EECS 412 Electromagnetic Fields III
Fall 2003

Homework #1:

Due September 18th

Reference Ramo, Whinnery, Van Duzer, Fields and Waves in Communications Electronics, 3rd Edition, Chapter 1.

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|---|---|
| Superposition | 1.4d |
| Conservative fields | 1.7a |
| Potential & Gauss' Law | 1.8b |
| Potential (spherical) | 1.10d |

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|---|---|
| Polarization | 1 (attached) |
| Method of images, electric fields | 2 (attached) |
| Electrostatic forces & energies | 3 (attached) |
| Electrostatic forces and potential | 5 (attached) |
| Lossy capacitor | 6 (attached) |

Reference Ramo, Whinnery, Van Duzer, Fields and Waves in Communications Electronics, 3rd Edition, Chapter 7.

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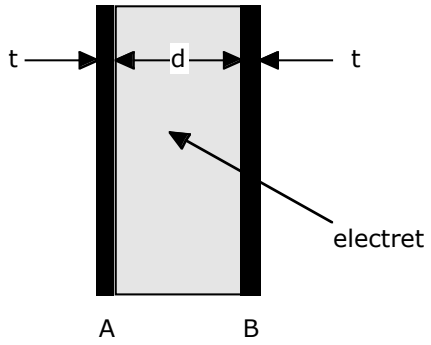
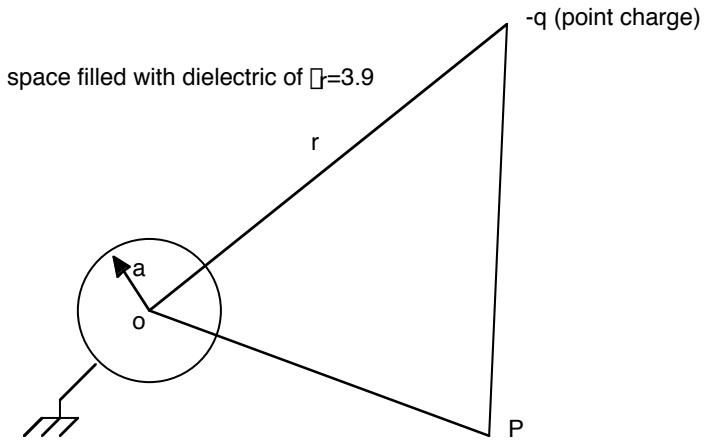
|---|---|
| Separation of variables, Laplaces equation | 4 (attached) |

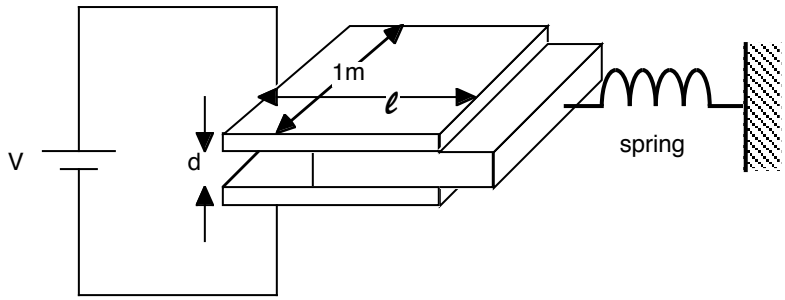
1. An electret (a permanently polarized substance) of polarization P is sandwiched between two metallic plates A and B. Find the distribution of the charges and the electric potentials in the system.



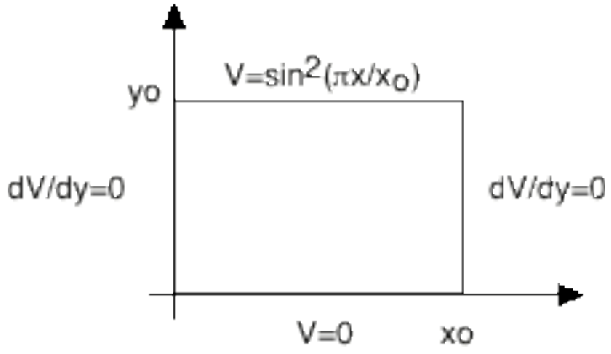

2. Find the electric field at point P in the following structure. The metallic sphere of radius a is grounded and space is filled with a dielectric of $\varepsilon$=3.9. Hint: use the method of images.



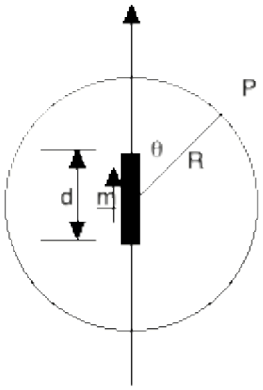
3. A slab of dielectric material of electric permittivity e and thickness d meters slides freely between two parallel metallic plates d meters apart. The metallic plates are connected to a battery with an e.m.f. of V volts. Find how far the slab will slide between the plates if the slab is attached to a spring with a stiffness of K newtons/meter. The dimensions are as shown in the figure. Neglect electric fringing in your calculations.




4. A two dimensional box has the potential shown on its boundary. Use a Fourier series expansion to describe the potential inside the box.



5. An electric dipole of moment m lies in the x-y plane/ A charge q is placed at the point P a distance R from the dipole. If the charge q is constrained to move in a circle of radius R, find the force on q and from it find the equilibrium position. Assume that d<<R and that the charge has no mass. Use the potential function $\Phi = \frac{m}{4\pi\varepsilon_0}\frac{\cos\theta}{r^2}$




6. Consider the parallel plate capacitor shown below. The region between the plates is filled with two lossy dielectrics having conductivities and permittivities $\sigma_1$, $\varepsilon_1$ and $\sigma_2$,$\varepsilon_2$ respectively. When the upper plate is at a potential V relative to the lower plate find the displacement flux density and conduction current density that flows between the two plates. You may neglect fringing field effects.