✓ for KSH #1

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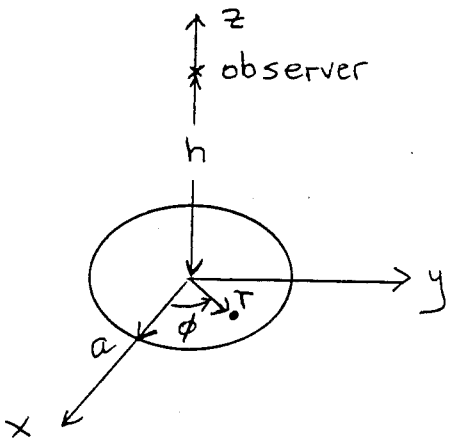
ELEC 251 - Fundamentals of Applied Electromagnetics
Class Test - Section U

Closed Book-no books or notes allowed!
Each question is worth 10 marks.

1.



A disc of radius a carries charge density $\rho_s(r,\phi) = 3\sin(\phi/2)$ Coul/metre^2. Find the scalar potential a point on the z-axis a distance h above the centre of the disc.

2. A cylindrical shell has inner radius a and outer radius b and contains a uniform volume charge density ρ_v Coul/metre^3. Find the electric field for $0 < r < \infty$.

3. A parallel-plate capacitor has plates of area A m^2 separated by distance d m. The dielectric has a permittivity given by

$$\varepsilon(z) = e^{\alpha z}\varepsilon_0$$

where z is the distance from the bottom plate charged with $-Q$, towards the top plate charged with $+Q$.

(i) Find the electric field in the dielectric.

(ii) Find the voltage V_0 at the top plate relative to the bottom plate.

Good practice problems

for test #1

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FUNDAMENTALS OF APPLIED ELECTROMAGNETICS
ELEC 251 --- CLASS TEST #2

Professor Plotkin
Professor Trueman

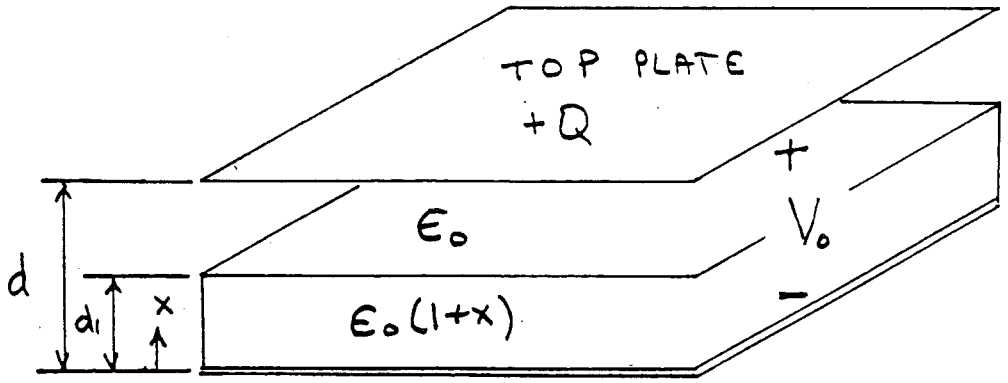
March 20, 1990.

ANSWER ALL QUESTIONS. 40 MARKS TOTAL.

1.(10 marks) State or define each of the following terms, including:
- a brief statement in words (1/2 mark)
- a formula (1/2 mark)
- a diagram (1/2 mark)
- the units of all quantities (1/2 mark).

(i) Polarization
(ii) Capacitance
(iii) Boundary condition for the normal component of D at a dielectric interface
(iv) Biot-Savart Law
(v) Ampere's Circuital Law

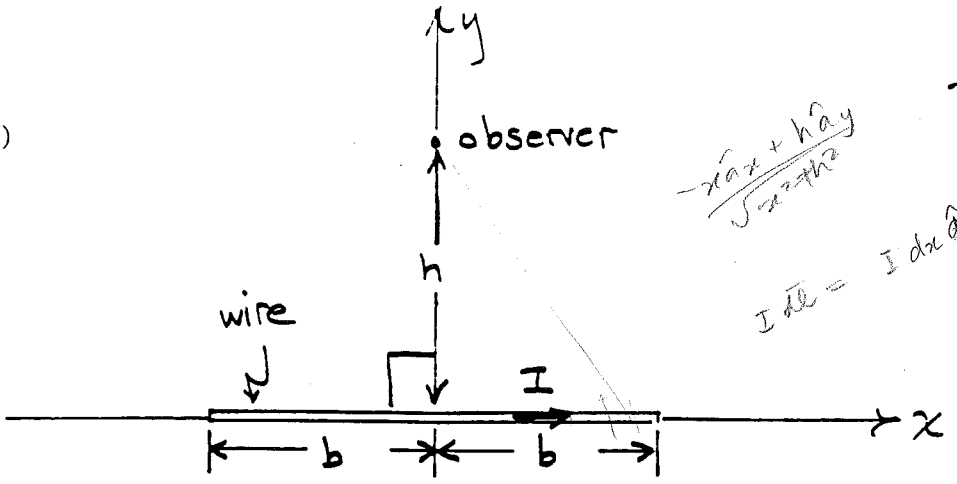
2.(10 marks)



