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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2018/2019 ACADEMIC YEAR

SECOND YEAR FIRSTSEMESTER REGULAR EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCEIN COMPUTER SCIENCE

COURSE CODE: **PHY 210**

COURSE TITLE: **ELECTRICITY AND MAGNETISM**

DATE: 18TH DECEMBER, 2018 **TIME: 2.00 PM – 5.00 PM**

INSTRUCTION TO CANDIDATES

- **SEE INSIDE**

THIS PAPER CONSISTS OF 6 PRINTED PAGES **PLEASE TURN OVER**

PHY 210: ELECTRICITY AND MAGNETISM

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

INSTRUCTIONS TO CANDIDATES

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

You may need to use the following constants

- *Permittivity of free space, $\varepsilon_O = 8.85 \times 10^{-12}$ F/m (k = 8.99 x 10^9 Nm^2C^{-2})*
- *Mass of an electron, $M_e = 9.11 \times 10^{-31}$ Kg*
- *Mass of a proton, $M_p = 1.67 \times 10^{-27}$ Kg*
- *Electronic charge, $e = 1.6 \times 10^{-19}$ C*
- *Permeability of free space, $\mu_O = 4\pi \times 10^{-7}$ Tm/A*
- *$1eV = 1.6 \times 10^{-19}$ J*

SECTION A

Question One (12 Marks)

a) A charge $q_1 = 2.0\ \mu C$ is located at the origin, and a charge $q_2 = -6.0\ \mu C$ located at (0, 3.0) m.

i. Find the total electric potential due to these charges at the point P, with co-ordinates (4.0,0) m. (2 Marks)

ii. Find the change in potential energy of the system of two charges plus a third charge $q_3 = 3.0\ \mu C$ as the latter is moved from infinity to the point P.(1 Mark)

b)i) Write down the expression of Gauss law of the electric field. (1 Mark)

ii) What is the electric field due to an infinitely long wire carrying a linear charge density λ C m^{-1}? (2 Marks)

c) Two point charges $q_1 = 4.5 \times 10^{-9}$ C and $q_2 = -4.5 \times 10^{-9}$ C are separated by 3.1 mm, forming an electric dipole.

i) Find the electric dipole moment (2Marks)

ii) The charges are in uniform electric field whose direction makes an angle of 36.9° with the line connecting the charges. What is the magnitude of this field if the torque exerted on the dipole has magnitude $7.2\times10^{-9}\,N.m$ (2Marks)

d) A vertical electric field of magnitude $2.0 \times 10^4\,N/C$ exists above the Earth's surface on a day when a thunderstorm is brewing. A car with a rectangular size of 6.00 m by 3.00 m is traveling along a roadway sloping downward at 10.0°. Determine the electric flux through the bottom of the car. (2 Marks)

Question Two (12 Marks)

a)A proton travels with a speed of 3×10^6 m/s at an angle of 37.0° with the direction of a magnetic field of 0.300 T. Determine: (i) the magnitude of the magnetic force on the proton and (ii) its acceleration? (3 Marks)

b) A current of 17.0 mA is maintained in a single circular loop of 2.00 m circumference. A magnetic field of 0.800 T is directed parallel to the plane of the loop. (i) Calculate the magnetic moment of the loop. (ii) What is the magnitude of the torque exerted by the magnetic field on the loop? (3 Marks)

c) A coil consisting of 100 circular loops with radius 0.60 m carries a 5.0-A current.Find the magnetic field at a point along the axis of the coil, 0.80 m from the center. (2 Marks)

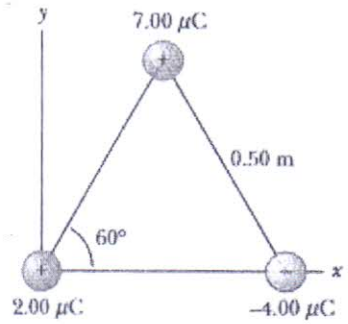
d) Deduce the expression for Ampere's law in magnetism. (2 Marks)

e) Compare and contrast Biot-Savart law in magnetostatics with Coulomb's law in electrostatics. (2 Marks)

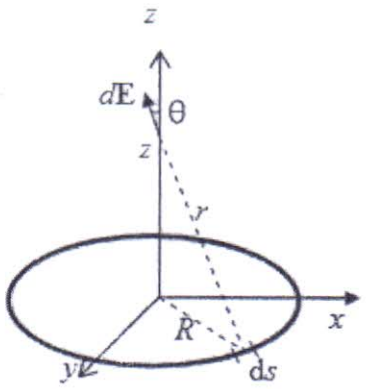
SECTION B

Question Three (12 Marks)

a)Three point charges are located at the corners of an equilateral triangle as shown in Figure below. Calculate the resultant electric force and magnitude of the electric field on the $7.00\mu C$ charge. (6 Marks)



b) A charge Q is uniformly distributed along the circumference of a thin ring of radius R. What is the electric field at points along the axis of the ring? (6 Marks)



Question Four (12 Marks)

