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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2018/2019 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER REGULAREXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

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COURSE CODE: PHY 221

COURSE TITLE: ELECTRICITY AND MAGNETISM II

DATE: 19TH, DECEMBER, 2018 **TIME: 9.00 AM – 12.00 NOON**

INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF 10 PRINTED PAGES **PLEASE TURN OVER**

PHY 221: ELECTRICITY AND MAGNETISM II

STREAM: BED (Scie) **DURATION: 3 Hours**

INSTRUCTIONS TO CANDIDATES

*i. Answer **TWO** question from section **A** and any other **THREE** questions from section **B**.*

SECTION A

Question One (12 Marks)

a) Define the terms

i) Electric flux (1 Mark)

iii) Polarization (1 Mark)

b) The electric potential due to certain charge distribution in certain coordinates is given as $V(x, y, z) = Ax^2y^2 + Bxyz$. What is the associated electric field? (3 Marks)

c) i) State the differential form of Gauss law for E.(1 Mark)

ii) Using Gauss law, determine the electric field due to an infinitely long wire carrying a linear charge density λ C m^{-1}. (2 Marks)

d) An infinitely long straight wire carries a slowly varying current $I(t)$. Determine the induced electric field as a function of distance S from the wire. (3 Marks)

e) Write down Poisson's and Laplace differential equations (1 Mark)

Question Two (12 Marks)

a) State the differential form of Gauss law for **B**.(1 Mark)

b) The plane of a rectangular loop of wire is parallel to a 0.19-T magnetic field. The loop carries a currentof 6.2 A.

(i) What torque acts on the loop?(2 Marks)

(ii) What is the magneticmoment of the loop? (1 Mark)

c)i) Define self-inductance. (1 Mark)

ii) By considering a coil of N turns carrying current I, deduce the expression of self-inductance. (3 Marks)

d) Write downMaxwell's equations of electromagnetism in their general differential form.

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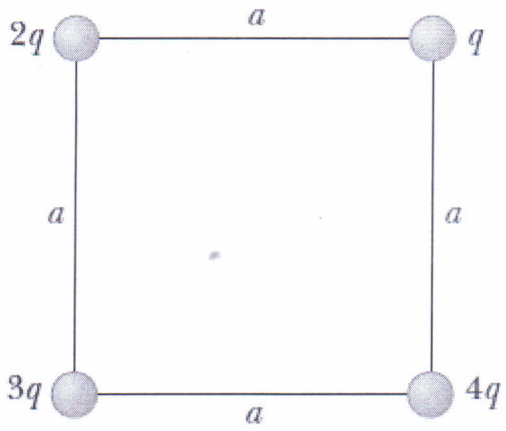
(4 Marks)

SECTION B

Question Three (12 Marks)

a) Four point charges are at the corners of a square of side a as shown in Figure below.

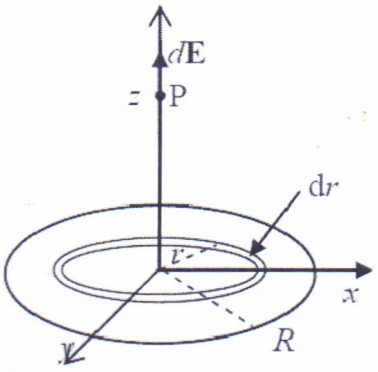


i) Determine the magnitudeof the electric field at charge q (5 Marks)

ii) What is the resultant force on q? (1 Mark)

b) The electric field at points along the axis of a thin ring of radius R due to charge Q that is uniformly distributed along the circumference of is given by $E = \frac{1}{4\pi\varepsilon_0}\frac{Qz}{\left(z^2+R^2\right)^{\frac{3}{2}}}\mathbf{k}$.

i) What is the electric field generated by a disc of radius R (see figure below) carrying a uniform charge density σ C m^{-2} at a point a distance z from thedisc and on the axis of the disc.



(5 Marks)

ii) Use the electric field determined in part (i) above to find an expression for the electric field generated by a large sheet carrying a uniform charge density σ C m^{-2}.

