TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF TECHNOLOGY IN RENEWABLE ENERGY
BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS
(BTRE 13S/BTAP 13S)

APS 4202: ELECTRICITY & MAGNETISM II

SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: JUNE 2015
TIME ALLOWED: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FOUR** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

Data:

$$u_o = 4\pi \times 10^{-7}\, Am^{-1}$$

Permeability of free space,

$$\varepsilon_o = 8.85 \times 10^{-12}\, Fm^{-1}$$

Permiltively of free space

$$1.602 \times 10^{-19} C$$

Electron charge z =
Mass of electron me = 9.11 x 10-31kg
Proton mass mp = 1.67 x 10^{-17}kg

Question One (Compulsory)

a) (i) A uniform electric field is set up within parallel plate conductor of plate separation d and potential difference 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 in (i) above is:

$$V = \sqrt{\frac{2qV}{m}}$$

b) A solid wire of radius R carries a current I. Determine the magnetic field intensity $\vec{H}$ at the radius r where:
(i) r > R and **(2 marks)**
(ii) r < R **(3 marks)**

c) Show that the capacitance per unit length of coaxial cable is given by $\frac{2\pi\varepsilon}{\ln\left(b/a\right)}$ 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 rectangular iron blocks shown in figure 1, assuming that $\vec{B}$ is uniform in each permeability in each block is uniform, the value in block 1 $\mu_1 = 500\mu_o$ and in block 2 $\mu_2 = 2000\mu_o$ being **(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 diameter (The medium is air, $\mu = u_o$) **(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 torque $\vec{T}$ tending to align the moment of the atomic loop with the field given by $\vec{T} = \vec{m} \times \vec{B}$ **(5 marks)**

c) Describe briefly the following magnetic behavior exhibited by material giving examples of each:
(i) Diamagnetic **(2 marks)**
(ii) Paramagnetic **(2 marks)**
(iii) Ferromagnetic **(2 marks)**

(iv) Super paramagnetic **(2 marks)**

Question Three

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

b) (i) Derive the expressions for magnetic energy Wm, stored in an inductor **(4 marks)**

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

c) A very long solenoid with 2 x 2 cm2 cross-sectional area has an iron core (μ = 100) and 4000 turns per metre. It carries a current of 500mA 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 propagating along x direction **(1 mark)**

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

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

b) An electromagnetic wave is given by the equation $E_y = E_o \cos(\omega t - \rho x)$. 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 impendence of an infinite uniform transmission line **(9 marks)**