UNIVERSITY OF NAIROBI

SECOND SEMESTER EXAMINATIONS - 2015/2016

FIRST YEAR EXAMINATIONS FOR THE DEGREES OF BACHELOR SCIENCE IN BIOSYSTEMS ENGINEERING, BACHELOR OF SCIENCE IN CIVIL ENGINEERING, BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING, BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING AND BACHELOR OF SCIENCE IN GEOSPATIAL ENGINEERING

FCE 132/FEB 104/FEE102/FME 112/FGE 176 : ENGINEERING PHYSICS 1B

DATE: MAY 27, 2016 **TIME: 9.00 A.M. – 11.00 A.M.**

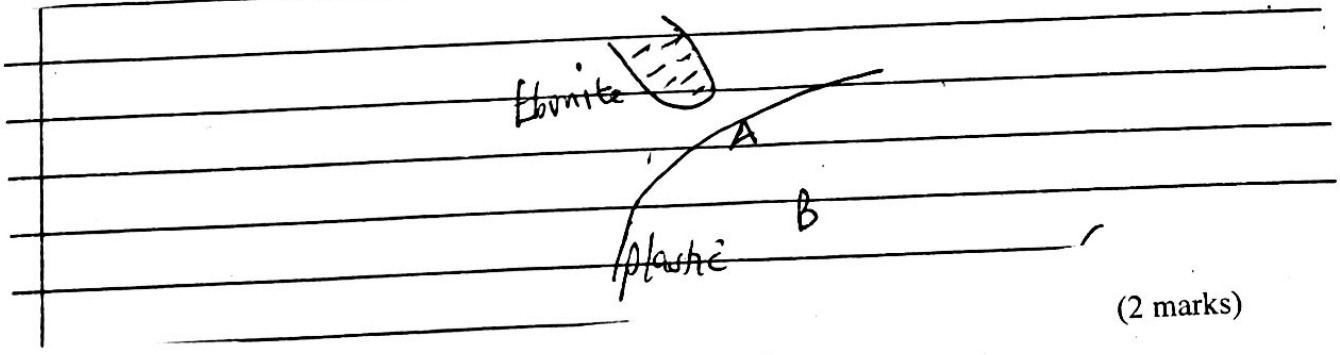
INSTRUCTIONS:

Answer **any THREE** Questions.

Question 1

a) i) What are the two types of charges in nature? (2 marks)

ii) The figure below shows a negatively charged ebonite rod near a plastic surface. What are the changes at points A and B?



(2 marks)

b) i) State Coloumb's law of charges. (1 mark)

ii) Two charges +1C and -1C are separated by a distance of 1km. (2 marks)

i) Calculate the force between the charges. (1 mark)

ii) Is the force attractive or repulsive?

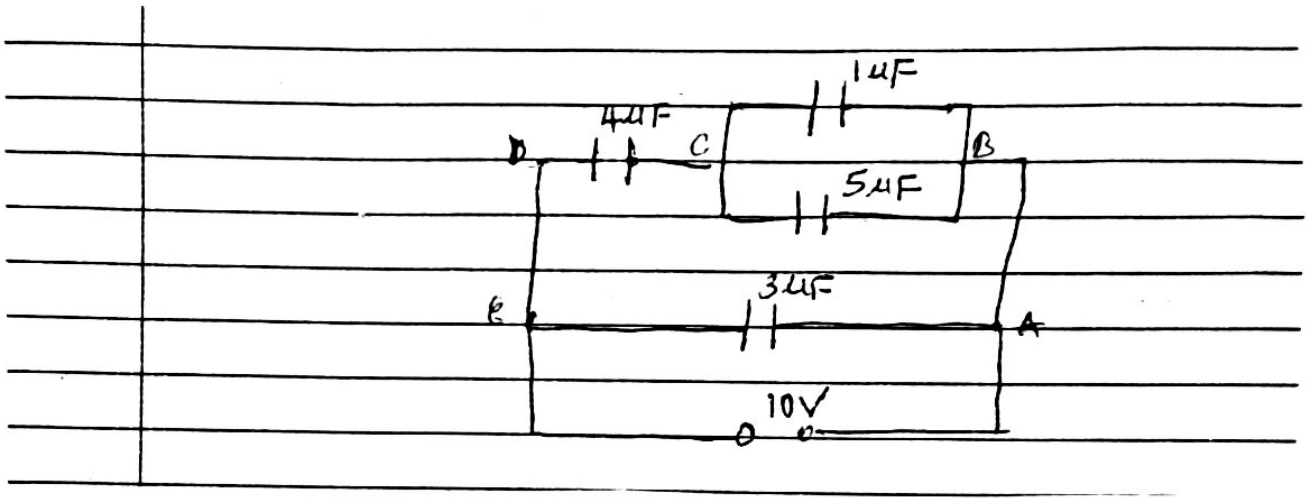
iii) Calculate the electric field strength, E at the 1C charge above. (2 marks)

