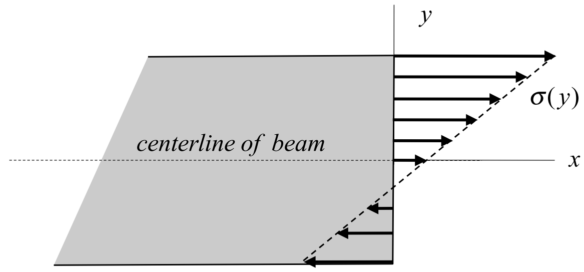
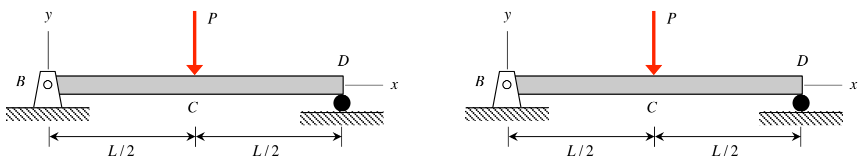
Conceptual question 10.1

The distribution of the normal stress σ at the cross section of a beam varies linearly with the coordinate y and is constant in its depth (in z-direction). Let F represent the resultant normal force due to this normal stress on the cross section. Circle the correct answer:

a) $F > 0$ (tensile)
b) $F = 0$
c) $F < 0$ (compressive)



Conceptual question 10.2



Beams (i) and (ii) shown above are identical, except that Beam (i) is made up of steel, and Beam (ii) is made up of aluminum. Note that $E_{steel} > E_{aluminum}$.

Let $\left(|\sigma|_{max}\right)_i$ and $\left(|\sigma|_{max}\right)_{ii}$ represent the maximum magnitude of flexural stress in Beams (i) and (ii), respectively. Circle the correct relationship between these two stresses:

a) $\left(|\sigma|_{max}\right)_i > \left(|\sigma|_{max}\right)_{ii}$
b) $\left(|\sigma|_{max}\right)_i = \left(|\sigma|_{max}\right)_{ii}$
c) $\left(|\sigma|_{max}\right)_i < \left(|\sigma|_{max}\right)_{ii}$

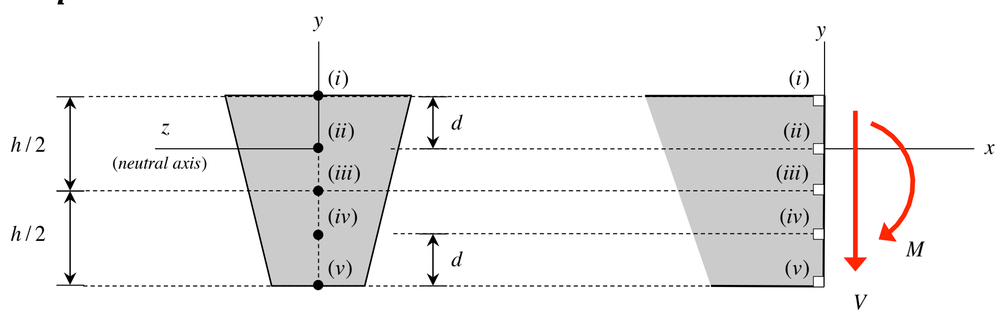
Let $\left(|\tau|_{max}\right)_i$ and $\left(|\tau|_{max}\right)_{ii}$ represent the maximum magnitude of the xy-component of shear stress in Beams (i) and (ii), respectively. Circle the correct relationship between these two stresses:

a) $\left(|\tau|_{max}\right)_i > \left(|\tau|_{max}\right)_{ii}$
b) $\left(|\tau|_{max}\right)_i = \left(|\tau|_{max}\right)_{ii}$
c) $\left(|\tau|_{max}\right)_i < \left(|\tau|_{max}\right)_{ii}$

