(ii) A circular coil of radius $5\times10^{-2}$m and with 40 turns is carrying a current of 0.25A. Determine the magnetic field of the circular coil at the centre [4mks]

(b) Highlight any two differences between coulomb's law and Biot- savart's law [4mks]

(c)(i) Explain the uniqueness theorem [4mks]

(ii) Current carrying component in high voltage power equipment must be cooled to carry away the heat caused by ohmic losses. A means of pumping is based on the force transmitted to the cooling fluid by charges in an electric field. The electrodynamic (EHD) pumping is modelled in figure 2, the region between the electrodes contains a uniform charge $P_o$ which is generated at the left electrode and collected at the right electrode. Compute the pressure of the pump if $P_o$= 25m C/m$^3$ and $V_O$ = 22kv [6mks]

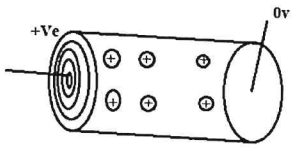


*Figure 2*

(a) State Biot-Savart,s law and express it mathematically [3mks]

(b) The conducting triangular loop shown in figure 1 carries a current of 10A. The magnetic field $\hat{H}$ at a point (0,0,5) due to side 1 of the loop is? [6mks]

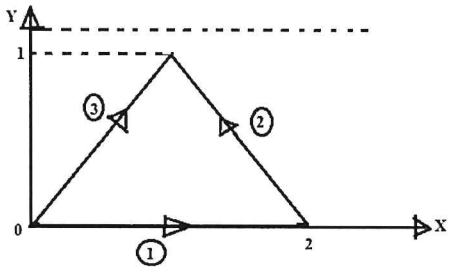


*Figure 1*

(c) (i)Define the term electric flux line [1mk]

(ii) Draw a diagram to show equipotential surface for point charge and an electric dipole [3mks]

(iii) Two dipoles with dipole moments $-5a_z$ n C/m and $9a_z$ n C/m are located at points (0,0, -2) and (0,0,3) respectively. Find the potential at the origin. [5mks]

## QUESTION 4

(a) State the ampere circuital law and express it in integral form [2mks]

(b) Apply ampere circuital law to compute the magnetic field strength

(i) Inside an ideal solenoid [3mks]

(ii) Inside a finite solenoid [4mks]

(c)(i) Define what is meant by the term toroid [2mks]

(ii) Explain the difference between a solenoid and a toroid [2mks]

(iii) Deduce the magnetic field in the empty space enclosed by the toroid of radius R [2mks]

(d)(i) Using relevant mathematical expression show the relation between flux density (B), magnetisation force (H) intensity of magnetisation I and susceptibility (K). [3mks]

(ii) Basing on susceptibility (K) explain the differences in the following material; ferromagnetic material, paramagnetic material and diamagnetic material [2mks]

## QUESTION 5

(a) Determine the magnitude of the magnetic field of a wire loop at the centre of the circle with radius R and current I [2mks]

## QUESTION 1

(a) State the two laws of electrostatics [2mks]

(b) Three identical point charges each Q coulombs are placed at the vertical of an equilateral triangle 10cm apart. Calculate the force on each charge [3mks]

(c) Explain stokes theorem [3mks]

(d)(i) State the faradays law of electromagnetic induction and derive relevant equations in relation to the laws [4mks]

(ii) The field coils of a 6 pole DC generator each having 500 turns are connected in series. When the field is excited, there is a magnetic flux of 0.02wb/pole. If the field circuit is a magnetic flux of 0.02seconds and residual magnetism is 0.02wb/pole. Calculate the average voltage which is induced across the field terminals. Deduce the directions in which the induced voltage is directed relative to the direction of current [4mks]

(e) A dielectric sphere ($\varepsilon r = 57$)of radius 10cm, has a point charge $2pC$ placed at its centre, Calculate:

(i) The surface density of polarization charge on the surface of the sphere [3mks]

(ii) The force exerted by the charge m-4pc point charge placed on the sphere [2mks]

(f) Derive the continuity current equation [5½mks]

(g)(i) Explain what is meant by method of images when dealing with boundary conditions [2mks]

(ii) State the advantages of using method of images [1mk]

## QUESTION 2

a) Define the following terms [3mks]

(i) Electric field

(ii) Electric intensity

(iii) Electric susceptibility

(b) A point charges in air are located as follows $+5\times10^{-8}$ C at (0,0) metres ,$4\times10^{-8}$C at (3,0) metres and $-6\times10^{-3}$at (0,4) metres. Find the electric intensity at (3,4) metres [6mks]

(c) (i)Use gauss law to derive the electric field of a sphere of uniform charge density and a total charge q [8mks]

(ii) Calculate the total charge of a sphere with radius =10cm if it has a uniform volume charge density = 280 $cm^3$ [3mks]

## QUESTION 3

# MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

**MAIN CAMPUS**

**UNIVERSITY EXAMINATIONS**
**2023/2024 ACADEMIC YEAR**

**THIRD YEAR FIRST SEMESTER EXAMINATIONS**

**FOR THE DEGREE OF**

**BACHELOR OF SCIENCE**
**IN**
**ELECTRICAL AND COMMUNICATIONS ENGINEERING**

**COURSE CODE: ECE 312**

**COURSE TITLE: ELECTROMAGNETICS 1**

**DATE: TUESDAY 05/12/2023 TIME: 8:00 AM – 10:00 AM**

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**INSTRUCTIONS TO CANDIDATES**

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating