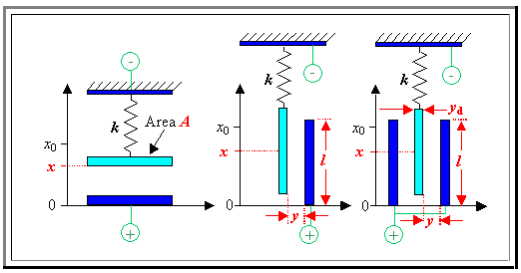
Exercise 7.1-2 Capacitors and Forces

Forces in Capacitive Structures

Let's look at the three different situations where we can produce forces electrostatically by using capacitive structures

- We consider one fixed plate with either a given area ***A*** or a dimension ***h*** · ***l*** (***h*** would be the height in the ***z***-direction in the drawing below), and a moveable plate of identical dimension to keep things easy. We also have a spring with a spring konstant ***k*** to keep the moveable plate in force equilibrium. The position x_0 is the equilibrium position for zero voltage. The terminals show schematically how voltage would be applied.



- We consider *only* movements in the ***x***-direction as shown for the three configurations given (where the plates have moved some distance ***x*** from their equilibrium position (zero voltage at ***x* = 0**).
- The third configuration embodies one element of a comb structure that we have encountered a few times already. We assume that there is a potential difference***U*** between the plates of the capacitors.

Here are the questions:

- **1.** Find the proper relations for the forces pulling at the moveable plates for all three configurations.
- **2.** Compare the relative strength of the first and third configuration (you may assume that $y \approx y_d$)
- **3.** Discuss the pros and cons of the two configurations for driving an actual actuator.

Hint: Consider the work ***W*** = ***E*** needed to move a plate and remember that Force $F = -dW/dx$

Solution