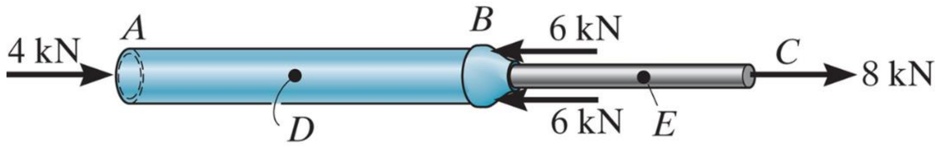
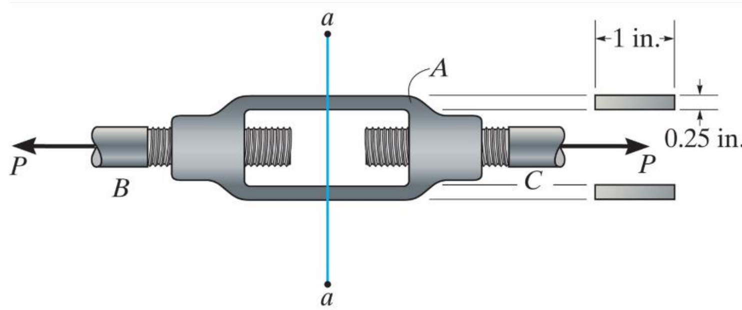
Module 2a Theory

Module 2a Example 1

The built-up shaft consists of a pipe AB and solid rod BC. The pipe has an inner diameter of 20 mm and an outer diameter of 28 mm. The rod has a diameter of 12 mm. Determine the average normal stress at D and E and represent the stress on a volume element located at each of these points.



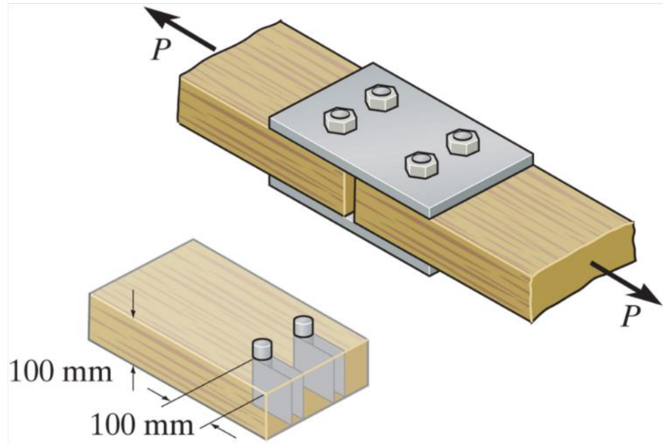
Module 2a Example 2



If the turnbuckle is subjected to an axial force of P=900 lb, determine the average normal stress developed in section a-a and in each bolt shanks at B and C. Each bolt shank has a diameter of 0.5 in.

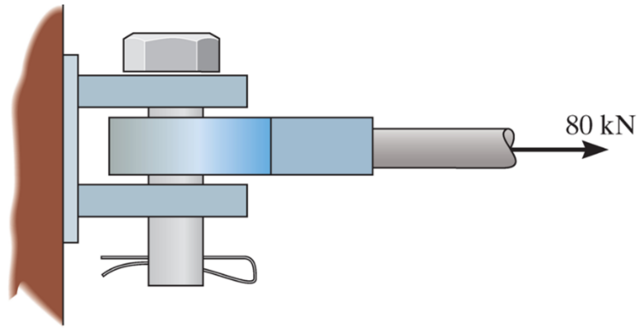
Module 2a Example 3

IF the joint is subjected to an axial force of P=9 kN, determine the average shear stress developed in each of the 6-mm diameter bolts between the plates and the members and along each of the four shaded shear planes.



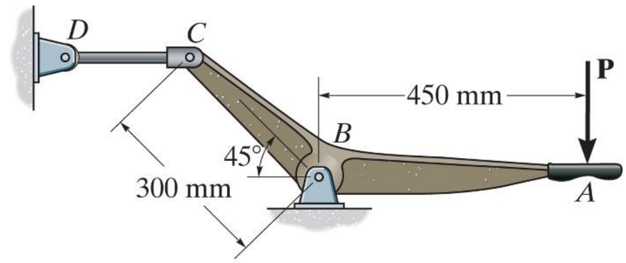
Module 2a Example 4

The pin is made of a material having a failure shear stress of 100 MPa. Determine the minimum required diameter of the pin to the nearest mm. Apply a factor of safety of 2.5 against shear failure.



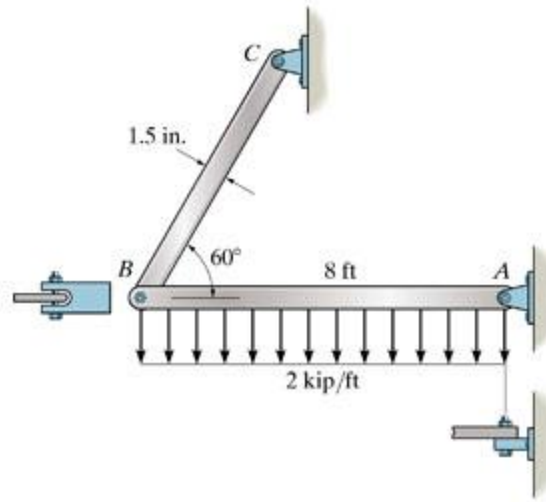
Module 2a Example 5

Determine the maximum vertical force P that can be applied to the bell crank so that the average normal stress developed in the 10 mm diameter rod, CD, and the average shear stress developed in the 6 mm diameter double sheared pin B not exceed 175 MPa and 75 MPa, respectively.