Let $\left(|\delta|_{max}\right)_i$ and $\left(|\delta|_{max}\right)_{ii}$ represent the maximum magnitude of deflection in Beams (i) and (ii), respectively. Circle the correct relationship between these two deflections:

a) $\left(|\delta|_{max}\right)_i > \left(|\delta|_{max}\right)_{ii}$
b) $\left(|\delta|_{max}\right)_i = \left(|\delta|_{max}\right)_{ii}$
c) $\left(|\delta|_{max}\right)_i < \left(|\delta|_{max}\right)_{ii}$

Conceptual question 10.3



cross section of beam ***SIDE view of beam***

A shear force V and bending moment M act at a cross section of a trapezoidal cross-sectioned beam. Consider the five points (i), (ii), (iii), (iv) and (v) on the beam cross section, as shown above. *Match up the state of stress at each of these five points with the stress elements (a) through (o) shown below.* If you choose "(o) NONE of the above", provide a sketch of the correct state of stress for your answer.

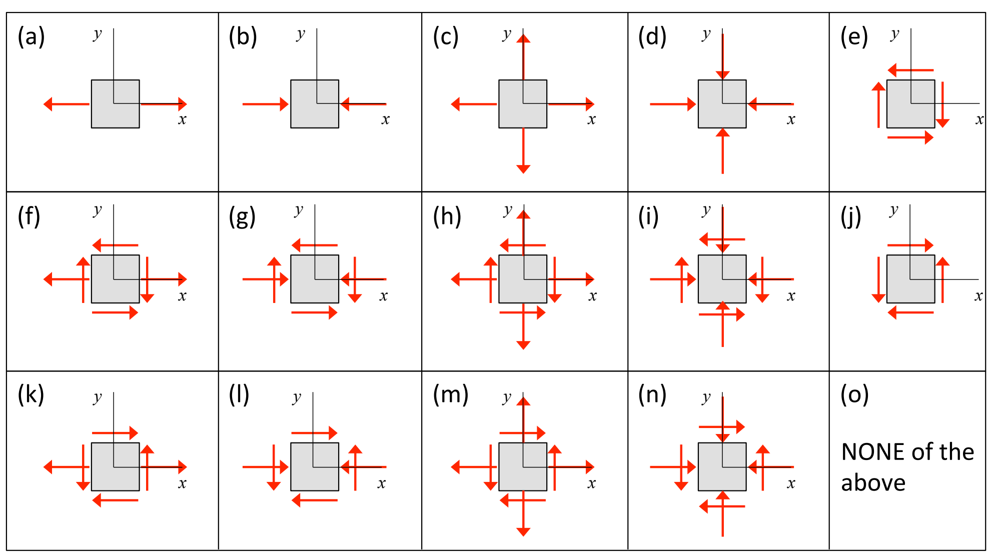
The state of stress at point (i) is_________________

The state of stress at point (ii) is _________________

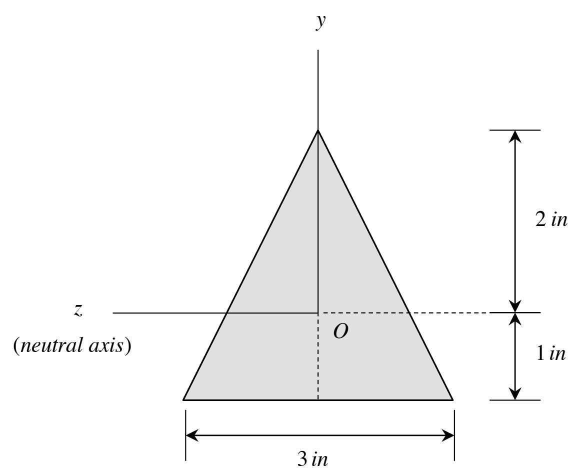
The state of stress at point (iii) is _________________

