TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING
BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING
(BSCE/BSEE - Y1 S2)

SPH 2171: PHYSICS II

END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2014
TIME ALLOWED: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FIVE** 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 **FOUR** printed pages

Where necessary use:

$\varepsilon_o = 8.5\times10^{-12}\,N^{-1}m^{-2}C^2;\ \kappa = \dfrac{1}{4\pi\varepsilon_o} = 8.99\times10^{9}\,Nm^2C^{-2}$

$C = 3.0\times10^{8}\,ms^{-1};\quad e = 1.602\times10^{-19}C$

$1eV = 1.602\times10^{-19}\,J:\ 1gauss = 1G = 10^{-4}T$

$1curie = 1Ci = 3.7\times10^{10}\,Bq = 3.7\times10^{10}\,delays/s$

Profon mass = n_p = 1.67 x 10^{-27}kg = 1.00783u
Neutron mass, m_n = 1.00866u
electron mass, m_e = 9.11 x 10^{-31}kg

1atomic unit = 1u = 931.49Mev/c^2

$\mu_o = 4\bar{\mu} \times 10^{-7} Tm/A$

Question One (Compulsory)

a) Define the following terms as applied to electric circuit networks.

(i) Node

(ii) Loop

(iii) Mesh **(3 marks)**

b) (i)

X

The magnetic flux around the closed path in the figure above is 3.77 x 10^{-6} Tm. Find the value of current I_3. **(4 marks)**

(ii) A 2cm diameter, 15cm long solenoid is tightly wound from 1.0mm diameter wire. What current is needed to generate 3.0mT field inside the solenoid? **(4 marks)**

c) The earth has a radius of 6.4 x 10^6m:

(i) What is its capacitance? **(2 marks)**

(ii) If the earth carries a negative charge that gives a field of about 100Vm^{-1} at the surface, calculate the total charge. **(2 marks)**

(iii) Calculate the potential at the surface of the earth. **(2 marks)**

d) Differentiate between:

(i) Passive network and active network **(2 marks)**

(ii) Drift velocity and velocity of field propagation **(3 marks)**

e) (i) Find the velocity of charge leading to 2A current which flows in a copper conductor wire (free electron density of copper is 8.5 x 10^{28}m^{-3}) of cross-section 5cm^2 and length 5km **(2 marks)**

(ii) How long will it take the electric charge to travel from one end of the conductor to the other? **(2 marks)**

f) Identify the unknown isotope X in the following decays:

(i) $^{230}_{90}Th \rightarrow X + \alpha$ **(2 marks)**

(ii) $^{35}_{16}S \rightarrow X + e^- + v$ **(2 marks)**

Question Two

$\vec{E} = \left(10^5 N/C\right)\hat{i}$

a) An electric field causes the 5 gram ball-point charge shown in the figure below to hang at a 20° angle.

m= 5g

What is the charge on the ball? **(6 marks)**

b) A parallel plate capacitor has plates of area A separated by a distance d. How is the capacitance affected by introducing an insulated sheet, of metal thickness do, parallel to the plates? (Assume the insulated material has the same cross section as the capacitor plates) **(6 marks)**

c) Two capacitors are connected in series as in the figure below. Calculate the ratio of the stored energies in these capacitors. **(4 marks)**

V

d) Proton moves in a plane inclined at an angle of 30° with the magnetic field of strength 0.5T. Find the magnitude and direction of the magnetic force on a proton moving at a speed of 1.0×10^7 ms^{-1} **(4 marks)**

Question Three

a) (i) Differentiate between ionization energy and binding energy. **(3 marks)**

(ii) Calculate the binding energy per nucleon (in MeV) for $^{12}_{6}C$ and $^{13}_{6}C$ **(5 marks)**

(iii) Which of $^{12}_{6}C$ and $^{13}_{6}C$ is more tightly bound. Explain **(2 marks)**

b) The radioactive hydrogen isotope $^{3}_{1}H$ is called tritium, with half-life of 12.33 years.

(i) What are the decay modes and the daughter nucleus of tritium? **(4 marks)**

(ii) Find the time constant and the decay rate of tritium

$atomic\ mass\ of\ 13_C = 13.00336u$

$atomic\ mass\ of\ 12_C = 12.000u$

(6 marks)

Question Four

a) What is the effect of increasing temperature on resistance for:

(i) Pure metals

(ii) Alloys

(iii) Electrolytes and insulators **(9 marks)**

b) In a test to determine the cable resistance of a simple core cable, an applied voltage of 2.5V was necessary to produce a current of 2A at 15°C.

(i) Calculate the resistance at 55°C if the temperature coefficient of resistance of copper at 0°C is $1/235$ per °C **(8 marks)**

(ii) If the cable under working conditions carries a current of 10A at this temperature (55°C) calculate the power dissipated in the cable. **(3 marks)**

Question Five

a) State Kirchhoff's mesh (or voltage) law. **(2 marks)**

b) Explain how you determine the voltage sign for:

(i) Battery's Emf **(4 marks)**

(ii) IR drop **(4 marks)**

c) Use the mesh-resistance matrix method to find the branch current in the circuit shown in the figure below. **(10 marks)**