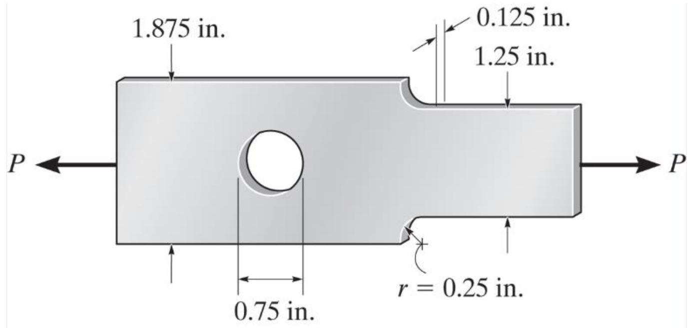
Module 2a Example 6

To the nearest 1/16”, determine the required thickness of member BC and the diameter of the pins at A and B if the allowable normal stress for member BC is σ_{Allow}=29 ksi and the allowable shear stress for the pins is τ_{Allow}=10 ksi.

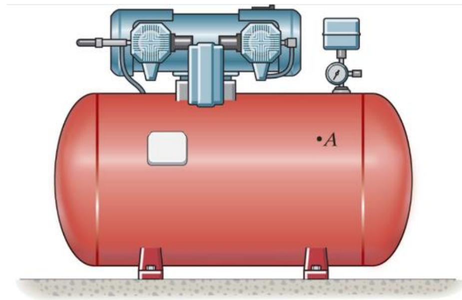


Module 2a Example 7

Determine the maximum normal stress developed in the bar when it is subjected to a tension of P=2 kip.



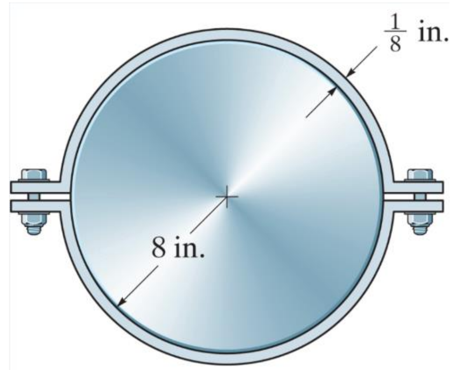
Module 2a Example 8



The tank of the air compressor is subjected to an internal pressure of 90 psi. If the internal diameter of the tank is 22 in, and the wall thickness is 0.25 in, determine the stress components acting at point A. Draw a volume element of the material at this point, and show the results on the element.

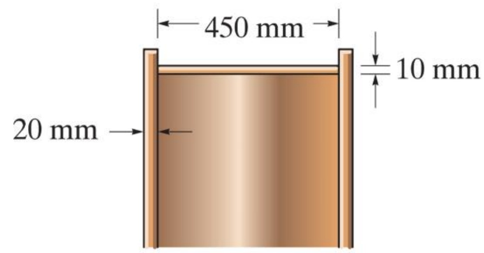
Module 2a Example 9

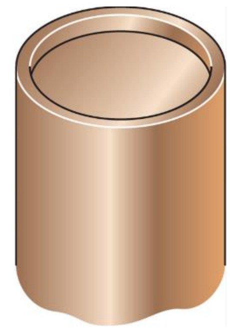
The A-36 steel band is 2 in wide and is secured around the smooth rigid cylinder. If the bolts are tightened so that the tension in them is 400 lb, determine the normal stress in the band, the pressure exerted on the cylinder, and the distance half the band stretches.



Module 2a Example 10

A pressure-vessel head is fabricated by gluing the circular plate to the end of the vessel as shown. If the vessel sustains an internal pressure of 450 kPa, determine the average shear stress in the glue and the state of stress in the wall of the vessel.

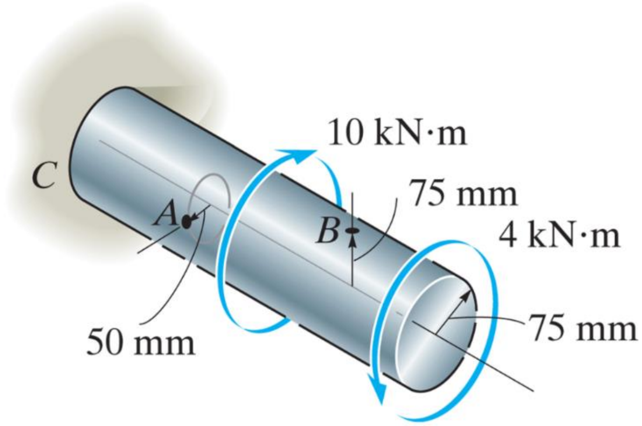




Module 2b Theory

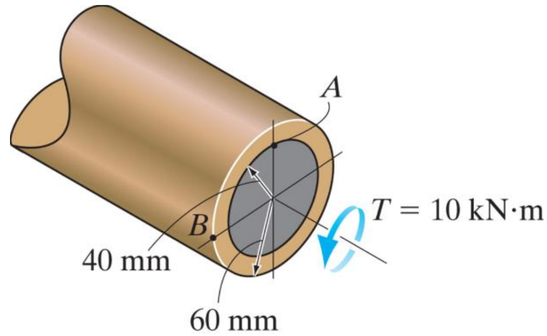
Module 2b Example 1

The solid shaft is fixed to the support at C and subjected to the torsional loadings shown. Determine the shear stress at points A and B and sketch the shear stress on the volume elements located at these points.



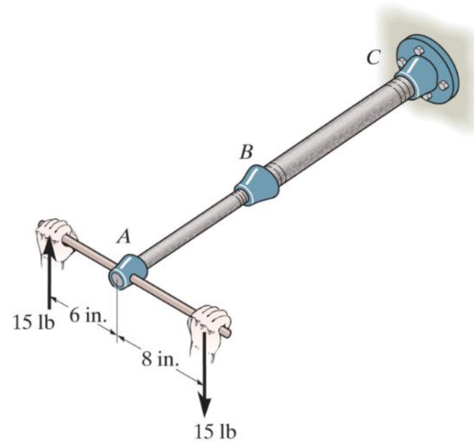
Module 2b Example 2

The hollow circular shaft is subjected to an internal torque of T=10 kNm. Determine the shear stress developed at points A and B. Represent each state of stress on a volume element.



