PROBLEM SET #4

Issued: Thursday, March 9, 2017

Due: Thursday, March 16, 2017, 10:00 a.m. in the EE C247B homework box near 125 Cory.

1. Fig. PS4.1 below presents a small micromechanical filter constructed in a 2μm-thick structural layer. Here, everything is suspended 2μm 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 Table PS4.1. Assume that all folding trusses and shuttles are rigid in all directions, including the vertical, *z* direction. Also, assume that all suspension and coupling beam widths are 2μm.

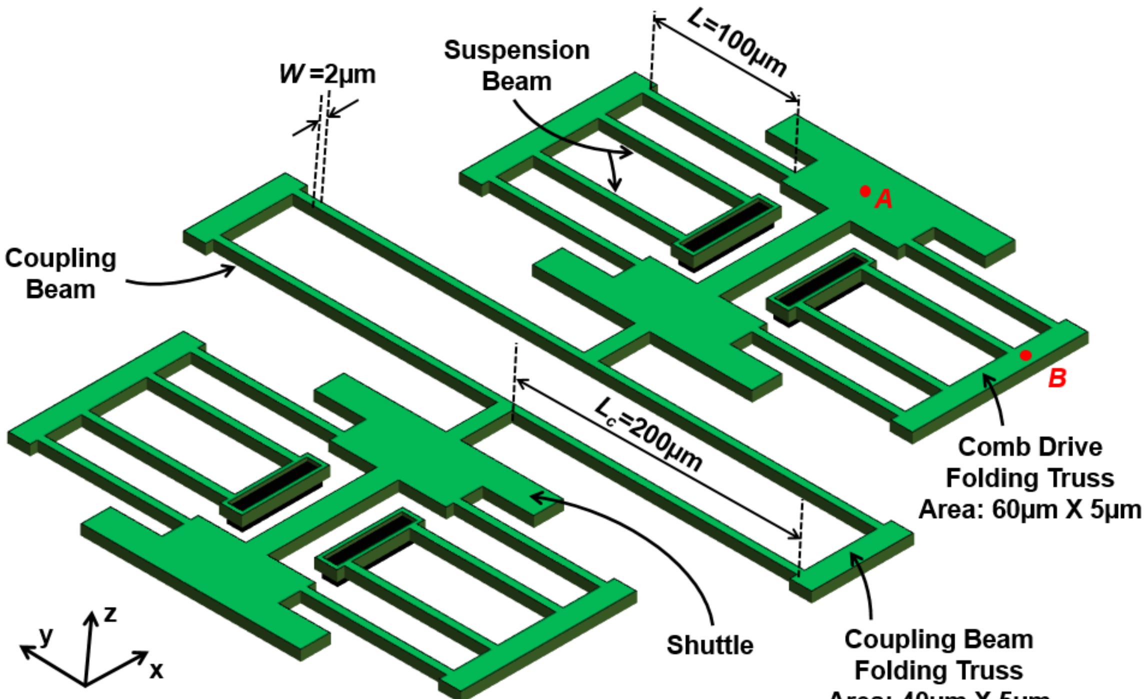

Fig. PS4.1

PARAMETER	VALUE	UNIT
Young's Modulus	150	GPa
Density	2300	kg/m^3
Poisson Ratio	0.226	-
DI Water Contact Angle for Structural and Substrate Materials	85°	-
Water-Air Interface Surface Tension	$72.75x10^{-3}$	N/m

Table PS4.1

Answer the following questions.

(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 Fig. PS4.1, will the coupling beam folding trusses be stuck down?

