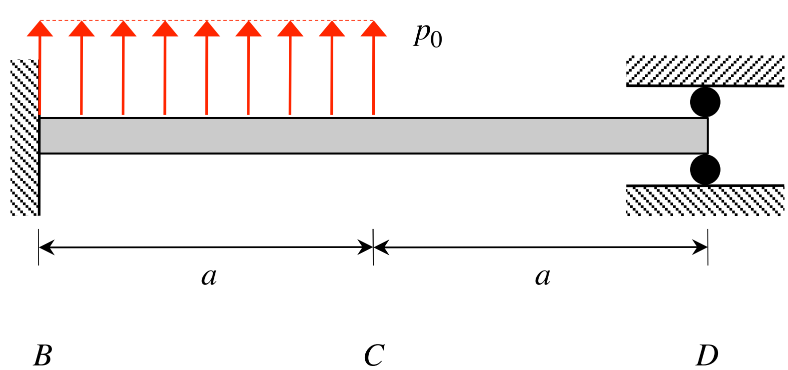
a) List all of the *geometric boundary conditions* for this problem. Make a sketch of the expected deflection shape of the beam, paying close attention to the geometric boundary conditions of the problem.

b) ***Equilibrium***. Draw a free body diagram of the entire beam and derive the equilibrium equations for the problem. Is this problem determinate or indeterminate?

c) ***Load/deflection***. Using the second-order integration method to derive an expression for the transverse deflection $v(x)$ of the beam over its full length.

d) ***Compatibility***. Write down the compatibility equation relating beam deflection at D to the geometric boundary condition at D.

e) ***Solve***. Using the equations from static equilibrium and displacement/deflection compatibility to solve for the reactions acting on the beam at ends B and D.



Example 12.3

A steel tank of an air compressor is subjected to internal pressure of 100 psi. The internal diameter of the tank is 20 in. and the wall thickness is 0.25 in. Determine:

(a) Stress components acting at point A (point on the surface). Show the stresses on a volume element of the material at this point.

(b) Determine the tensile force per inch length of the weld between the right and left sections of the tank, as shown in the figure.