The state of stress at point (iv) is _________________

The state of stress at point (v) is _________________

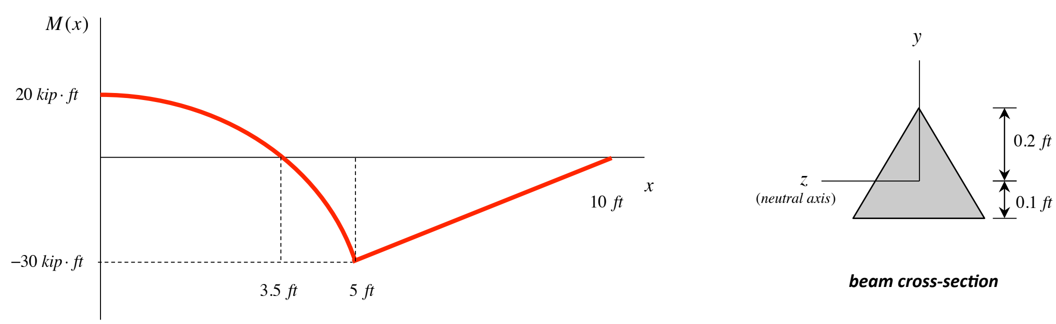


Conceptual question 10.4



At a given location along a beam, it is known that a shear force of $V = 4\ kips$ acts in the y-direction on the beam's triangular cross section. Determine the *shear stress* at O on the cross section of the beam.

Conceptual question 10.5



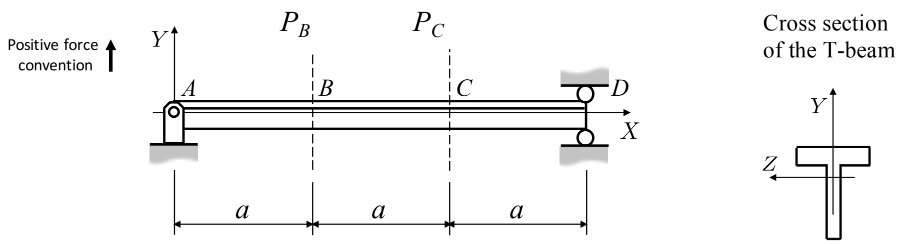
The longitudinal axis of a beam is aligned with the x axis. The beam has a triangular cross-section, as shown above. The loading on the beam produces the bending moment diagram for M(x) shown above.

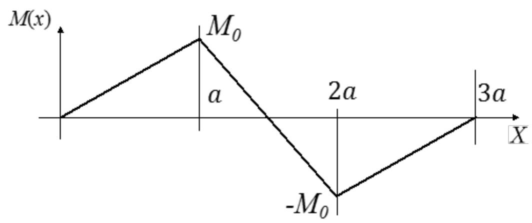
a) Provide the x-y coordinates of the point on the beam that experiences the largest magnitude *compressive* normal stress.

b) Provide the x-y coordinates of the point on the beam that experiences the largest magnitude *tensile* normal stress.

Conceptual question 10.6

A T-beam of length $3a$ is supported at the two ends and loaded by forces P_B and P_C. The line of action of the forces is indicated (dashed lines) but the direction is to be determined. The correct moment diagram is properly shown below.





(a) Indicate the cross section(s) where the maximum *tensile* stress is attained:

(i)	$x = 0$	(iii)	$x = 2a$
(ii)	$x = a$	(iv)	$x = 3a$

(b) Indicate the cross section(s) where the maximum *compressive* stress is attained:

(i)	$x = 0$	(iii)	$x = 2a$
(ii)	$x = a$	(iv)	$x = 3a$

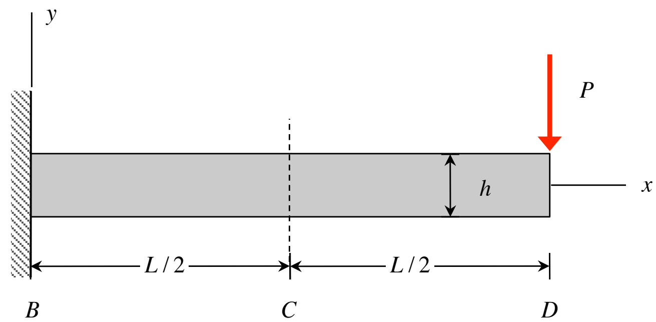
(c) Indicate the value of the reaction at A, that is of A_y:

