CHUKA   **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE

PHYS 342: ELECTRICITY AND MAGNETISM II

STREAMS: **TIME: 2 HOURS**

DAY/DATE: TUESDAY 04/12/2018   **8.30 A.M. – 10.30 A.M.**

INSTRUCTIONS:

- **Answer question one and any other two questions**

QUESTION ONE (30MARKS)

1 a) Differentiate between electric potential and electric field intensity   [2marks]

b) Derive an expression for electric potential V at a point r from a point charge Q

[4marks]

c) Show that work done in moving a test charge Q_t around a closed path in the field of a point charge Q is zero   [5marks]

d) Distinguish between a conductor and a dielectric   [2marks]

e) Calculate the potential at a point P which is 0.15 m from a dipole formed by charges $Q_1=1.6\times10^9C$ and $Q_2= -1.6\times10^{-9}C$, given that P makes an angle of 30^0 from the centre of the dipole. Assume the charge separation distance is 2 mm.

[4marks]

f) Derive Gauss's law in the form

$$\int_S E.d\alpha = \frac{Q}{\varepsilon o}$$ [5marks]

g) Write down Maxwell's equations of electromagnetism in their general differential form in a vacuum
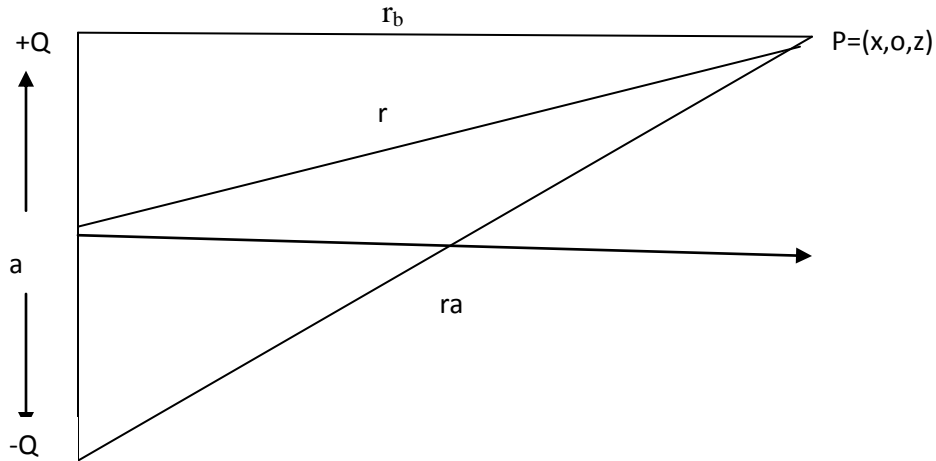
[4marks]

h) Explain the reason as to why charges only reside on the surface of a conductor

[4marks]

QUESTION TWO (20MARKS)

2a) Show that potential due to the dipoles at a point P is given by $V_p = \dfrac{Qa \cos \varphi}{4\pi\epsilon \; \pi r2}$

[8marks]

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

$$E_x = \frac{3P\sin\theta\cos\theta}{4\pi\varepsilon o}\left(\frac{1}{r3}\right) \qquad \text{[9marks]}$$

c) State any three applications of Gauss's law   [3marks]

QUESTION THREE (20MARKS)

3a) Derive the Maxwell's electromagnetic equation   [9marks]

$$\nabla \times E = -\frac{\delta B}{\delta t}$$

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

c) Calculate the electric field at a point 0.04 m from the surface of a charged sphere of radius 0.05 m and volume charge density 4×10^{-7} C/m^3 [4marks]

QUESTION FOUR (20MARKS)

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

b) Show that the volume change density is given by

$$\rho_b = -\nabla . P$$ [6marks]

c) Derive the equation of continuity [8marks]

QUESTION FIVE (20MARKS)

5a) A circuit contains a capacitor with capacitance 4.5 µF and an inductor of inductance 2.5 mH. The capacitor is fully charged using a 12 V battery and then connected to the circuit. Find

i) the angular frequency of the circuit
ii) the total energy in the circuit
iii) charge on the capacitor after the time t=3 sec [8marks]

b) For a series arrangement of R, L and C circuit and given that R=3×10^5 Ω, L= 10^{-3} H and C= 60PF. 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) Explain the significance of resistor in an LRC circuit [2marks]