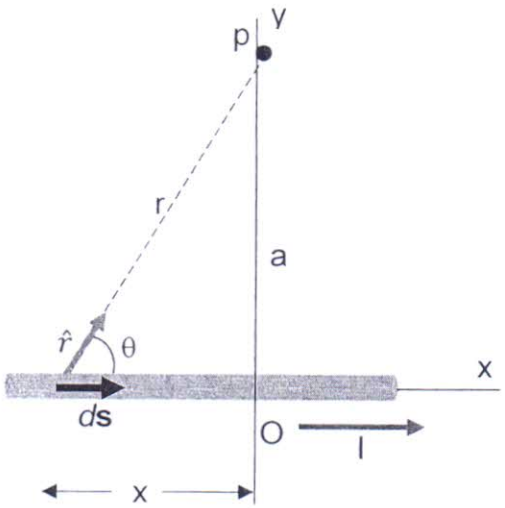
A charge Q is distributed uniformly throughout a sphere of radius R.

a) Calculate the electric field at a point within the sphere. (5 Marks)

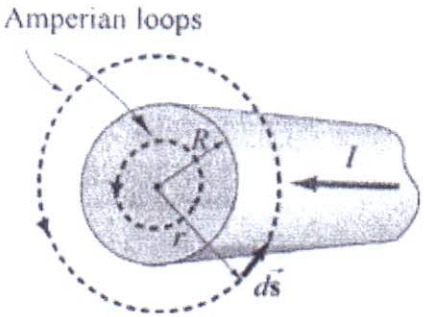
b) Calculate electric potential at a point within the sphere (7 Marks)

Question Five (12 Marks)

a)Consider a thin, straight wire carrying a constant current$I$ and placed along the x axis as shown in figure below.Determine the magnitude and direction of the magneticfield at point P due to this current. (6 Marks)



b) Consider a long straight wire of radius R carrying a current I of uniform current density, as shown in Figure below. Using Ampere's, find the magnetic field inside ($r \leq R$) and outside the wire ($r \geq R$). (6 Marks)



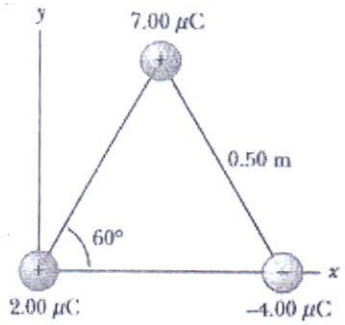
Question Six (12 Marks)

a) The plates of a parallel-plate capacitor are 2.50 mm apart, and each carries a charge of magnitude80.0 nC. The plates are in vacuum. The electric field between the plates has a magnitude of $4.0 \times 10^6\ V/m$

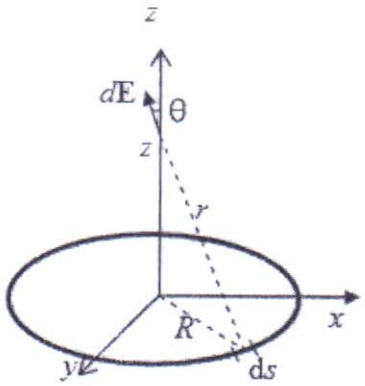
i. What is the potential difference between the plates?(2 Marks)

ii. What is the area of each plate?(2 Marks)

iii. What is the capacitance?(2 Marks)



b) A charge Q is uniformly distributed along the circumference of a thin ring of radius R. What is the electric field at points along the axis of the ring? (6 Marks)



Question Four (12 Marks)

A charge Q is distributed uniformly throughout a sphere of radius R.

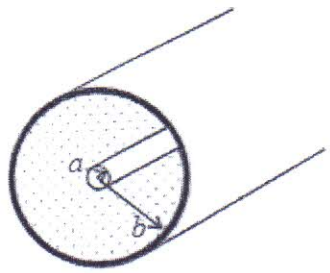
a) Calculate the electric field at a point within the sphere. (5 Marks)

b) Calculate electric potential at a point within the sphere (7 Marks)

Question Five (12 Marks)

a)Consider a thin, straight wire carrying a constant current$I$ and placed along the x axis as shown in figure below.Determine the magnitude and direction of the magneticfield at point P due to this current. (6 Marks)

b) What is the capacitance of a long cylindrical (coaxial) cable of inner radius a, outer radius b and length L as shown? How is the capacitance changed if the insulation between the conductors is plastic with a dielectric constant k? (6 Marks)



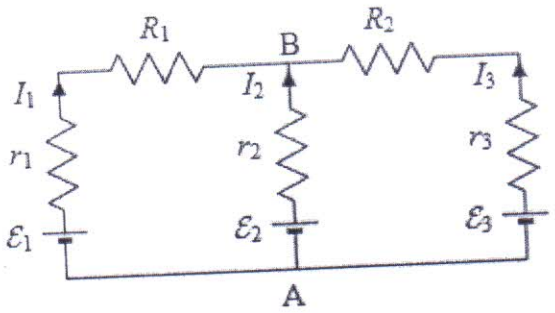
Question Seven (12 Marks)

a)Given three resistors of resistances R_1 ,R_2 and R_3, derive an expression for R that:

(i) maximize the equivalent resistance (2 Marks)

(ii) minimize the equivalent resistance? (2 Marks)

b) The circuit below consists of 3 different imperfect batteries connected to two equal resistors. Find the currents I_1, I_2 and I_3 leaving the batteries, and the potential difference from A to B, V_{AB}. (8 Marks)



Take $\mathcal{E}_1 = 6$ V, $r_1 = 1\Omega$, $\mathcal{E}_2 = 10$ V, $r_2 = 2\Omega$, $\mathcal{E}_3 = 12$ V, $r_3 = 3\Omega$ and $R_1 = R_2 = 20\Omega$.

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