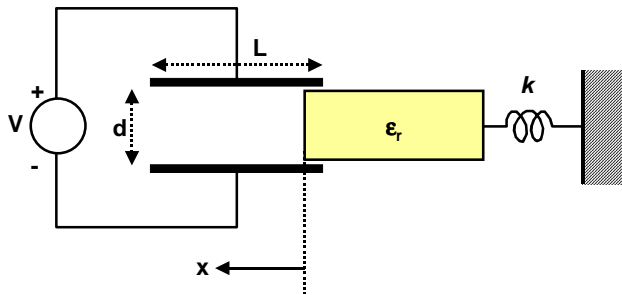


HW#1

1) Consider the following electrostatic actuator:



A dielectric material is placed in between a parallel plate capacitor with an area of A and a gap spacing of d . The dielectric material is able to move laterally into the capacitor and is supported by a spring. Ignore the friction between the dielectric slab and the capacitor.

- Derive the expression for the force of this actuator.
- Will this actuator exhibit pull-in phenomenon?
- When the voltage across the capacitor is increased from 0 to V , find the displacement of the dielectric slab.
- Construct the equivalent lumped circuit element model for the actuator, including both the electrical and the mechanical domains. The mass of the slab is m .
- Solve the equivalent circuit in (c) using Kirchoff's Laws. Find the transfer function of the equivalent circuit (i.e., displacement x as a function of voltage V). Compare that with the expression found in (b).
- Using the following parameters, find the force on the dielectric slab and the displacement of the slab:

$V = 10$ V, $L = 100$ μm , W (width of parallel plate) = 500 μm , $\epsilon_r = 40$, $k = 1$ N/m.