Class Exercise #25 1.050 Solid Mechanics
Fall 2004

Here are 6 problems of the same type, drawn from past years' final exams.

i) What do they have in common? What's different?

ii) What must you know in order to do the common part of the problem?

iii) Which is the most difficult problem? Why? Which is the easiest?

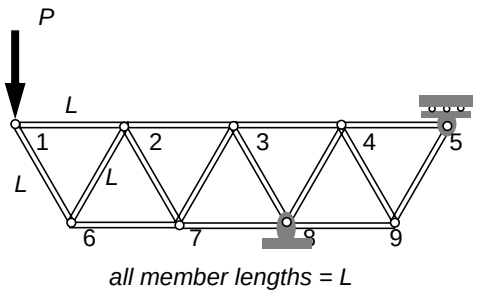
iv) Formualte a new problem - a variation on the common theme - that I might assign on this year's final.

98 - Problem 2.

Truss structure carries a load P at node #1.

Find the force in member 5-9.

Which member is liable to buckle if the load P is increased without limit.



all member lengths = L

99 - Problem 1

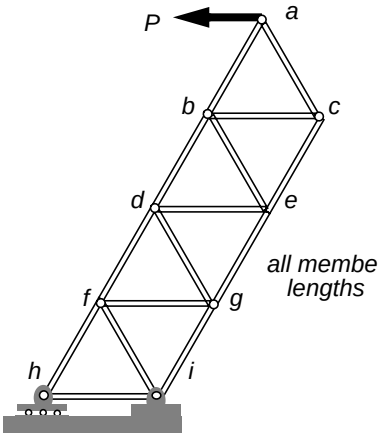
Truss structure carries a load P at node ***a***.

Find the force in members ***fh, fi***, and ***gi*** in terms of ***P***.

Find the reactions at nodes ***h*** and ***i.***

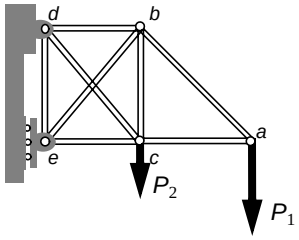
Which member is liable to buckle if the load P is increased without limit.

Note: all members have the same length.



00 - Problem 1

For each of the three problems 1a, 1b, and 1c, state whether the problem posed is statically *determinate* or statically *indeterminate.* In this, assume all information regarding the geometry of the structure is given as well as values for the applied loads.



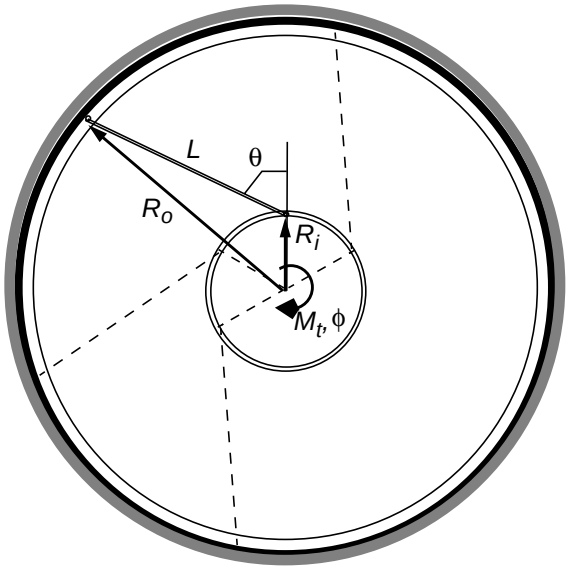
1a) Determine the force in member *ab*.

1b) Determine the force in member *bd*

1c) Determine the reactions at the wall.

01- Problem 3

A rigid ring of Radius R_o is fixed to ground as indicated by the shading. An inner, rigid ring of radius R_i is free to rotate clockwise or counterclockwise about an axis through its center and perpendicular to the plane of the paper when subject to a torque M_t.



The inner ring is connected to the outer ring by means of "*n*" steel spokes. (Only four of the *n* spokes are shown but the *n* are symmetrically disposed about the axis of rotation. Think of a bicycle wheel).

The inner ring, when subject to a torque M_t experiences a small rotation, ϕ, which is much less than 1.0 (radian).

The spoke is made of steel with Elastic modulus

E = 200 E09 Pascals and shows a yield stress σ_y = 400 E06 Pascals.

i) Express the extension of a spoke, call it δ, in terms of R_i, ϕ, and θ where θ is the angle between the extension of the radius R_i and the spoke.

ii) Derive an expression for the rotational stiffness of the system, i.e., K_T in the equation

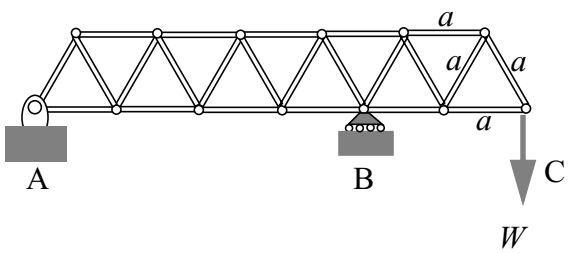
$$M_T = K_T \phi,$$

in terms of *n*, the number of spokes, $k = AE/L$, the uni-axial stiffness of the spoke, and the geometric parameters R_i and θ.

iii) Express the ratio of the torque required for buckling of the spoke to the torque required for yielding of the spoke in terms of the ratio *(r/L)* where *r* is the radius of the spoke and *L* its length.

iv) If L = 0.5m, will the spoke buckle or yield? (Again, think bicycle wheel).

02 - Problem 2.

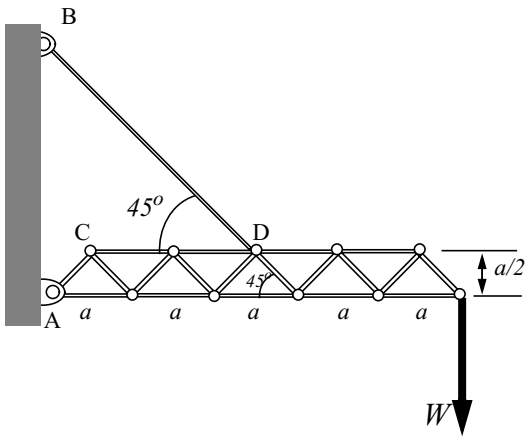


A planar truss carries a concentrated load at one end as shown. All members have length *a,* as indicated.

Which member experiences the greatest tensile force and what is its magnitude in terms of *W*?

Which member is likely to buckle first?

03-Problem 2.



A planar truss carries a concentrated load at one end as shown. All horizontal members have length *a* and the diagonal members are all inclined at 45 degrees*,* as indicated.

Find the force in the cable, *BD*, as a function of *W*.

Find the forces carried by the two members joined at node *A*, again in terms of *W*?