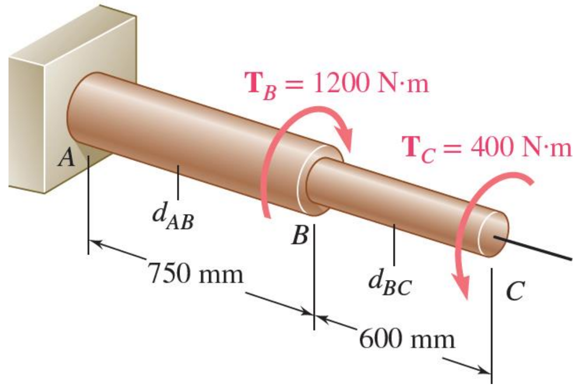
Module 2b Example 3

The assembly consists of two sections of galvanized steel pipe connected together using a reducing coupling at B. The smaller pipe has an outer diameter of 0.75 in and an inner diameter of 0.68 in, whereas the larger pipe has an outer diameter of 1 in and an inner diameter of 0.86 in. If the pipe is tightly secured into the wall at C, determine the maximum shear stress developed in each section of the pipe when the couple shown is applied to the handles of the wrench.



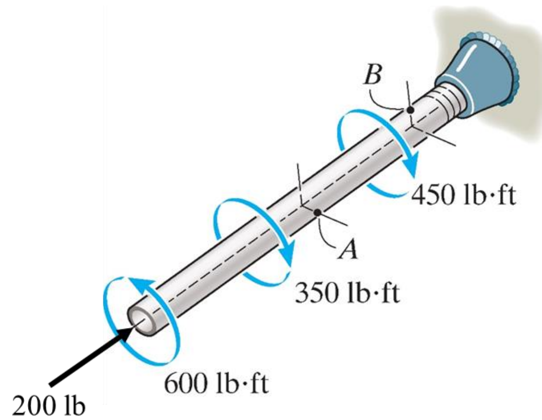
Module 2b Example 4

The solid shaft shown is formed of a brass for which the allowable shearing stress is 55 MPa. Neglecting the effect of stress concentrations, determine the smallest diameters d_{AB} and d_{BC} for which the allowable shearing stress is not exceeded.



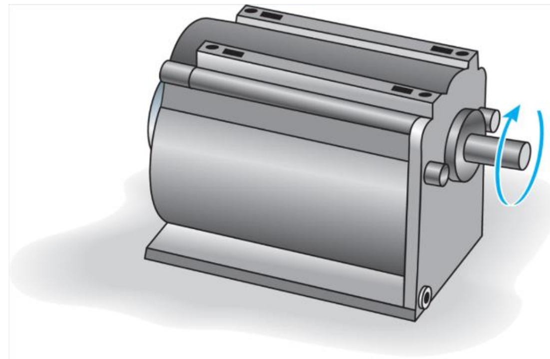
Module 2b Example 5

The copper pipe has an outer diameter of 2.50 in and a wall thickness of 0.1 in. If it is tightly secured to the wall and three torques and one compressive force are applied to it, determine the stress developed at points A and B. These points lie on the pipe's outer surface. Sketch the stress on a volume element for each point.



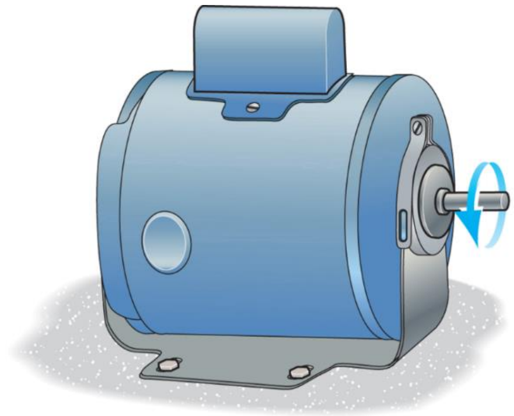
Module 2b Example 6

The gear motor can develop 3 hp when it turns at 150 rev/min. If the allowable shear stress for the shaft is τ_{allow}=12 ksi, determine the smallest diameter of the shaft to the nearest 1/8 in that can be used.

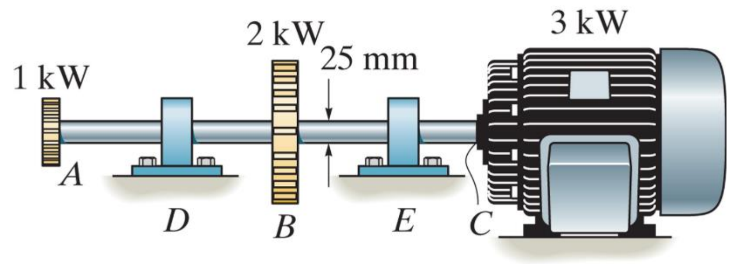


Module 2b Example 7

The 25 mm diameter shaft on the motor is made of a material having an allowable shear stress of τ_{allow}=75 MPa. If the motor is operating at its maximum power of 5 kW, determine the minimum allowable rotation of the shaft.



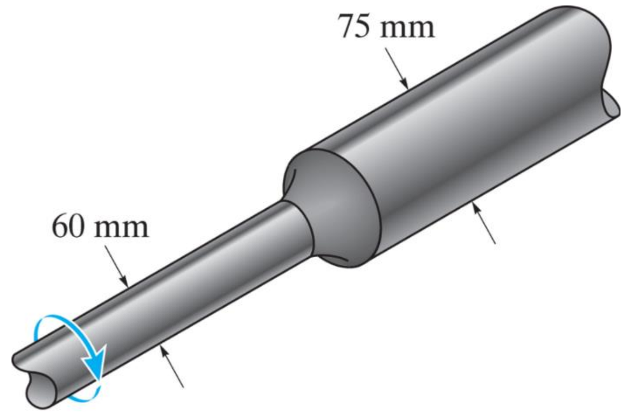
Module 2b Example 8



The solid steel shaft AC has a diameter of 25 mm and is supported by smooth bearings at D and E. It is coupled to a motor at C, which delivers 3 kW of power to the shaft while it is turning at 50 rev/s. If gears A and B remove 1 kW and 2 kW, respectively, determine the maximum shear stress developed in the shaft within regions AB and BC. The shaft is free to turn in its support bearing D and E.

