MURANG'A UNIVERSITY COLLEGE

(A Constituent College of Jomo Kenyatta University of Agriculture and Technology)

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

DIPLOMA IN ELECTRICAL AND ELECTRONICS TECHNOLOGY

(POWER MODULE III)

MAIN EXAMINATION

LEVEL: **DIPLOMA**

CLASS: **KNEC/EEP/15DJ3**

TERM/SEMESTER: **I**

ACADEMIC YEAR: **2014/2015**

UNIT: **ELECTROMAGNETIC FIELD THEORY**

UNIT CODE: **EE1306**

DATE: 22ND APRIL 2015 **TIME: 3 HOURS**

Instructions to candidates

- This paper contains **SEVEN (7)** questions.
- Attempt **ANY FIVE (5) QUESTIONS.**
- **ALL QUESTIONS CARRY EQUAL MARKS.**
- You should have the following for this examination:
  - Answer booklet
  - Scientific calculator
- **NO MOBILE PHONES ARE ALLOWED WITHIN THE EXAMINATION ROOM!!!!!!!**

QUESTION ONE

a) Describe the source(s) and detector(s) of the following types of electromagnetic radiations:
   i. Radio waves
   ii. Visible light
   iii. Ultraviolet radiations **(6 marks)**

b) State Coulomb's Law. **(2 marks)**

c) Calculate the electrostatic force of repulsion between two α-particles when at a distance of 10^{-13} m from each other. Charge of α-particle is 3.2×10^{-12} C. The mass of each particle is 6.68×10^{-27} N-m^2/kg^2. **(4 marks)**

d) Define the following terms:
   i. Electric field
   ii. Electric field intensity/Electric field strength
   iii. Electric flux
   iv. Electric flux density/Electric flux displacement **(8 marks)**

QUESTION TWO

a) Define the following terms:
   i. Magnetic field strength
   ii. Magnetic potential **(4 marks)**

b) Two small identical conducting spheres have charges of 2.0×10^{-9} C and -0.5×10^{-9} C respectively. When they are placed 6 cm apart, what is the force between them? If they are brought into contact and then separated by 4 cm, what is the force between them? **(6 marks)**

c) Two infinitely long horizontal parallel plates are 2.0 cm apart in vacuum and the upper plate is maintained at a positive potential relative to the lower so that the field strength between them is 2.5×10^5 v/m.
   i. Determine the potential drop between the plates.
   ii. If an electron of charge 1.6 x 10-19 C and mass of 9.1 x 10-31 kg is released from rest at the lower plate, determine its speed on reaching the upper plate. **(10 marks)**

QUESTION THREE

a) State Gauss's Law. **(2 marks)**

b) Point charges in air are located as follows: $+5 \times 10^{-8}$ C at (0, 0) metres, $+4 \times 10^{-8}$ C at (3, 0) metres and -6×10^{-8} C at (0, 4) metres. Find the electric field intensity at (3, 4) metres. **(10 marks)**

c) Describe the source(s) and detector(s) of the following magnetic radiations:
   i. Microwave radiations
   ii. X-ray radiations
   iii. Gamma-ray radiations
   iv. Infrared radiations **(8 marks)**

QUESTION FOUR

a) State the ampere's circuital law. **(2 marks)**

b) Calculate the magnetising force and flux density at a distance of 5 cm from a long straight circular conductor carrying a current of 250 A and placed in air. Draw a curve showing the variation of flux density (B) from the conductor surface upwards if its diameter is 2 mm. **(6 marks)**

c) Explain the meaning of the following terms as relates to properties of electromagnetic waves:
   i. Transverse electromagnetic wave
   ii. Longitudinal electromagnetic wave
   iii. Frequency
   iv. Wavelength
   v. Period
   vi. Attenuation **(12 marks)**

QUESTION FIVE

a) With the aid of a sketch, explain the Bio-Savart's law in a magnetostatics field. **(5 marks)**

b) Point charges 1 mC and -2 mC are located at (3, 2,-1) and (-1, -1, 4) respectively. Determine the electric force on a 10 nC charge located at (0, 3, 1) and the electric field intensity at that point. **(10 marks)**

c) An iron-ring of mean length 120 cm, cross-sectional area 8 cm^2 and a relative permeability of 1245 is wound with a coil of 480 turns, taking a current of 2 A, determine:
   i. Resistance of the ring
   ii. Flux produced in the ring **(5 marks)**

QUESTION SIX

a) Express the following electrical quantities into their equivalent magnetic quantities:
   i. Voltage (V)
   ii. Electrical field intensity (E)
   iii. Current density (J)
   iv. Current (I) **(8 marks)**

b) A parallel-plate capacitor with plate area of 5 cm^2 and separated by a distance of 3 mm has a voltage 50sin103t volts applied across its plates. Assuming $E=2\varepsilon_0$, determine the value of the displacement current. **(12 marks)**

QUESTION SEVEN

a) Define the following terms:
   i. Flux density
   ii. Intensity of magnetisation
   iii. Susceptibility **(6 marks)**

b) An electron has a velocity of 1.5×10^7 m/s at right angles to the uniform electric field between two parallel deflecting plates of a cathode-ray tube. If the plates are 2.5 cm long and spaced 0.9 cm apart and p.d between the plates is 7.5 V, calculate how far the electron is deflected sideways during its movement through the electric field. Assume electronic charge to be 1.6×10^{-19} coulombs and electronic mass to be 9.1×10^{-31} kg. **(10 marks)**

c) A parallel-plate capacitor has plates 0.15 mm apart and dielectric with relative permittivity of 3. Find the electric field intensity and the voltage between the plates if the surface charge is 5×10^{-4} $\mu C/cm^2$. **(4 marks)**