

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR

PHYS 313: ELECTRICITY AND MAGNETISM II

STREAMS:

TIME: 2 HOURS

DAY/DATE: MONDAY 4/12/2017

2.30 P.M -4.30 P.M

INSTRUCTIONS:

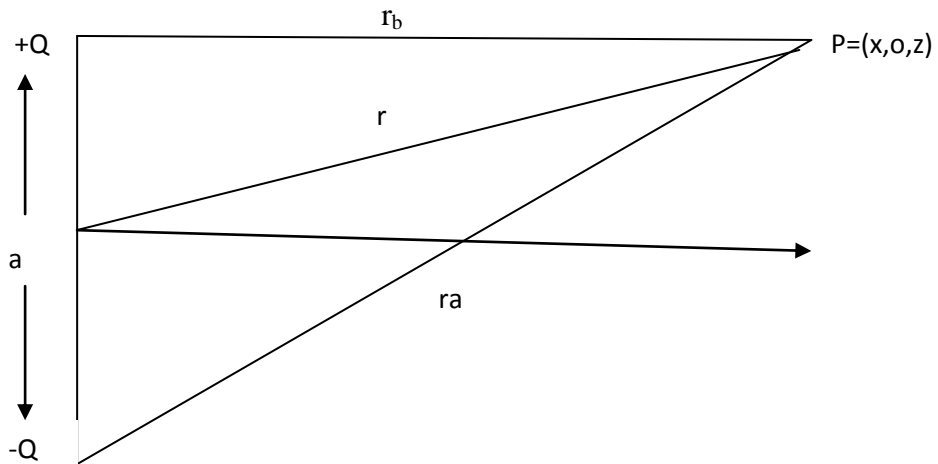
- Answer question one and any other two questions

QUESTION ONE (30MKS)

- 1 a) State any three applications of Gauss's law [3marks]
- b) Derive an expression for electric potential V of a point charge Q [4marks]
- c) Calculate the potential at a point 0.05 m inside a charged sphere of radius 0.1 m and volume charge density $2.4 \times 10^{-7} \text{C/m}^3$ [5marks]
- d) Distinguish between a conductor and a dielectric [2marks]
- e) Derive an expression for the work done in changing the orientation of a dipole in electric field E from 90° to θ° [4marks]
- f) Derive Gauss's law in the form
- $$\int_S E \cdot da = \frac{Q}{\epsilon_0} \quad [5marks]$$
- g) Write down Maxwell's equations of electromagnetism in their general differential form in a vacuum [4marks]
- h) Explain the reason as to why charges only reside on the surface of a conductor [3marks]

QUESTION TWO (20MKS)

2a) Show that potential due to the dipoles at a point P is given by $V_p = \frac{Qa \cos \varphi}{4\pi\epsilon \pi r^2}$ [7marks]



b) From the equation for potential due to a dipole at point P, show that the electric field component in the Z- direction is given by

$$E_z = \frac{P}{4\pi\epsilon_0} \left(\frac{3\cos^2\theta - 1}{r^3} \right) \quad [10marks]$$

b) Explain any three types of filters [3marks]

QUESTION THREE (20MKS)

3a) Laplace equation in Cartesian rectangular coordinates is

$$\frac{\sigma^2 v}{\sigma x^2} + \frac{\sigma^2 v}{\sigma y^2} + \frac{\sigma^2 v}{\sigma z^2} = 0$$

Assuming that the solution of this equation is a product of three functions which are separately functions of x, y and z. Show the most general form of this solution

[9marks]

b) Derive an expression for electric field **E** at a point P outside a sphere of radius R and uniform volume charge density ρ [7marks]

c) Calculate the electric field at a point 0.001 m from the surface of a charged sphere of radius 0.05 m and volume charge density $4 \times 10^{-7} \text{ C/m}^3$ [4marks]

QUESTION FOUR (20MKS)

4a) Starting from Gauss's law in a vacuum derive an expression for the Gauss's law in dielectric [6marks]

b) Show that the volume charge density is given by

$$\rho_b = -\nabla \cdot P \quad [6marks]$$

c) Derive the equation of continuity [8marks]

QUESTION FIVE (20MKS)

- 5a)** Starting from ampere's law, derive Maxwell's electromagnetic equation [8marks]
- b)** For a series arrangement of R, L and C circuit and given that $R=3 \times 10^5 \Omega$, $L= 10^{-3} \text{H}$ and $C= 60 \text{PF}$. Calculate:
- i.** The total current in each arm when a voltage of 20 V r.m.s at a frequency of 0.1 MHz is applied [5marks]
 - ii.** The phase of the total current drawn from the generator. [5marks]
- c)** Define polarization [2marks]
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