A parallel plate capacitor has plates of area A and separation d. The space between the plates is partly filled with air and partly filled with dielectric with $\varepsilon = \varepsilon_o(1+x)$.

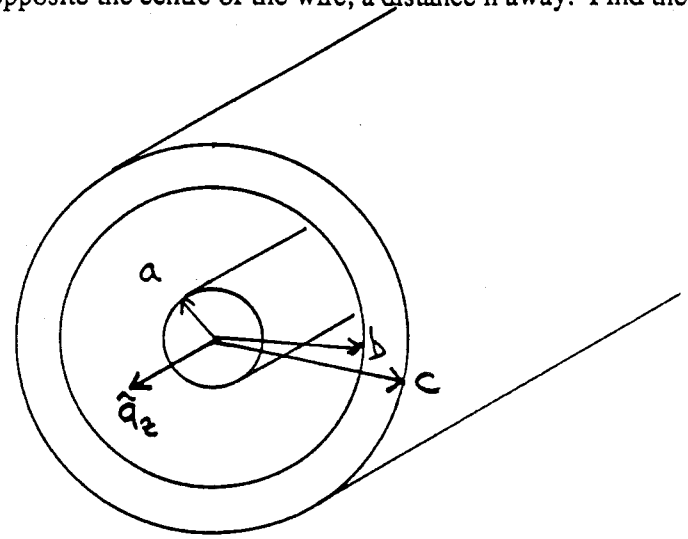
(i) If the voltage between the plates is V_o, then find the charge Q on the top plate.
(ii) Find the capacitance.
(iii) Find the polarization of the dielectric.

3.(10 marks)



A wire extends along the x-axis from x=-b to x=b, and carrys a current I. An observer is on the y-axis opposite the centre of the wire, a distance h away. Find the magnetic field at the observer.

4.(10 marks)



A coaxial cable has a solid inner conductor of radius a, carrying current density

$$\bar{J} = J_1 \hat{a}_z \quad \text{amps/m}^2$$

The outer conductor is a solid cylindrical shell from r=b to r=c, and carrys the current density

$$\bar{J} = -J_2 \hat{a}_z \quad \text{amps/metre}^2$$

Find the magnetic field for $0 < r < \infty$.

$$\int \frac{dx}{\sqrt{(x^2+a^2)^3}} = \frac{x}{a^2\sqrt{x^2+a^2}}$$

$$\int \frac{x\,dx}{\sqrt{(x^2+a^2)^3}} = \frac{-1}{\sqrt{x^2+a^2}}$$

$$\int \frac{x^2 dx}{\sqrt{x^2+a^2}} = \frac{x}{2}\sqrt{x^2+a^2} - \frac{a^2}{2}\log(x+\sqrt{x^2+a^2})$$

$$\int \frac{dx}{x^2\sqrt{x^2+a^2}} = \frac{-\sqrt{x^2+a^2}}{a^2 x}$$

Fundamentals of Applied Electromagnetics - ELEC 251

Class Test - Section W

Thursday, February 18, 1993.
Dr. C.W. Trueman

1. (10 marks) A line charge of $\rho_l = 10^{-10}$ Coul/metre lies along the x-axis from $x = -\infty$ to $x = \infty$, in free-space.
(i) Find the magnitude of the electric field at $(x = 1, y = 2, z = 3)$ metres. Give the (x, y, z) components of a unit vector in the direction of the electric field vector.
(ii) Find the position of a point charge of $Q = 10^{-9}$ Coul such that the net electric field at $(x = 1, y = 2, z = 3)$ m is zero.

2. (10 marks) A sphere of radius $a = 1$ cm is centred at the origin and is filled with charge density

$$\rho_{v1} = 30r \quad \text{pC/m}^3$$

where r is distance from the origin. It is surrounded by a spherical shell of charge of inner radius $b = 2$ cm and outer radius $b = 3$ cm containing charge density

$$\rho_{v2} = -2 \quad \text{pC/m}^2$$

Find the electric flux density for $0 < r < \infty$. Draw a neat, well-labelled graph of the magnitude of the electric flux density as a function of r.

