FINAL EXAM

1) (25 POINTS)

Consider the wooden beam spanning 16 feet illustrated in Figure 1. The beam is loaded by a uniformly distributed load of 250 lbs/ft, as well as a point load of 1,000 lbs at midspan. The beam has a rectangular cross-section 12" high and 6" wide. You may assume that the self-weight of the beam is included in the uniform loading.

a) What are the support reactions at points A and B due to the applied load? (4 pts)

b) Draw the shear diagram due to the applied load. (4 pts)

c) Draw the moment diagram due to the applied load and clearly label the location and magnitude of maximum moment. (4 pts)

d) Given the cross-sectional dimensions of 6" x 12", what is the moment of inertia of the rectangular section which resists the applied loading? (3 pts)

e) What is the maximum bending stress in the beam due to the applied load? (4 pts)

f) Suggest one way to reduce the material use for this beam by modifying the cross-section. Also suggest one way to reduce the material use by modifying the longitudinal profile (side elevation). Illustrate each conceptual suggestion with a simple sketch (no dimensions required). (6 pts)

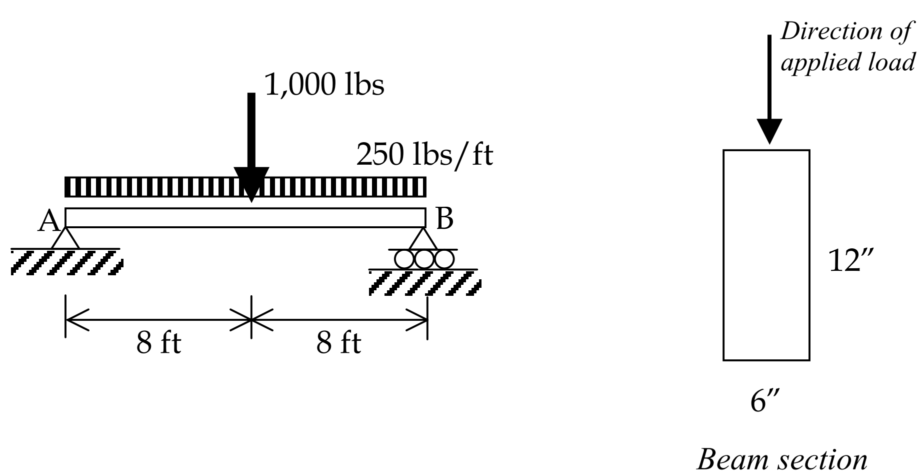


Figure 1.

2) (25 POINTS)

The truss illustrated in Figure 2 spans 36 feet between points A and B. Make the usual assumptions for truss analysis and neglect the self-weight of the truss.

a) What are the support reactions at A and B due to the two vertical loads? (4 pts)

b) Using either graphical or numerical methods, calculate the internal forces in all members of the truss. For graphical solutions, label the problem clearly with Bow's notation. Present your solution as a sketch showing the internal bar forces. Label each force as tension or compression. (12 pts)

c) If the horizontal top chord of the truss is composed of one 8" x 8" hollow square steel box section with a constant wall thickness of ¼", what is the axial stress in this element due to the applied load? (3 pts)

d) By how much does the top chord change in length due to the applied load? (3 pts)

e) Explain the value of axial force in the diagonal member in the center panel for this particular loading. (3 pts)

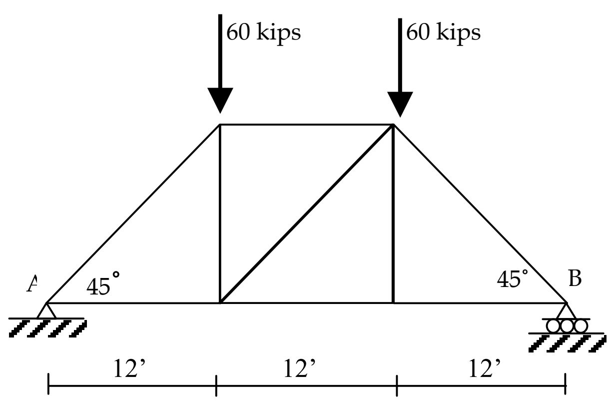
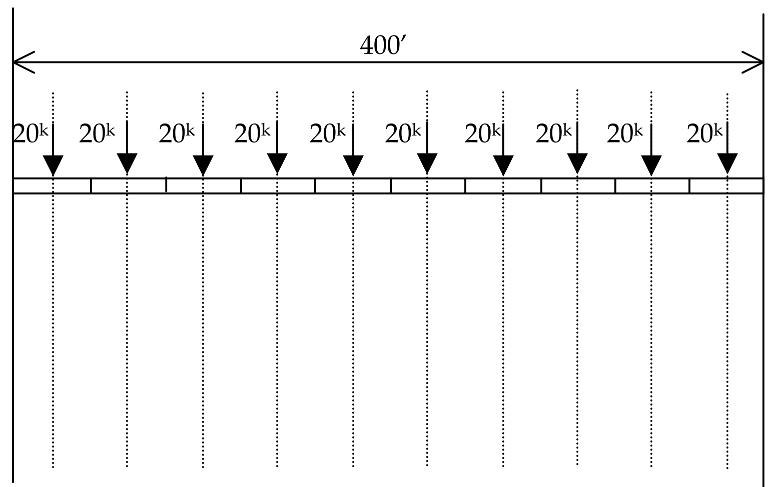


Figure 2.

3) (25 pts) A hanging cable supports a uniform load of 200 kips over a span of 400 feet. This load is divided into 10 point loads of 20 kips each which act on the cable at 20-foot intervals. (Note: the first load acts at a "half" interval, 10 feet from the cable support.) Label the problem using Bow's notation and construct the load line. Use a graphical construction to find the form of the cable such that its maximum axial force is 230 kips under the total load of 200 kips. If the cable is made from a solid steel section with an allowable stress of 80 ksi, calculate the required diameter of the cable.

<u>Scoring</u>
Notation and load line (8 pts)
Pole location (6 pts)
Funicular polygon (6 pts)
Cable area (5 pts)



4) Heat Transfer (25 pts)

An exterior wall is 10 ft high x 25 ft long. It is constructed of R-30 prefabricated wall panels. This is the total thermal resistance of the wall excluding air films. Below is a table of material properties.

a) Find the R-value of the wall including interior and exterior air film resistances. (5 pts)

b) Two (2) windows are now cut into the wall. Each is 3 feet wide by 5 feet high. Find the equivalent R-value, R_{eq}, of the wall and window, combined. Units should be (h ^oF ft^2)/Btu. (5pts)

c) Conductive heat transfer (Btu/h) is given by this equation:$Q=UA\Delta T$. Given the inside temperature T_{in}=68 ^oF and T_{out}=38 ^oF, what is the conductive heat flow through the walls and windows (combined)? (4 pts)

d) Given the incident solar radiation, I_{sol}, and the transmissivity of the windows, τ_{glass}, equal to 0.80, what is the solar gain through the window in Btu/h? (5 pts)

e) Suggest two strategies to bring the space behind the wall into equilibrium. (6 pts)

Material	R-Value		Material	R-Value
Wall panels	30 (h ^oF ft^2)/(Btu)		Inside air film	0.68 (h ^oF ft^2)/(Btu)
I_{sol}	350 Btu/(h ft^2)		Outside air film	0.17 (h ^oF ft^2)/(Btu)
			Window	2.0 (h ^oF ft^2)/(Btu)

Note:
$U=1/R$
$Q_{conduction}=UA\Delta T$