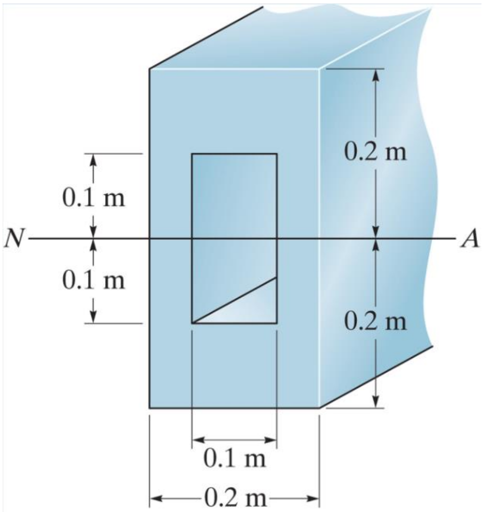
Module 2b Example 9

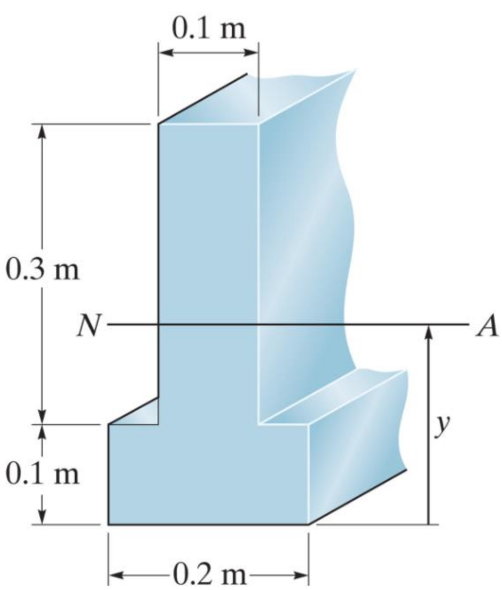
The step shaft is to be designed to rotate at 720 rpm while transmitting 30 kW of power. Is this possible? The allowable shear stress is τ_{allow}=12 MPa and the radius at the transition on the shaft is 7.5 mm.



Module 2c Moment of Inertia 1 & 2

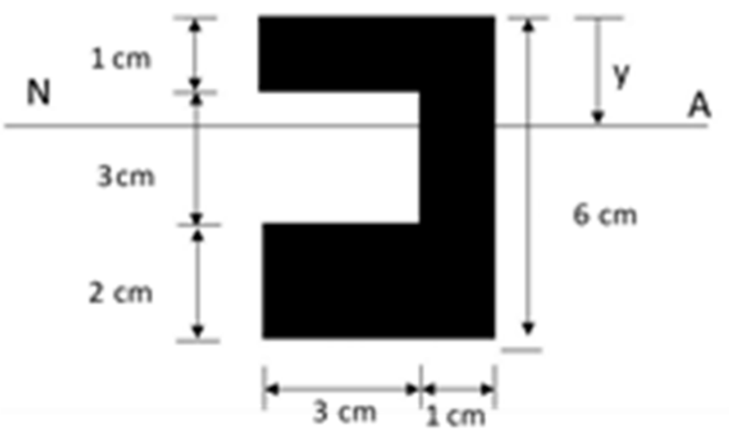
Determine the centroid and moment of inertia of the following cross-sections about the designated neutral axis.





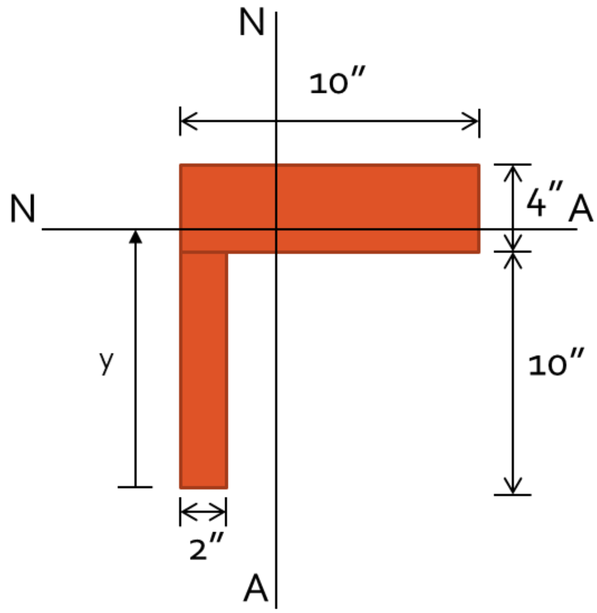
Module 2c Moment of Inertia 3

Determine the centroid and moment of inertia of the following cross-sections about the designated neutral axis.



Module 2c Moment of Inertia 4

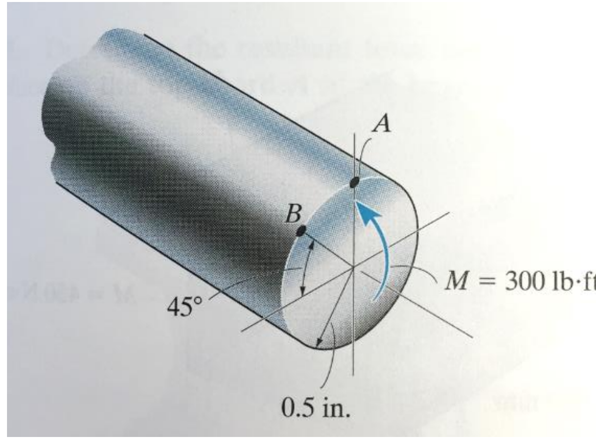
Determine the centroid and moment of inertia of the following cross-sections about the designated neutral axis.



