ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

SEMESTER I EXAMINATION, 2016/2017 ACADEMIC SESSION

COURSE TITLE: ELECTROMAGNETIC FIELDS

COURSE CODE: EEE 313

EXAMINATION DATE: 5TH APRIL, 2017

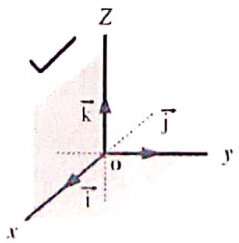
COURSE LECTURER: DR R. O. Alli-Oke

HOD's SIGNATURE

TIME ALLOWED: 2½ HRS

INSTRUCTIONS:

1. ANSWER **QUESTION 1** AND ANY OTHER TWO QUESTIONS **(TOTAL OF 3 QUESTIONS)**
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM.
3. YOU ARE **NOT** ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS DURING THE EXAMINATION.
4. SEPARATION VECTOR $\xi$ IS **ALWAYS** $r - r'$ i.e. FIELD POINT – SOURCE POINT.
5. COULOMB'S LAW: $\vec{\mathbf{E}} = \frac{1}{4\pi\epsilon_0}\frac{q}{\xi^2}\hat{\xi}$ VACUUM PERMITIVITY $\epsilon_0$ : $8.854\times10^{-12}\ \mathrm{Fm}^{-1}$
6. COLOUMB'S CONSTANT $k_e = \frac{1}{4\pi\epsilon_0} = 8.988\times10^{9}\ \mathrm{Nm}^2\mathrm{C}^{-2}$
7. USE THE FOLLOWING COORDINATE SYSTEM THROUGHOUT THE EXAM



1)

a) What is a vector field? **(3 marks)** State 3 coordinate systems for describing vector fields. **(3 marks)**

b) The charges below shows particles with charges $q_1 = +2Q$ , $q_2 = -2Q$ , and $q_3 = -4Q$ each at a distance $d$ from the origin. What is the net electric field at the origin? *Hint: You may use separation vectors approach. Note that the origin is already specified.* **(8 marks)**

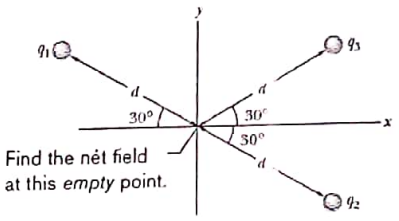



Figure 1: Configuration of Discrete Charges

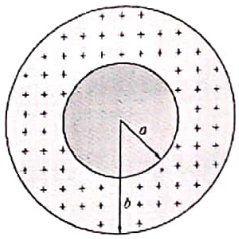



Figure 3: Thick Spherical Shell

c) The figure below (Fig. 2a) shows a non-conducting rod with uniformly distributed charge $+Q$. The rod forms a half-circle of radius R and produces an electric field of magnitude $E_{arc}$ at its center of curvature P. If the arc is collapsed in a single point from P (see Fig 2b), by what factor is $E_{arc}$ multiplied? You must use separation vectors approach. *Hint: ratio of the electric field at P in Fig 2b to $E_{arc}$ at P in Fig 2a.* **(8 marks)**

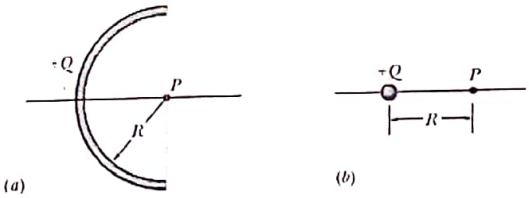



Figure 2: Configuration of Uniformly Distributed Charges

d) An electron travels with a velocity of $4.9\times10^6$ m/s in the $i$-direction through a point in space where the magnetic field is 0.111T in the $j$-direction. Force of the electron at this point is $F = (9.5\times10^{-14})\,i + (9.5\times10^{-14})k$ N. Determine the electric field at this point. *Hint: Use Lorentz force law*
**(7 marks)**

2)

a) State Gauss's law. **(3 marks)** State 3 symmetries that are easily applicable with Gauss law. **(3 marks)**

b) Using Gauss's law, compute $|\vec{E}|$ at the radial distance $r$ from an infinitely long thin rod of with uniform charge density $\lambda$. Assume that the rod is aligned with the $y$-axis. **(4 marks)**

c) An infinite line of charge produces a field of magnitude $4.5\times10^4$ N/C at a radial distance of 2.0m. Determine the linear charge density. *Hint: Use the result obtained in (b).* **(2 marks)**