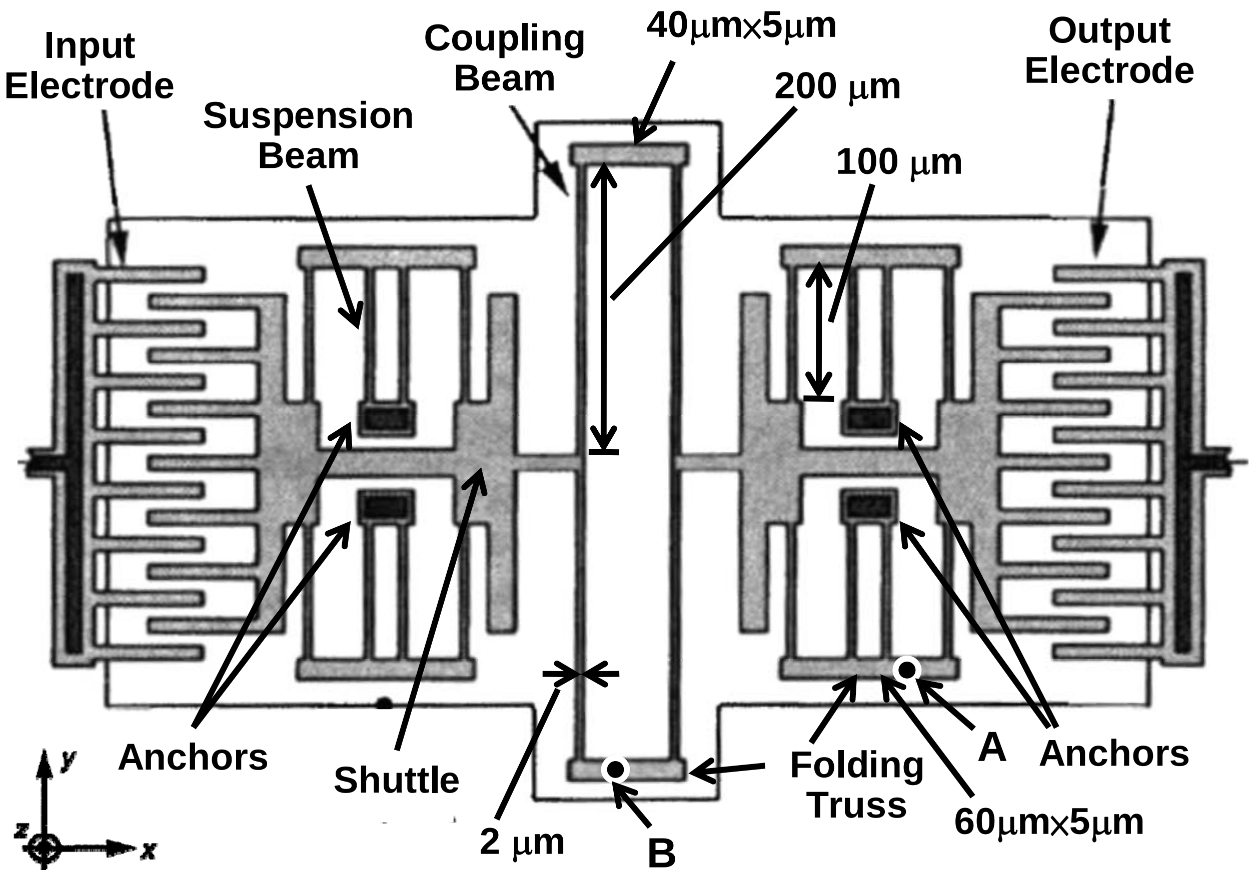
PROBLEM SET #5

Issued: Thursday, Oct. 22, 2009

Due (at 7 p.m.): Thursday, Oct. 29, 2009, in the EE C245 HW box in 240 Cory.

1. The figure below presents the top view of a small micromechanical filter constructed in a 2μm-thick structural layer. Here, everything is suspended 2 μm above the substrate except for the anchoring locations indicated as the darkly shaded regions. Data on the structural material used in this problem is given in the box below the figure. Also, assume that all folding trusses and shuttles are rigid in all directions, including the vertical (i.e., *z*) direction. Also, assume that all suspension and coupling beam widths are 2 μm.



Structural Material Properties:
Young's Modulus, E = 150 GPa; Density, ρ = 2,300 kg/m^3; Poisson ratio, ν = 0.226
DI Water Contact Angle for Structural and Substrate Materials: 85^o
Water-Air Interface Surface Tension: 72.75×10^{-3} N/m

(a) Write an expression for the static spring constant in the *x*-direction at location A in the figure and calculate its numerical value (with units).

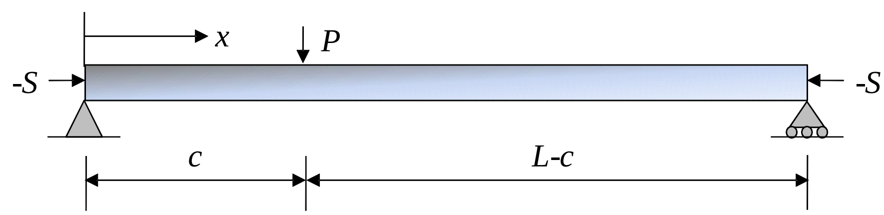
(b) Write an expression for the static spring constant in the *x*-direction at location B in the figure and calculate its numerical value (with units).

(c) Suppose an incomplete HF/DI rinse release step were performed, after which the shuttles were not fully released, but all suspension beams and folding trusses were successfully released. Using the data in the figure, will the coupling beam folding trusses be stuck down?

2. A simple beam of length *L* is subjected to a concentrated load *P* at location *c* while being compressed by two equal and opposite forces *S* as shown in the figure.

(a) Derive an expression for the deflection *w* as a function of location *x*, i.e., get *w*(*x*).

(b) Determine the deflection and the spring constant at $c=L/4$ and $c=L/2$, respectively.



3. Suppose a cantilever beam of length *L* is subjected to a uniform load of intensity *q* and a concentrated load *P* at the free end of the beam.

(a) Derive an expression for the deflection *w* as a function of location *x*, i.e., get *w*(*x*), using the principle of virtual work.

(b) Determine the deflection at the free end and the spring constant if $q=P/L$.