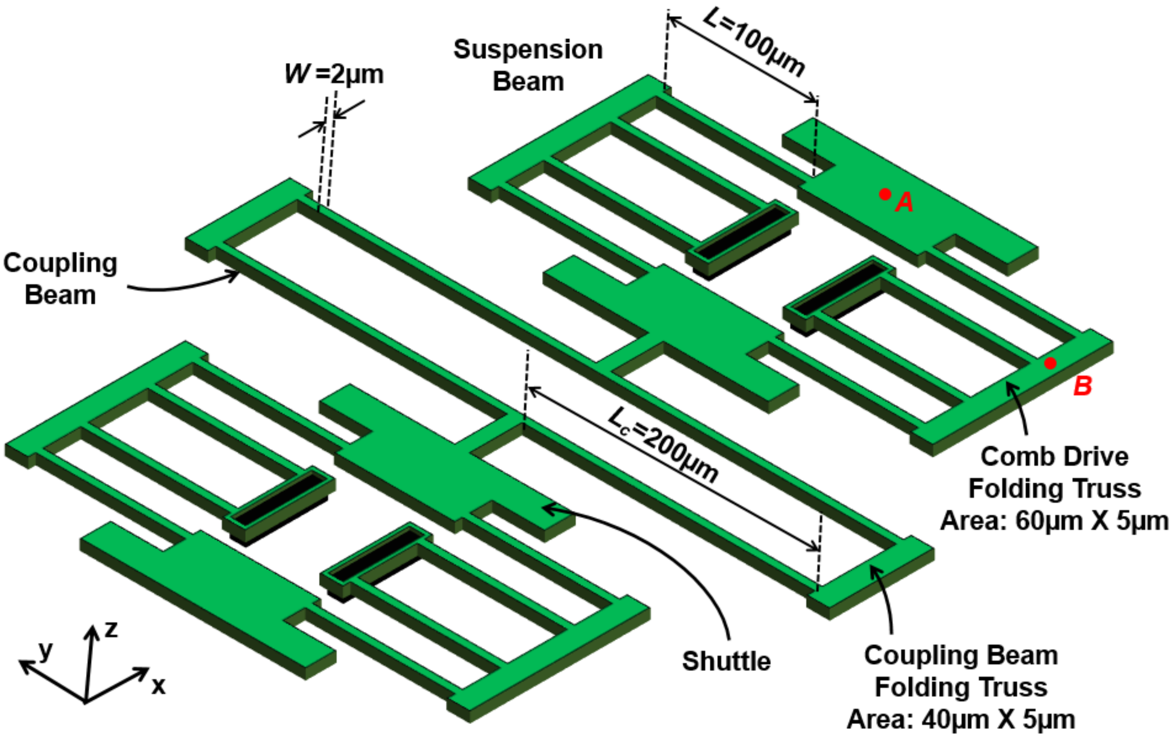

Fig. PS4.2

Now, suppose the shuttles in the structure have been split as shown in Fig. PS4.2.

(d) Repeat parts (a), (b), and (c) for the structure in Fig. PS4.2.

2. Fig. PS4.3 below presents a micromechanical structure constructed in a 2μm-thick structural layer. Here, everything is suspended 2μm 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 Table PS4.1. Assume that all folding trusses and shuttles are rigid in all directions, including the vertical, *z* direction. Also, assume that all suspension and coupling beam widths are 2μm.

