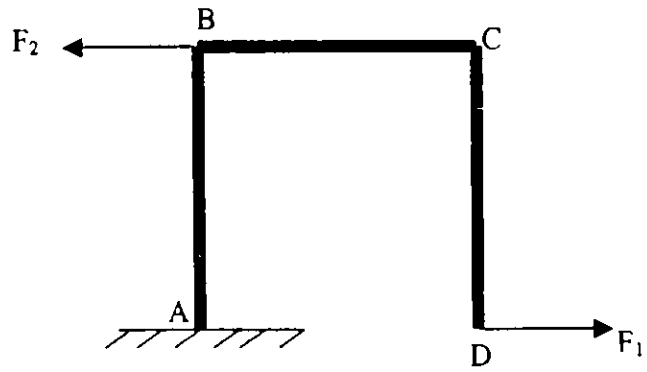
UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING
MIE320S -- Mechanics of Solids II
FINAL EXAMINATION, April 2001
Examiner: Professor J.K. Spelt

Aids permitted: Course text, handwritten class notes, distributed solutions and distributed data sheets.
NO OTHER MATERIALS ARE PERMITTED ON YOUR DESK
Any calculator may be used, but its memory must not contain information related to the course. Answer all 4 questions. Marks are shown in [ ].

Question #1 [12]

A machine component is modeled as the U-shaped frame shown below, acted on by forces F_1 and F_2. All 3 sections of the frame have the same EI and length, L.

Find an expression for the horizontal deflection of the free end D.



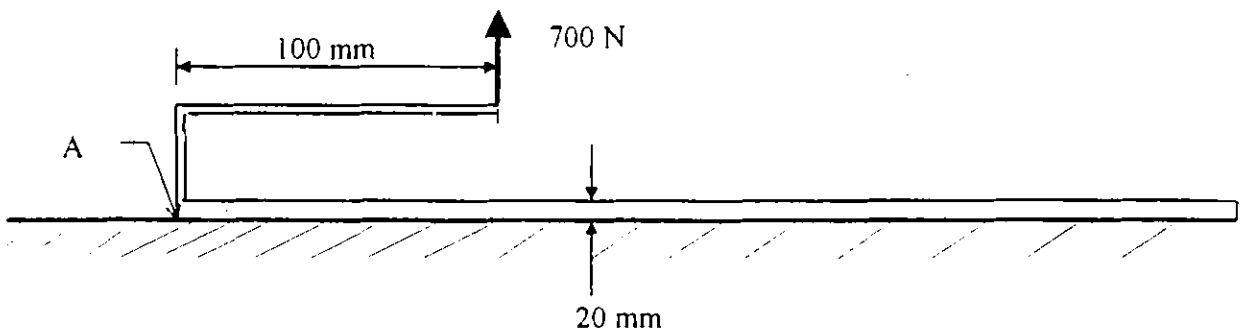
Question #2 [12]

A bracket is modeled as a beam on an elastic foundation (shown below). The beam has a rectangular cross-section (20 mm deep x 15 mm wide) and rests on a hard rubber pad with a foundation spring constant of 0.2 GPa. The beam is made of brass (E=82.7 GPa) and is welded at the end to a thin, stiff L-shaped bracket so that a concentrated load P=700 N can be applied at the location shown.

a) Estimate the vertical deflection at the lower left corner of the beam (A).

b) How far from the left end will the vertical deflection be zero?

c) What is the vertical deflection at A is the direction of P is reversed; i.e. P points downward.



Question #3 [12]

The horizontal platform shown below is pinned at each end and is supported by a thick walled aluminum pipe. The supporting pipe is also pinned at each end, and furthermore it is pinned in the middle by a perpendicular brace (all pins are parallel to z axis). This brace prevents the pipe from deflecting in the y direction but cannot prevent the pipe from moving out of the x-y plane.

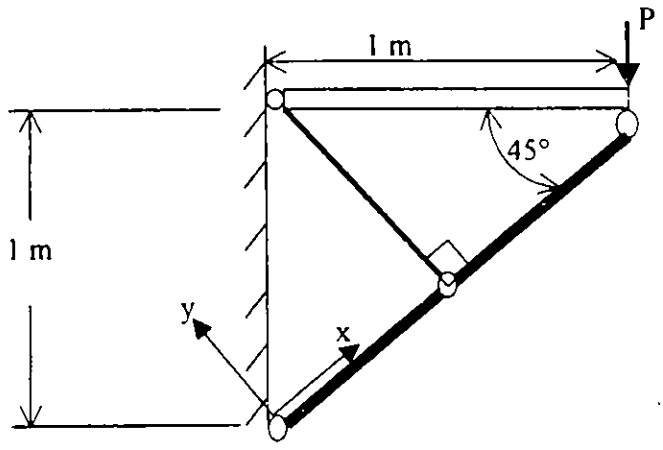
Find the maximum load, P, that can be carried at the end of the platform before the aluminum pipe yields or buckles in either the x-y plane or the x-z plane.

Note that the pins on either end of the aluminum pipe prevent rotation about the y axis but allow rotation about the z axis.

Pipe properties:

E=70 GPa σ_{yield} = 260 MPa

Outer diameter = 4 cm Inner diameter = 2 cm



Question #4 [12]

A relatively long slender cantilever beam is 30 in. long and has a constant flexural rigidity $EI=1x10^7$ psi. When the beam is loaded at the midpoint by a load p=100 lb, it deflects at the end 0.02 in. before it begins to contact a spring with a stiffness $k=1x10^4$ lb/in. Use superposition to solve the following.

a) Find an expression for the deflection of the endpoint of a cantilever beam of length L that is loaded at its midpoint by a load P (i.e. the situation shown below but without a spring present).

b) At equilibrium, what is the force carried by the spring in the arrangement shown below?