Problem 1 (30)

A rigid beam, pinned at its left end, is supported at its right end by two cables. The stiffness of the two cables in tension, both of length $L$, are the same, namely, $k$, $<$force/length$>$

The bottom cable is pre-loaded during assembly of the structure. Initially, before the weight $W$ is applied, it carries a tension $P_0$.

i) Letting $K$ be the stiffness in the vertical direction at D, i.e.,

$$W = K \Delta$$

express $K$ in terms of the stiffness of the cables alone (the little $k$) and the geometric properties of the structure.

ii) At what value of the load will the bottom cable go slack? What is the stiffness $K$ as you increase the load further?

Problem 2 (30)

A beam is supported by frictionless pins at its ends and at mid-span by a linear spring of stiffness $k$. It carries a concentrated load as shown. The bending stiffness is the usual $EI$.

i) Write out the equations of equilibrium, intending to determine the reactions at the ends of the beam and the force in the spring. Can you solve for these in terms of $P$ and $L$? If not, say why not, and go on to part ii).

ii) Write out a relevant compatibility of deformation condition involving the displacement at mid span.

iii) Write out two force/deformation relations that involve the displacement at midspan.

iv) Describe in words alone how you would proceed from this point on to determine the maximum bending moment and where it acts along the span.

Problem 3 (15)

Three strain gages are mounted in the directions shown on the surface of a thin plate. The values of the extensional strain each measures is also shown in the figure.

2a) Determine the shear strain component $\gamma_{xy}$ at the point with respect to the $xy$ axes shown.

2b) What orientation of axes gives extreme values for the extensional strain components at the point.

2c) What are these values.

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1. One of these 5 problems will be on the final exam.
**Problem 4 (20)**

A uniform beam is pinned at one end and supported by a roller at some distance $a$ from this end. The beam carries a load $W$, at its end.

i) Determine the reactions at the pin supports.

ii) Draw a shear force and bending moment diagram and determine where the bending moment is a maximum (in magnitude).

**Problem 5 (30)**

A thin cylindrical shell, $(t/R << 1)$ is closed at both ends and subject to an internal pressure $p_o$.

i) What is the state of stress at the point shown (enlarged many times)?

ii) A moment or torque is applied such that the shear stress is equal to the “hoop stress”. Determine the maximum normal stress at the point at the orientation of the plane upon which it acts.