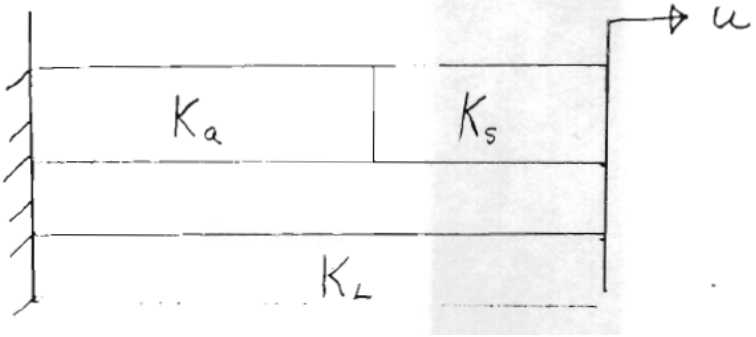
Homework No. 5

Due Date: June 02 (Mon) 6:30 PM

1.

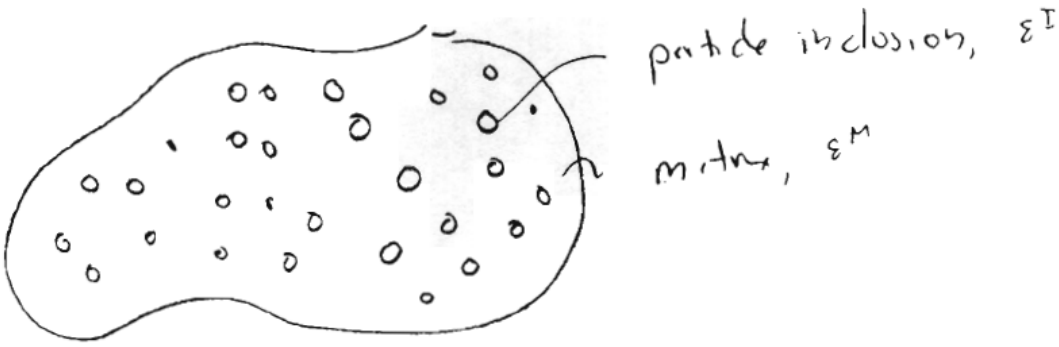
Consider a unidirectional linear elastic actuator of stiffness K_a and blocked for F_a working through some series stiffness, K_s on a load K_l, determine the properties of the composite actuator as a function of the ratio $\frac{K_a}{K_s}$. Calculate the external work done by the actuator alone. Compare it to the increase in energy of the series K_s and parallel K_l elements. Let $K_s = K_a$ is there an optimal K_l for maximizing the work done on the load. How does the optimal compare if $K_s = \infty$.



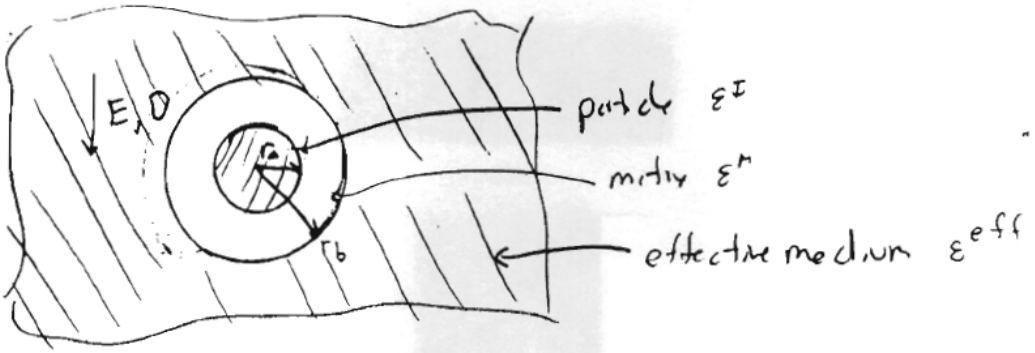
2.

A classical problem in electrostatics of dielectric's is that of computing the effective dielective properties of a mixture of two material phases.

Consider a composite material made of an electrically isotropic matrix material with dielectric ε^M (low) and a particulate material with dielectric ε^I (high) (for now assume it is also isotropic). Consider only the two dimensional problem of an infinite material.



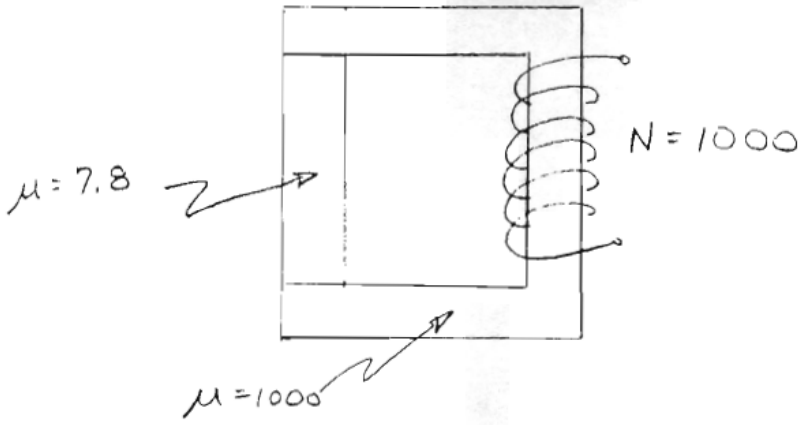
One method of determining the properties of the material is to consider the composite material as homogeneous except in the vicinity of a particle. The geometry can be represented as a particle surrounded by a ring of matrix surrounded by a material which has the dielectric of the homogeneous medii ε^{eff}.



On average the field in the homogeneous material will be uniform, E. Find the effective dielectric constant, ε^{eff} as a function of the phase properties which is consistent with the fields in the material. Is it isotropic? What volume fraction of properties do I need to create an effective media of $\varepsilon^{eff} = 50$ if $\varepsilon^m = 3$ (epoxy) and $\varepsilon^I = 3000$ (piezoelectric).

3.

Consider a magnetic circuit shown below. Estimate the coercive field, H, in the terfenol. How much current would it take to get H = 500 oersteds?



Consider the ratio of magnetic iron mass to terfenol (assume that both have the same density as iron). How does the coercive field vary as the mass ratio is decreased. If the strain output of the actuator is linear with H, is there an optimal to the mass weighted strain $\frac{\varepsilon \ell M_A}{M_{tot}}$?