NDU **PHS 212 - Electricity & Magnetism**

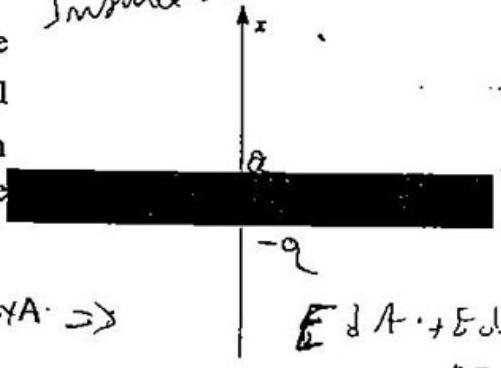
Faculty of Natural and Applied Sciences **Final Exam**

Department of Sciences

Solve all problems (13 points each)

1. A charge Q is to be divided into two parts $(Q-q)$ and q. What is the relation of Q to q if the two parts, placed a given distance apart, are to have a maximum Coulomb repulsion?

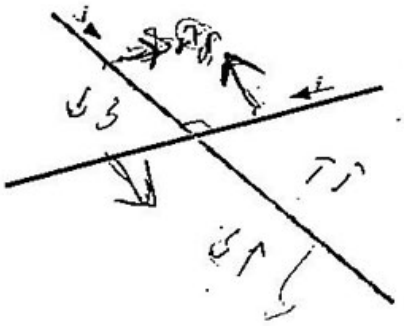
2. A plane slab of thickness d has a uniform volume charge density ρ. Find the magnitude of the electric field at all points in space both (a) inside and (b) outside the slab, in terms of x, the distance measured from the median plane of the slab.



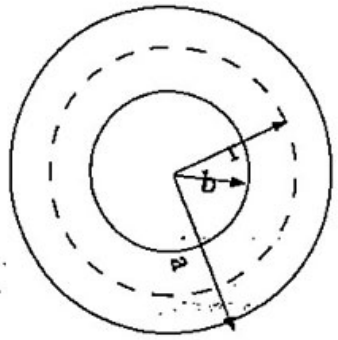
3. Consider two widely separated conducting spheres, 1 and 2, the second having twice the diameter of the first. The smaller sphere initially has a positive charge q and the larger one is initially uncharged. You now connect the spheres with a long thin wire. a) How are the final potentials V_1 and V_2 of the spheres related? b) Find the final charges q_1 and q_2 in terms of q.

4. When $115\,V$ is applied across a $9.66-m$ - long wire, the current density is $1.42\,A/cm^2$. Calculate the conductivity of the material.

5. Two long, straight wires, each carrying current i, are perpendicular to one another as shown here. If the wire are free to move, what happens?



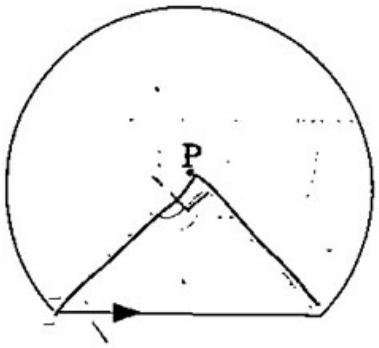
6. The figure shows a cross section of a hollow cylindrical conductor of radii a and b, carrying a uniformly distributed current i. a) Using the circular Amperian loop shown, verify that $B(r)$ for the range $b<r<a$ is given by



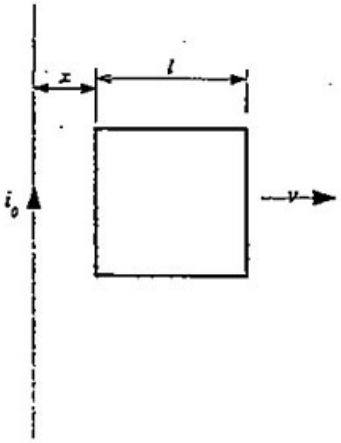
$$B(r)=\frac{\mu_0 i}{2\pi(a^2-b^2)}\frac{r^2-b^2}{r}.$$

b) Test this formula for the special cases of $r=a, r=b$, and $b=0$.

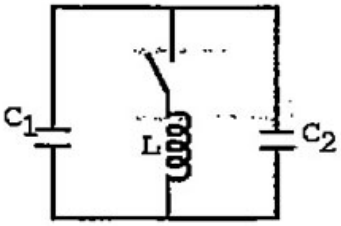
7. A wire having the form shown here carries current i. Find the magnitude and direction of the magnetic field at P.



8. The long wire in the figure below carries a current i_0. The square wire loop with sides l moves to the right with speed v.
a. Find the emf induced in the loop as a function of the distance x between the long wire and the left side of the loop.
b. What is the direction of the current in the loop?



9. The two capacitors, $C_1=2.2\,\mu F, C_2=3.4\,\mu F$, in the circuit illustrated below are initially charged to a 220-V potential difference. At $t=0$, the switch is closed. Find an expression for the current through the inductor, $L=4.1\,mH$, as a function of time.



10. Two long parallel wires, each of radius a, whose centers are a distance d apart carry equal currents in opposite directions. Show that, neglecting the flux within the wires, themselves, the inductance of a length l of such a pair of wires is given by

$$L=\frac{\mu_0 l}{\pi}\ln\frac{d-a}{a}$$