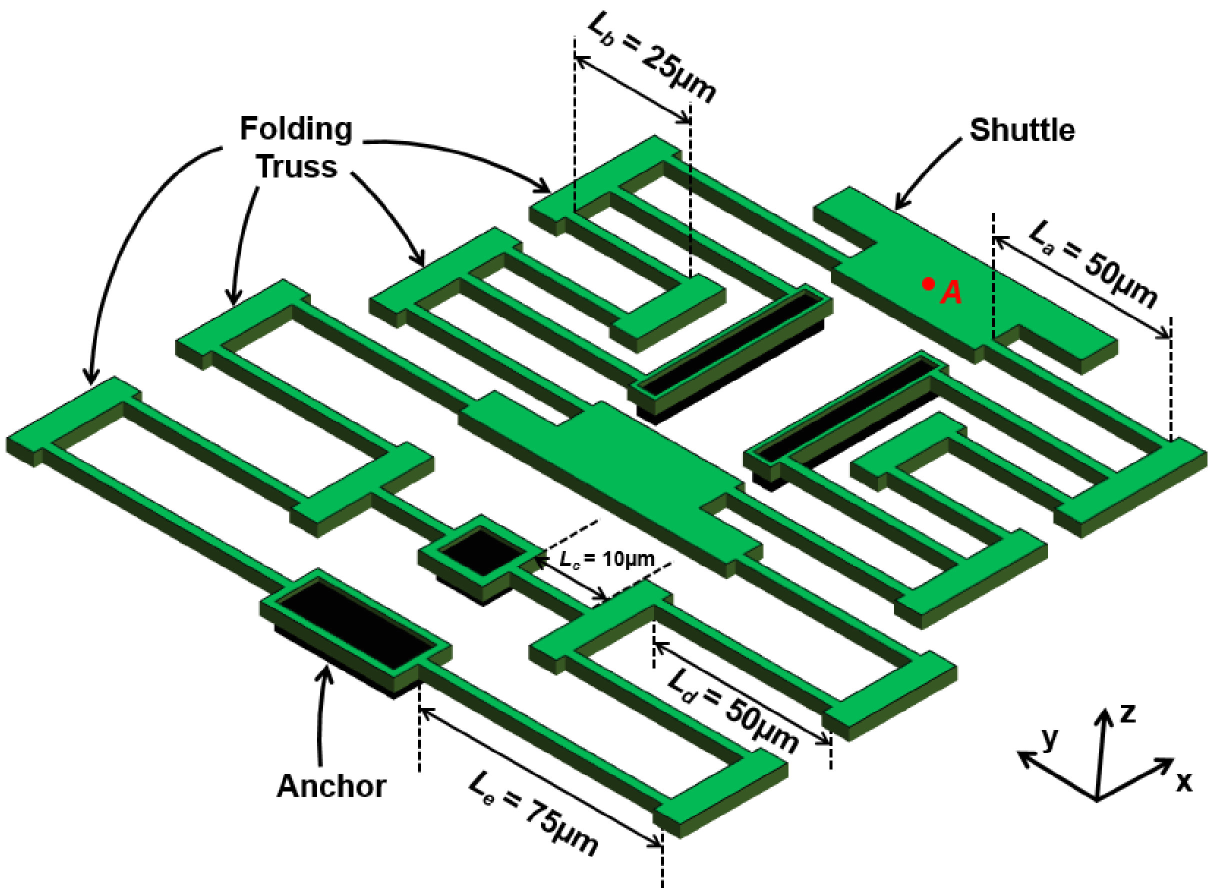

Fig. PS4.3

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

3. Fig. PS4.4 below presents a micromechanical structure constructed in a 2μm-thick structural layer. Here, everything is suspended 2μm 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 Table PS4.1. Assume that all folding trusses and shuttles are rigid in all directions, including the vertical, *z* direction. Also, assume that all suspension and coupling beam widths are 2μm.

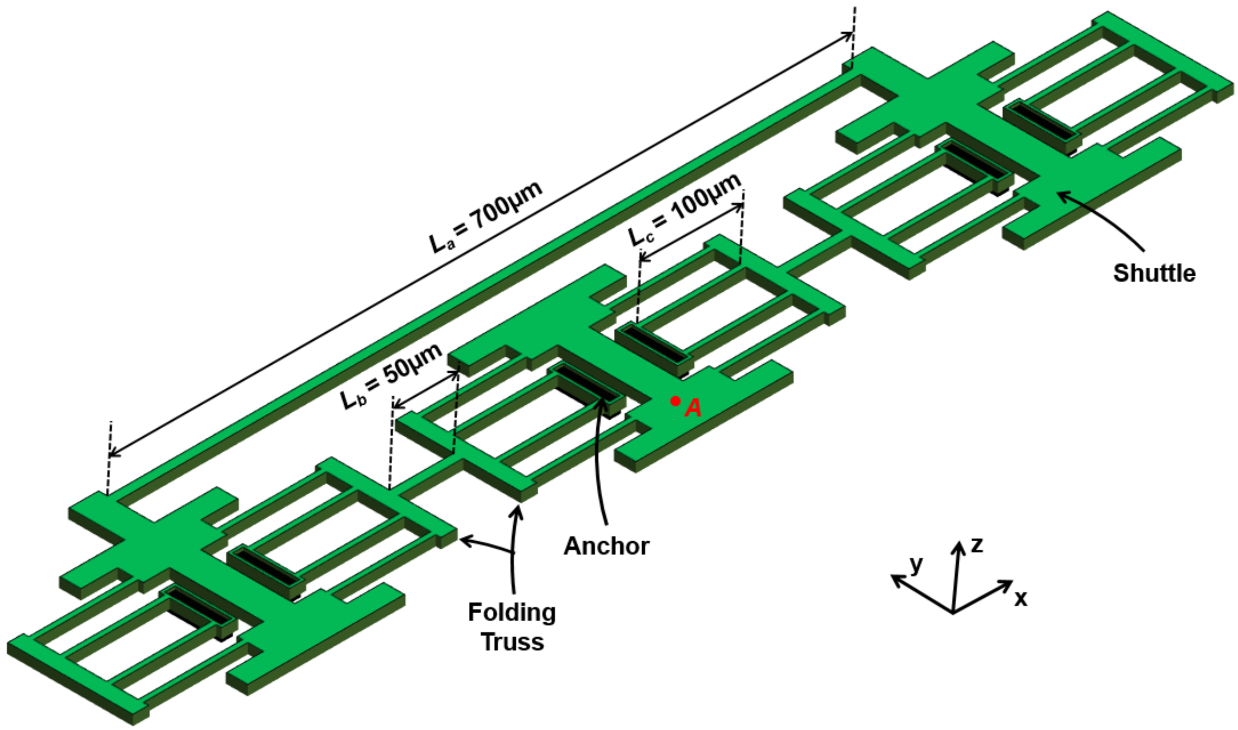

Fig. PS4.4

Write an expression for the static spring constant in the *y*-direction at location A and calculate its numerical value with units.

4. Suppose a cantilever beam of length, *L* is subjected to a linearly distributed load of intensity as shown in Fig. PS4.5.

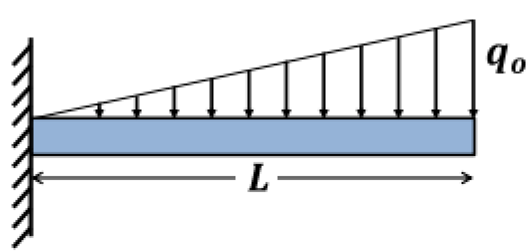

Fig. PS4.5

(a) Derive an expression for the deflection, *w* as a function of location, *x* by integrating the moment.

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