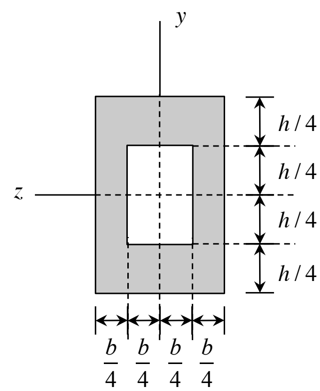
(i)	$A_y = M_0/a$	(iii)	$A_y = 2M_0/a$	(v)	$A_y = 3M_0/a$
(ii)	$A_y = - M_0/a$	(iv)	$A_y = - 2M_0/a$	(vi)	$A_y = - 3M_0/a$

(d) Indicate the value of the load at B, that is of P_B:

(i)	$P_B = M_0/a$	(iii)	$P_B = 2M_0/a$	(v)	$P_B = 3M_0/a$
(ii)	$P_B = - M_0/a$	(iv)	$P_B = - 2M_0/a$	(vi)	$P_B = - 3M_0/a$

Conceptual question 10.7

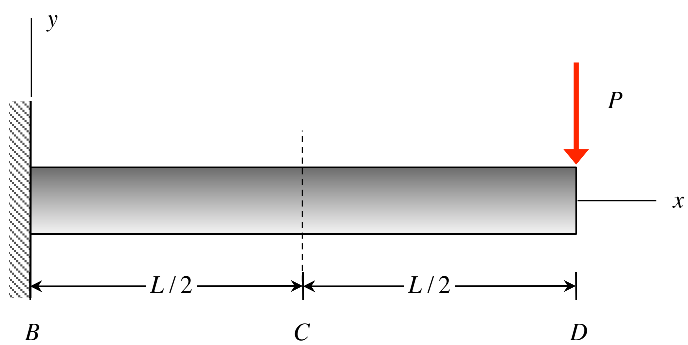


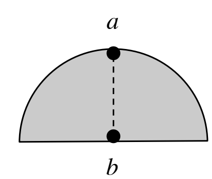


beam cross section at C

Consider the cantilevered beam above with the concentrated load P at end D. Determine the *shear stress* on the neutral surface of the beam at location C along the beam.

Conceptual question 10.8





beam cross section at C

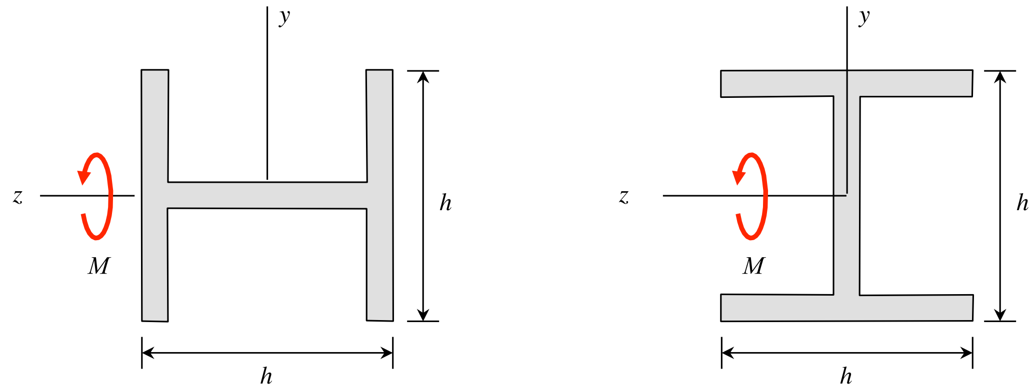
Consider the cantilevered beam above with the concentrated load P at end D. Consider the axial components of stress at points “a” and “b” (σ_a and σ_b, respectively) at location C along the beam. Circle the response below that most accurately describes the relative sizes of the magnitudes of these two stresses:

