# TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED &HEALTH SCIENCES

MATHEMATICS & PHYSICS DEPARTMENT

## UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS AND BACHELOR OF TECHNOLOGY IN ENVIRONMENTAL PHYSICS & RENEWABLE ENERGY

APS 4202: ELECTRICITY & MAGNETISM II

END OF SEMESTER EXAMINATION

**SERIES: MAY 2016**

**TIME:** 2 HOURS

**DATE:** MAY 2016

**Instructions to Candidates**

You should have the following for this examination

*-Answer Booklet, examination pass and student ID*

This paper consists of 4 questions. **Do not write on the question paper. Answer question ONE (compulsory) and any other two questions.**

DATA: Permeability of vacuum/free space, $\mu_0 = 4\pi \times 10^{-7}\ Hm^{-1}$

Permittivity of vacuum/ free space, $\varepsilon_0 = 8.85 \times 10^{-12}\ Fm^{-1}$

Electron charge, $q = 1.602 \times 10^{-19}\ C$

Mass of electron, $m_e = 9.11 \times 10^{-31}\ kg$

Proton mass, $m_p = 1.67x10^{-27}\ kg$

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**Question ONE**

(a) (i) A uniform electric field is set up within parallel plate conductor of plate separation d and potential differences V. An electronic charge q of mass m is released on the negative plate. Determine the acceleration of the electronic charge q within the plate. (3 marks)

(ii) Hence show that the final velocity of the charge is (i) above is

$$V = \sqrt{\frac{2qV}{m}}$$ (3 marks)

(b) A solid wire of radius $R$ carries a current $I$. Determine the magnetic field intensity $\vec{H}$ at a radius $r$

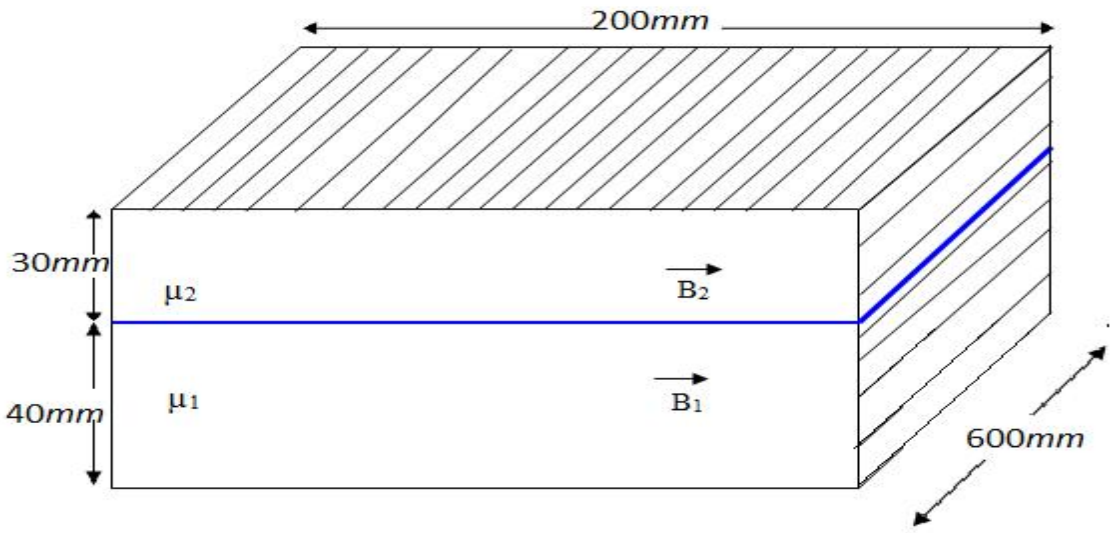
Where (i) $r > R$ (2 marks)

(ii) $r < R$ (3 marks)

(c) Show that the capacitance per unit length of a coaxial cable is given by $\frac{2\pi\varepsilon}{\ln(b/a)}$ where a and b are the inner and outer radii respectively of the conductors. (5 marks)

(d) Using the atomic current loop model derive an expression for the magnetization $M$ for a uniformly magnetized rod. (4 marks)

(e) Find the total reluctance and permeance between the ends of the parallel-connected rectangular iron blocks shown in figure 1, assuming that $\vec{B}$ is uniform in each block and normal to the ends. The permeability in each block is uniform, the value in block 1 being $\mu_1 = 500\mu_0$ and in block 2 being $\mu_2 = 2000\mu_0$.




(6 marks)

(f) Compute the inductance of a solenoid of 2000 turns wound uniformly over a length of 500mm on a cylindrical paper tube 40mm in a diameter. (The medium is air, $\mu = \mu_0$)

(4 marks)

**Question TWO**

(a) State Ampere's law and use it to explain magnetomotance, F. (4 marks)

(b) (i) Explain the term atomic current loop and define atomic magnetic moment

(3 marks)

(ii) Show that when a magnetic field $\vec{B}$ is applied to the atomic loop, there is a torgue $\vec{T}$ tending to align the moment of the atomic loop with the field given by $\vec{T} = \vec{m}x\vec{B}$ (5 marks)

(c) Describe briefly the following magnetic behavior exhibited by materials giving examples of each.

(i) Diamagnetic (2 marks)

(ii) Paramagnetic (2 marks)

(iii) Ferromagnetic (2 marks)

(iv) Super paramagnetic (2 marks)

**Question THREE**

A bar magnet of pole strength $Q_m$ and length $L$ is placed in a uniform $\vec{B}$ field such that the length $L$ makes an angle with $\vec{B}$. Show that the torque $\vec{T}$ on the bar magnet is given by $\vec{T} = Q_m Lb\sin^{-}$ (5 marks)

(b) (i) Derive the expressions for magnetic energy $w_m$, stored in an inductor.(4 marks)

(ii) Hence use the concept of field cells to show that the magnetic energy density in the conductor is given by $w_m = \frac{1}{2}«H^{z}$ (5 marks)

(c) A very long solenoid with $2x2cm^2$ cross-sectional area has an iron core $(« = 1000)$ and 4000 turns per metre. If it carries a current of 5000mA,

Find: (i) Its inductance per metre (3 marks)

(ii) The energy density stored in its field. (3 marks)

**Question FOUR**

(a) (i) Give the wave equation in $H_z$ and propagation along x direction ( 9 marks)

(ii) Relate the wave velocity to permeability and permittivity ,and ( 2marks)

(iii) Hence compute the speed of electromagnetic waves vacou ( 2marks)

(b) An electromagnetic wave is given by the equation $E_y = E_0 \cos(\mu t - x)$

Determine :

(i) The direction of the propagation ( 2 marks)

(ii) The velocity of the wave( 2 marks)

(iii) The wavelength of the wave( 2 marks)

(c) Derive the transmission line wave equations and use them to obtain the characteristic impedance of an infinite uniform transmission line (9 marks)