3. (10 marks) A line charge extends from $x = -10$ m to $x = 2$ m on the x-axis, and carries charge density

$$\rho_l = 10x^2 \quad \text{C/m}$$

Find the scalar potential at $(x = 0, y = 0, z = 5)$ metres, relative to zero volts at infinity. The material is free space.

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$$\int \frac{x^2\,dx}{\sqrt{x^2 \pm a^2}} = \frac{x}{2}\sqrt{x^2 \pm a^2} \mp \frac{a^2}{2}\log\left(x + \sqrt{x^2 \pm a^2}\right)$$

$$\int \frac{x^3\,dx}{\sqrt{x^2 \pm a^2}} = \frac{1}{3}\sqrt{(x^2 \pm a^2)^3} \mp a^2\sqrt{x^2 \pm a^2}$$

$$\int \frac{dx}{x^2\sqrt{x^2 \pm a^2}} = \mp\frac{\sqrt{x^2 \pm a^2}}{a^2 x}$$

$$\int \frac{dx}{x^3\sqrt{x^2 + a^2}} = -\frac{\sqrt{x^2 + a^2}}{2a^2x^2} + \frac{1}{2a^3}\log\frac{a + \sqrt{x^2 + a^2}}{x}$$

$$\int \frac{dx}{x^3\sqrt{x^2 - a^2}} = \frac{\sqrt{x^2 - a^2}}{2a^2x^2} + \frac{1}{2|a^3|}\sec^{-1}\frac{x}{a}$$

$$\int \frac{x\,dx}{\sqrt{x^2 \pm a^2}} = \sqrt{x^2 \pm a^2}$$

$$\int x\sqrt{x^2 \pm a^2}\,dx = \tfrac{1}{3}\sqrt{(x^2 \pm a^2)^3}$$

CONCORDIA UNIVERSITY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
ELEC 251 MIDTERM EXAM
February 18, 1992

Instructors: Dr. N.Plotkin, Dr.C.Trueman

Answer all questions (40 marks total)

1. (10 Marks) State or define each of the following terms, including

- - a brief statement in words
- - a formula
- - a diagram
- - the units of all quantities

I. Coulomb's Law

II. Gauss' Law

III. Continuity equation

IV. Boundary condition for the tangential and normal components of the electric flux density for conductor-free space boundary

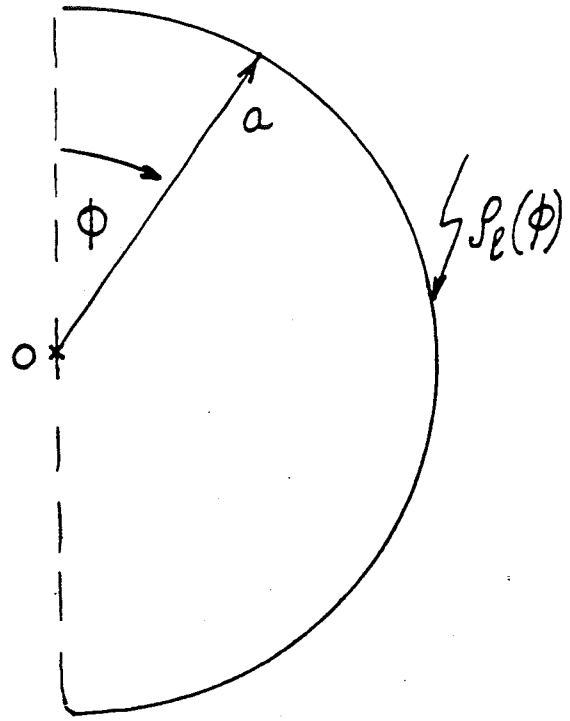
V. Scalar potential

2. (10 Marks)

A spherical shell centered at the origin has inner radius a and outer radius b , and is filled with charge density $\rho_v = 2r\ C/m^3$

Find the electric flux density $\bar{D}$ at the radius $r = (a+b)/2$

3. (10 Marks)



A semi-circle of radius a carries charge density

$$\rho_l(\phi) = A\cos\phi \; C/m,$$

when angle ϕ is defined in the figure.

- a) Find the electric field vector at the center of the semi-circle, at point O
- b) Find the scalar potential V at the point O

4.(10 Marks)

A wire of circular cross-section increases from radius a_1 at $z = 0$ to radius a_2 at $z = L$, where $L \gg a_1$; $L \gg a_2$

If the conductivity of the material σ is uniform, find the resistance between $z = 0$ and $z = L$.