Module 2c Theory

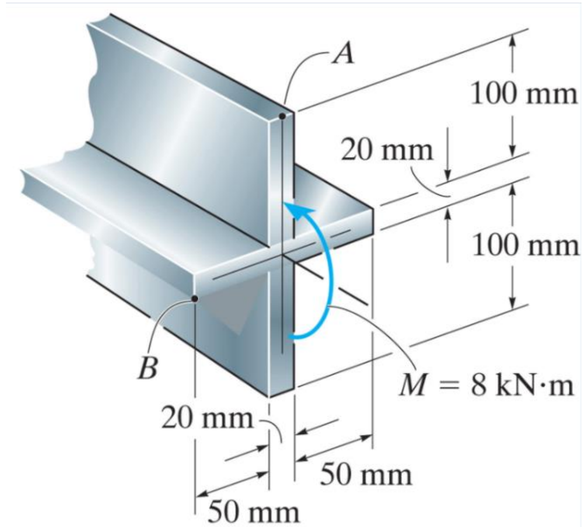
Module 2c Example 1

The steel rod having a diameter of 1 in is subjected to an internal moment of M=300 lb-ft. Determine the stress created at points A and B. Also, sketch a 3-D view of the stress distribution acting over the cross section.



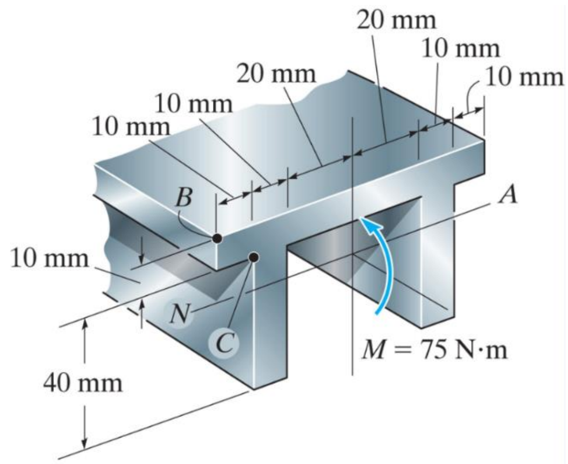
Module 2c Example 2

The aluminum strut has a cross-sectional area in the form of a cross. If it is subjected to the moment M = 8 kNm, determine the bending stress acting at points A and B, and show the results acting on volume elements located at these points.



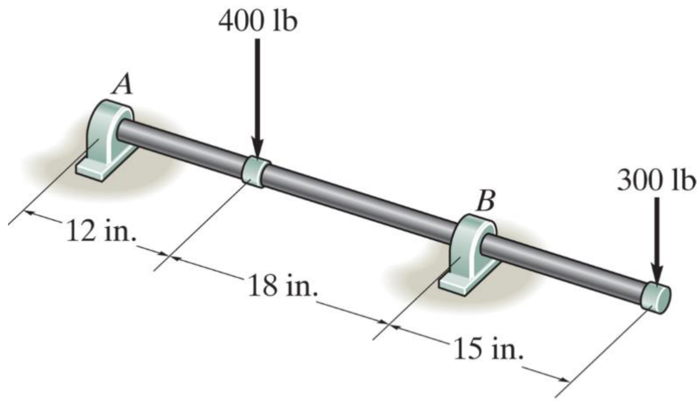
Module 2c Example 3

The aluminum machine part is subjected to a moment of M = 75 Nm. Determine the maximum tensile and compressive bending stresses in the part.



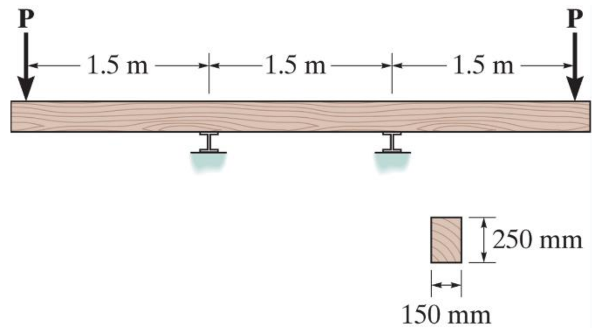
Module 2c Example 4

Determine the smallest allowable diameter of the shaft which is subjected to the concentrated forces. The sleeve bearings at A and B support only vertical forces, and the allowable bending stress is σ_{allow}=22 ksi.



Module 2c Example 5

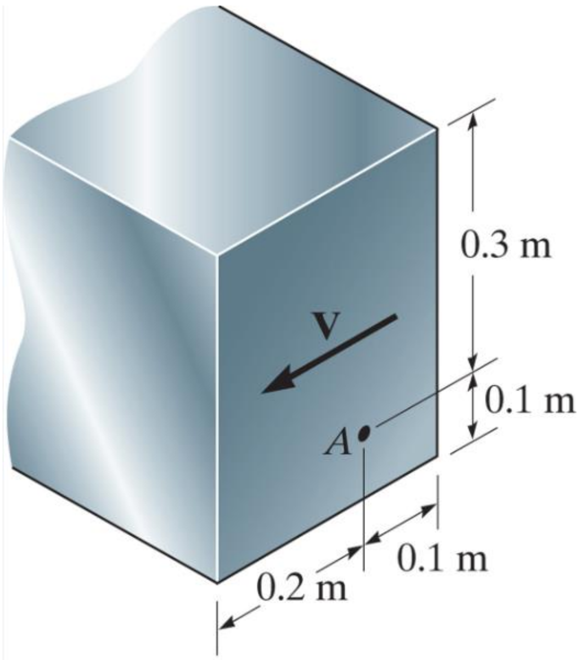
The beam has a rectangular cross section as shown. Determine the largest load P that can be supported on its overhanging ends so that the bending stress does not exceed σ_{max}=10 MPa.