(1 Mark)

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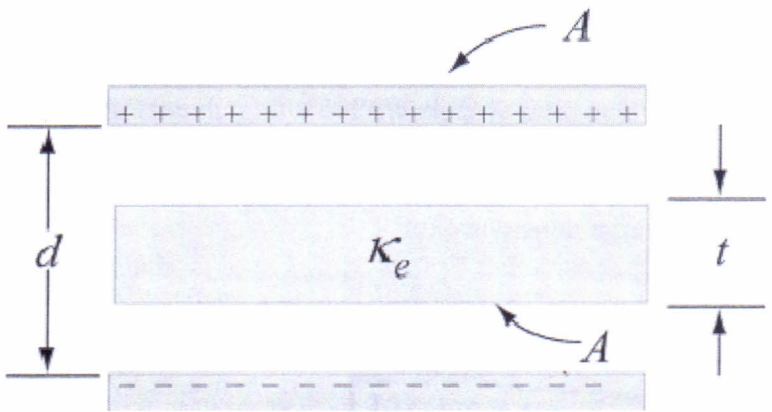
Question Four (12 Marks)

a) A parallel-plate capacitor has dielectric between its plates with dielectric constant k_e .The magnitude of the charge on each plate is Q. Each plate has area A and the distancebetween the plates is d. Deduce the Gauss's law for the dielectric. (6 Marks)

b) A non-conducting slab of thickness t, area A and dielectric constant k_e is inserted into the space between the plates of parallel plate capacitor with spacing d, charge Q and area A as shown in the figure below. What is the capacitance of the system? (6 Marks)



Question Five (12 Marks)

a) Derive an expression for the magnetic potential energy stored by an inductance L in a circuit where current I is flowing. (6 Marks)

b) Deduce the differential form taken by the circuital law for **E**in a region where **B**varies with time. (6 Marks)

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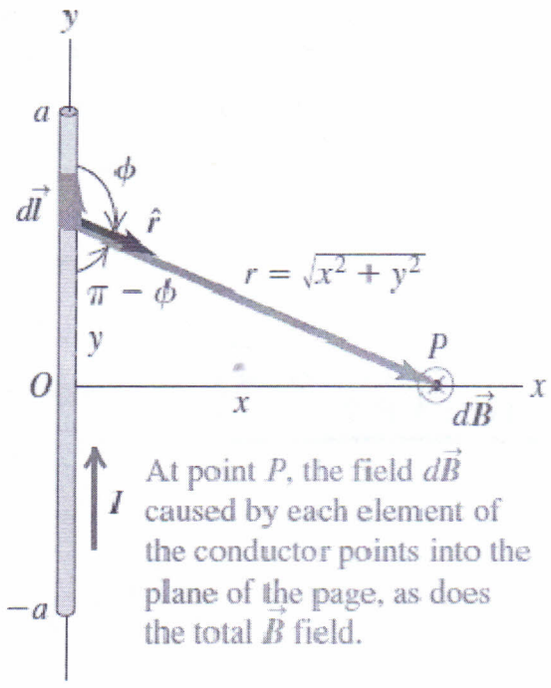
Question Six (12 Marks)

a) A long straight current carrying conductor with length 2a and carrying current I is placed along the y-axis as shown below. Using Biot-Savart law, evaluate the field at point P. (6 Marks)



b) Consider a solenoid carrying a steady current I, which is infinitely long with turns N tightly packed. Use Ampere's law to find the magnetic field inside the solenoid. (6 Marks)

Question Seven (12 Marks)

a) Show that Maxwell's equations combine to form wave equations for B and E. (7 Marks)

b)Obtain the Poynting vector **S** and intensity $\langle \boldsymbol{S} \rangle$ for plane electromagnetic wave in vacuum, whose electric and magnetic components are $\mathbf{E}=E_0\cos(kx-\omega t)\mathbf{j}$ and $\mathbf{B}=B_0\cos(kx-\omega t)\mathbf{k}$ respectively. (5 Marks)

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