a) $|\sigma_a| > |\sigma_b|$

b) $|\sigma_a| = |\sigma_b|$

c) $|\sigma_a| < |\sigma_b|$

Conceptual question 10.9



cross section #1 **cross section #2**

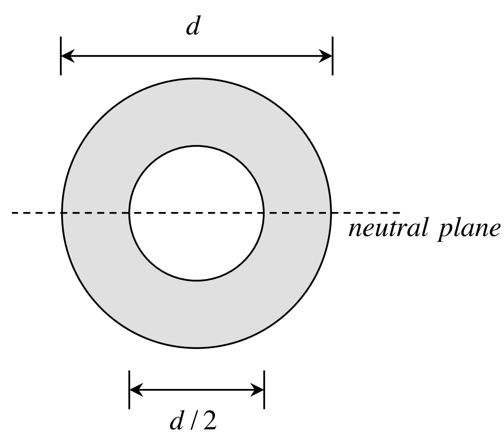
The cross sections of two beams are shown above, where cross section #2 is that of cross section #1 when rotated $90°$ about the x-axis. Both beams experience the same bending moment M at the cross section. Let σ_1 and σ_2 represent the magnitudes of the normal stress acting on cross section #1 and cross section #2, respectively. Circle the answer below that most accurately describes the relative sizes of σ_1 and σ_2:

a) $\sigma_1 < \sigma_2$

b) $\sigma_1 = \sigma_2$

c) $\sigma_1 > \sigma_2$

Conceptual question 10.10



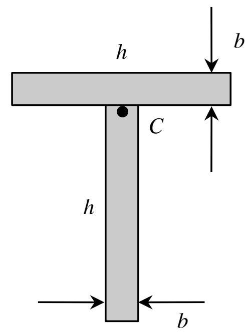
A beam experiences an internal shear force on a cross section having the shape shown above. The following equation is to be used to calculate the shear stress at the neutral plane of the beam:

$$\tau = \frac{VA^*\overline{y}^*}{It}$$

a) What is an algebraic expression for $A^*\overline{y}^*$ of the neutral axis for this cross section?

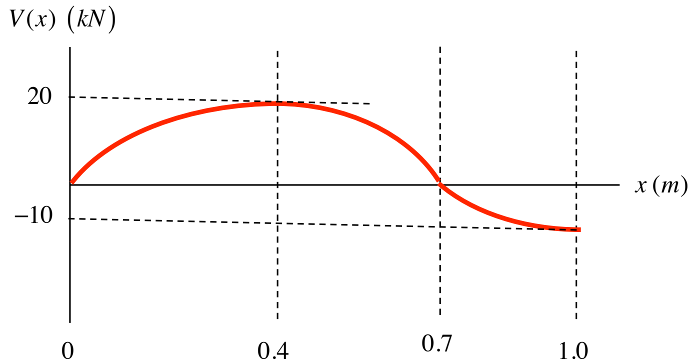
b) What is the algebraic expression for "t" of the neutral axis for this cross section?

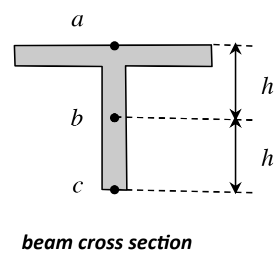
Conceptual question 10.11



Consider a beam with the T-shaped cross section shown above, where a shear force V acts on this face. Consider point C on the cross section that is directly below the horizontal section of the cross section. Determine the shear stress at point C. The second area moment of the cross section is the known quantity of I (*i.e., you do NOT need to compute I*).

Conceptual question 10.12





Consider a beam with a T-shaped cross section along a longitudinal x-axis. The distribution of shear force as a function of x is shown above. It is known that the bending moment in the beam at $x = 0$ is given by $M(0) = 0$.

a) At what location along the x-axis is the largest magnitude *shear stress* in the beam?

b) For the location of maximum shear stress in a) above, which point on the cross section "a", "b" or "c" has the largest magnitude shear stress?

c) At what location along the x-axis is the largest magnitude *normal stress* in the beam?

d) For the location of maximum normal stress in c) above, which point on the cross section "a", "b" or "c" has the largest magnitude normal stress?