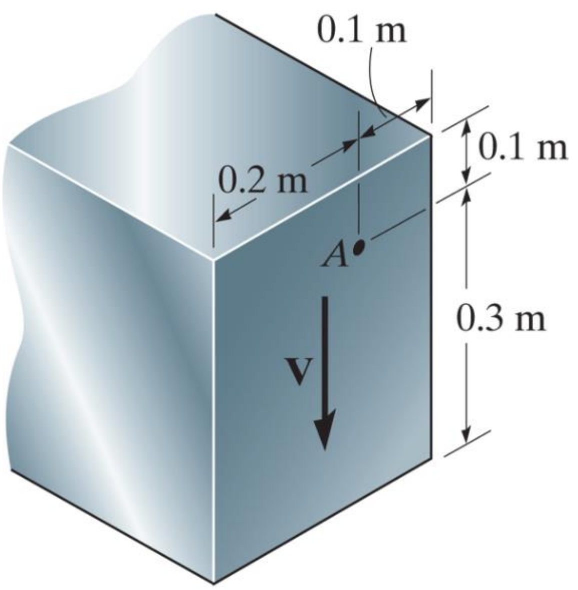


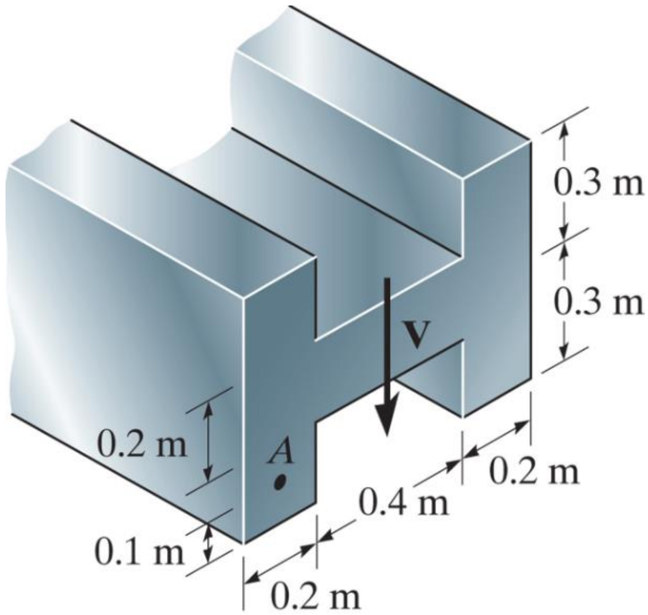
Module 2d Theory

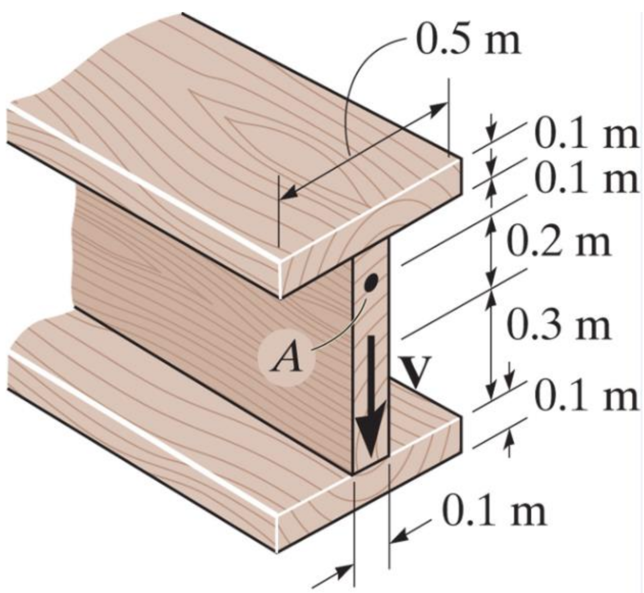
Module 2d Solving for I, Q, and t

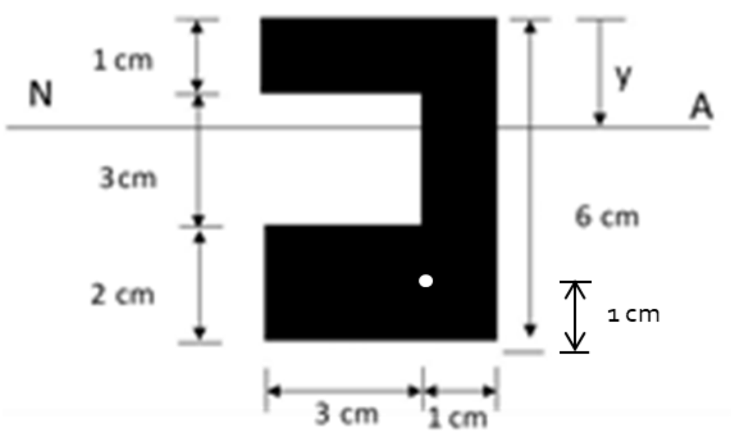
Calculate the value of I, Q and t that are used in the shear formula for finding the shear stress at point A.

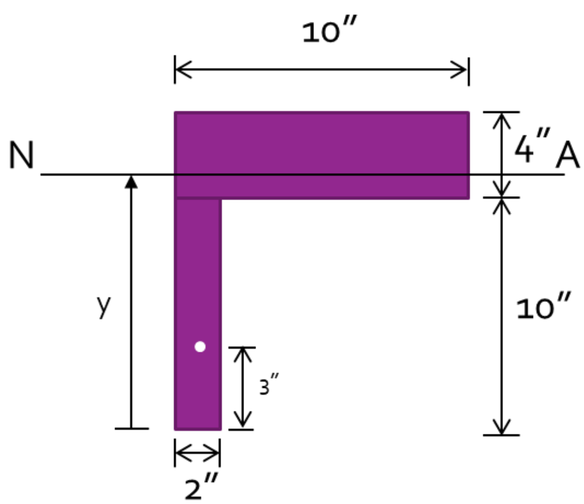





0.3 m
0.3 m
V
0.2 m
A
0.2 m
0.4 m
0.1 m
0.2 m

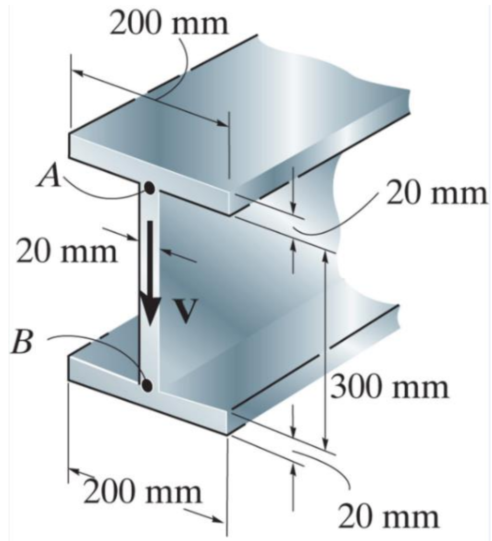

0.5 m
0.1 m
0.1 m
0.2 m
0.3 m
A
V
0.1 m
0.1 m


1 cm
N
3cm
2 cm
y
A
6 cm
1 cm
3 cm
1 cm


10″
N
4″
A
y
10″
3″
2″

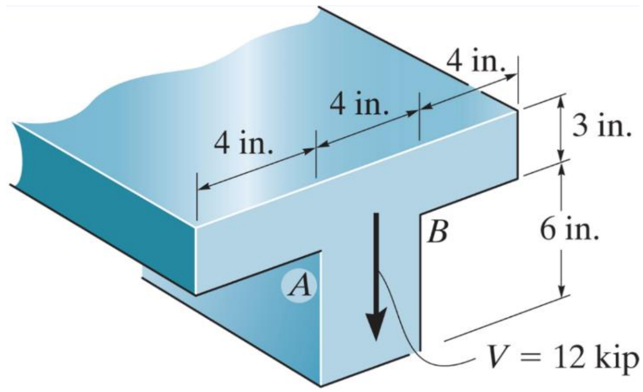
Module 2d Example 1

If the wide-flange beam is subjected to a shear of V=20 kN, determine the shear stress on the web at A. Indicate the shear-stress components on a volume element located at this point.



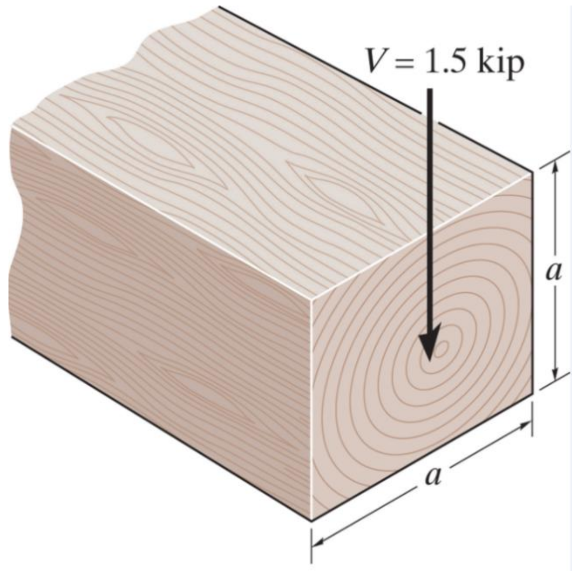
Module 2d Example 2

If the T-beam is subjected to a vertical shear of V = 12 kip, determine the maximum shear stress in the beam. Also, compute the shear-stress jump at the flange-web junction AB. Sketch the variation of the shear-stress intensity over the entire cross section.



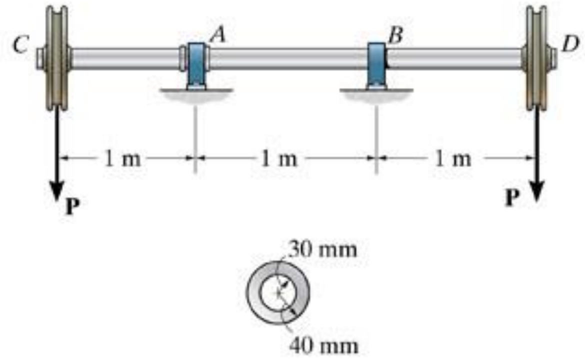
Module 2d Example 3

The beam has a square cross-section and is made of wood having an allowable shear stress of 1.4 ksi. If it is subjected to a shear force of 1.5 kip, determine the smallest dimension a of its sides.



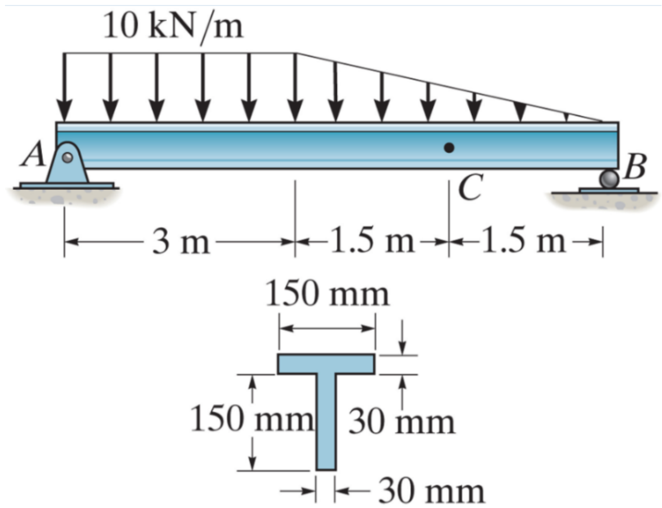
Module 2d Example 4

The shaft is supported by a smooth thrust bearing at A and a smooth journal bearing at B. If P=26 kN, determine the absolute maximum shear and normal stress in the shaft.



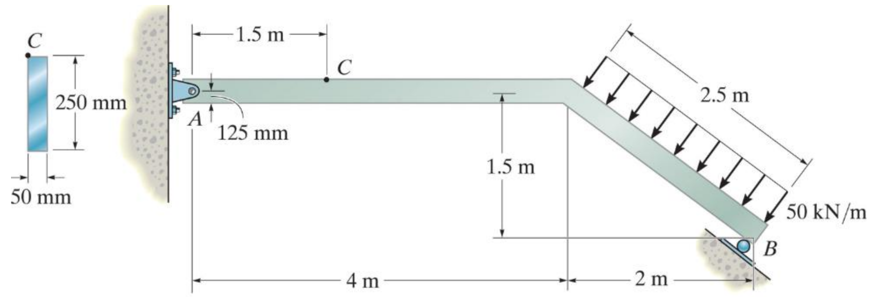
Module 2d Example 5

Determine the maximum shear stress and normal stress in the T-beam at the critical section where the internal shear force is maximum and the internal bending moment is maximum.



Module 2d Example 6

The member shown has a rectangular cross section. Determine the state of stress that the loading produces at C and D.

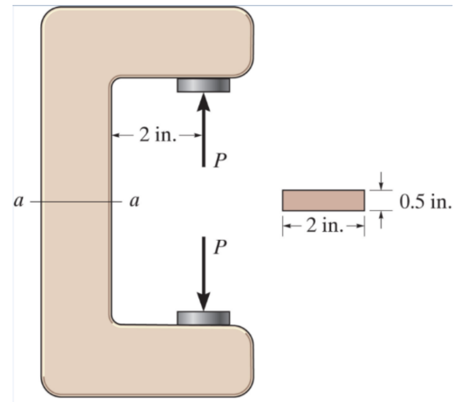


(a)

Module 2e Theory

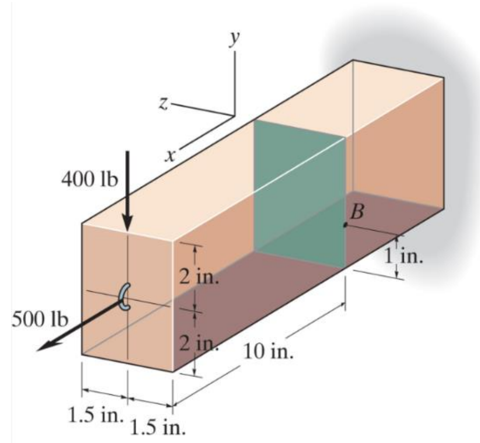
Example 1

Determine the magnitude of the load P that will cause a maximum normal stress of 30 ksi in the link along section a-a.



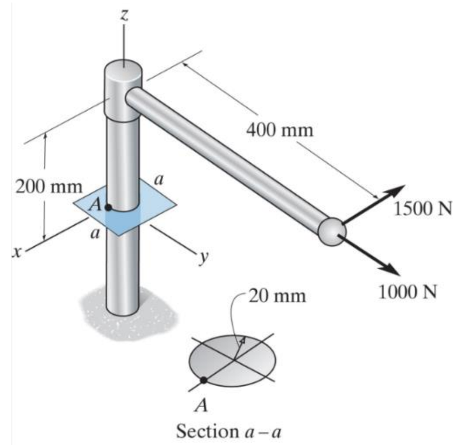
Example 2

The beam has a rectangular cross section and is subjected to the loading shown. Determine the state of stress at point B. Show the results in a differential element at the point.



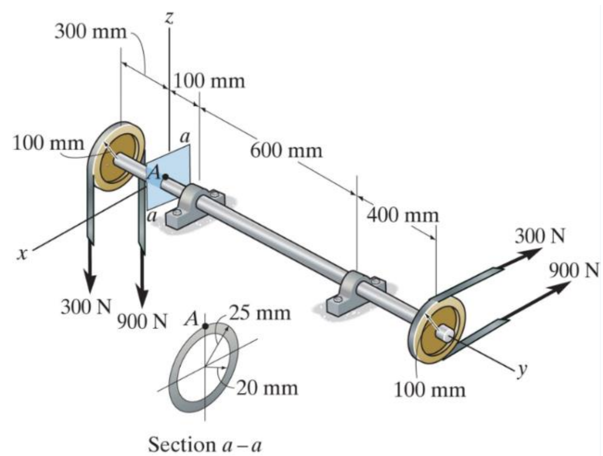
Example 3

Determine the state of stress at point A on the cross section of the pipe assembly at section a-a. Show the results in a differential element at the point.



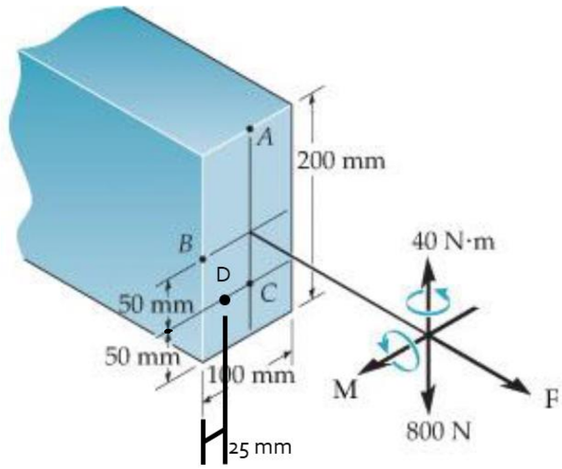
Example 4

Determine the state of stress at point A on the cross section of the shaft at section a-a. Show the results in a differential element at the point.



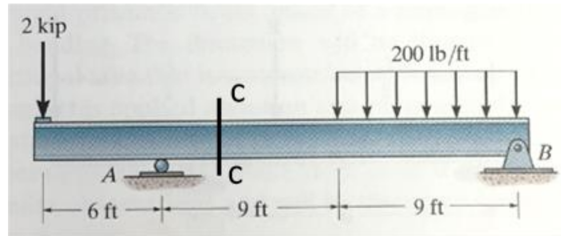
Example 5

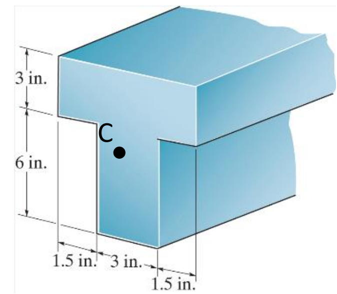
Determine the state of stress at point D on the cross-section shown. The internal loads are shown in the diagram. M is 30 Nm and F is 500 N.



Example 6

Determine the state of stress at point C of the cross-section at section c-c. Section c-c is 3 ft from point A and point C is 2 in from the bottom of the cross section. Sketch the results on a volume element.





Example 7

Several forces are applied to the pipe assembly. Knowing that each section of pipe has inner and outer diameters equal to 36 and 42 mm, respectively, determine the normal and shear stresses at point H located at the top of the outer surface of the pipe.