(Electronic charge, $e = 1.6 \times 10^{-19} C$ proportional Constant, $K = 9 \times 10^{9}\ Nm^2/C^2$)

c) i) What is a capacitor? (1 mark)

ii) Explain the term 'Capacitance'. (1 mark)

iii) The diagram below shows a network of capacitors connected to a 10V power supply.



i) Compute the equivalent (total) capacitance of the capacitors. (3 marks)

ii) Calculate the charge on the 3 μF capacitor. (5 marks)

Question 2

a) On the same axis or separate axes sketch the variation of pure resistance, capacitive reactance and inductive reactance (x axis) with the frequency (y) of an input signal. (4 marks)

b) Explain with the aid of clear diagrams, the relationship between current and voltage in a:-

i) Purely resistive circuit. (4 marks)

ii) Purely capacitive circuit. (4 marks)

iii) Purely inductive circuit (4 marks)

c) A circuit has a 3.6 mH inductor which is connected to a Generator of r.m.s. voltage of 25V. Calculate the r.m.s current in the circuit when the Generator frequency is:

i) 1×10^{2} Hz

ii) 5×10^{3} Hz

(4 marks)

Question 3

a) i) Explain what x-rays are? (1 mark)

ii) With the aid of a well labelled diagram explain how x-rays are produced. (3 marks)

iii) List the disadvantages of using ultrasound over x-rays in medical diagnosis. (2 marks)

b) An x-ray tube operates at 30 kV with a current of 2.0mA. Calculate:

i) The electrical power input, (1 mark)

ii) The number of electrons striking the target per second, (2 marks)

iii) The speed of the electrons when they hit the target, (3 marks)
[Mass of an electron, Me = 9.11×10^{-31} kg]

iv) The lower wavelength limit of the x-rays emitted. (2 marks)

c) Explain what is meant by photoelectric effect? Give THREE of the experimental observations associated with this effect. (6 marks)

Question 4

a) Explain the following terms as applied to a radioactive substance

i) Radioactivity (1 mark)
ii) Decay constant (1 mark)
iii) Half-life (1 mark)

b) List two properties of each of the following type of particles/radiations:

i) Alpha-particles (2 marks)
ii) Beta-particles (2 marks)
iii) Gamma-rays (2 marks)

c) At a certain instant, a piece of radioactive material contains 10^{12} atoms. If the half-life of the material is 30 days

i) Calculate the number of disintegrations in the first second. (3 marks)
ii) How long will elapse before 10^{4} atoms remain? (5 marks)
iii) What is the count rate at this time (ii above)? (3 marks)

Question 5

a) Write down in vector form the expression of force $\vec{F}$ on charge q.

i) Moving in an electric field of charge, $\vec{E}$. (2 marks)

ii) Moving with speed $\vec{V}$ in a magnetic fields. (2 marks)

iii) Moving with speed, $\vec{V}$ in both electric and magnetic fields. (2 marks)

b) An electron moves through uniform magnetic field given by

$$B = B_x \underline{i} + 3B_x \underline{j}.$$

At a particular instant, the electron has velocity

$$\vec{V} = 2\underline{i} + 4\underline{j} \text{ m/s}$$

and the magnetic force acting on it is:

$$6.4\times10^{-19} \text{ N } \underline{\kappa}$$

Find B_x. (8 marks)

c) i) Write an expression of a magnetic force, $\vec{F}$ wire of length, $\vec{L}$ carrying current, I through it in magnetic field, $\vec{B}$. (2 marks)

ii) At what orientation in the magnetic field of the length of wire carrying current is this force minimum and maximum? (4 marks)

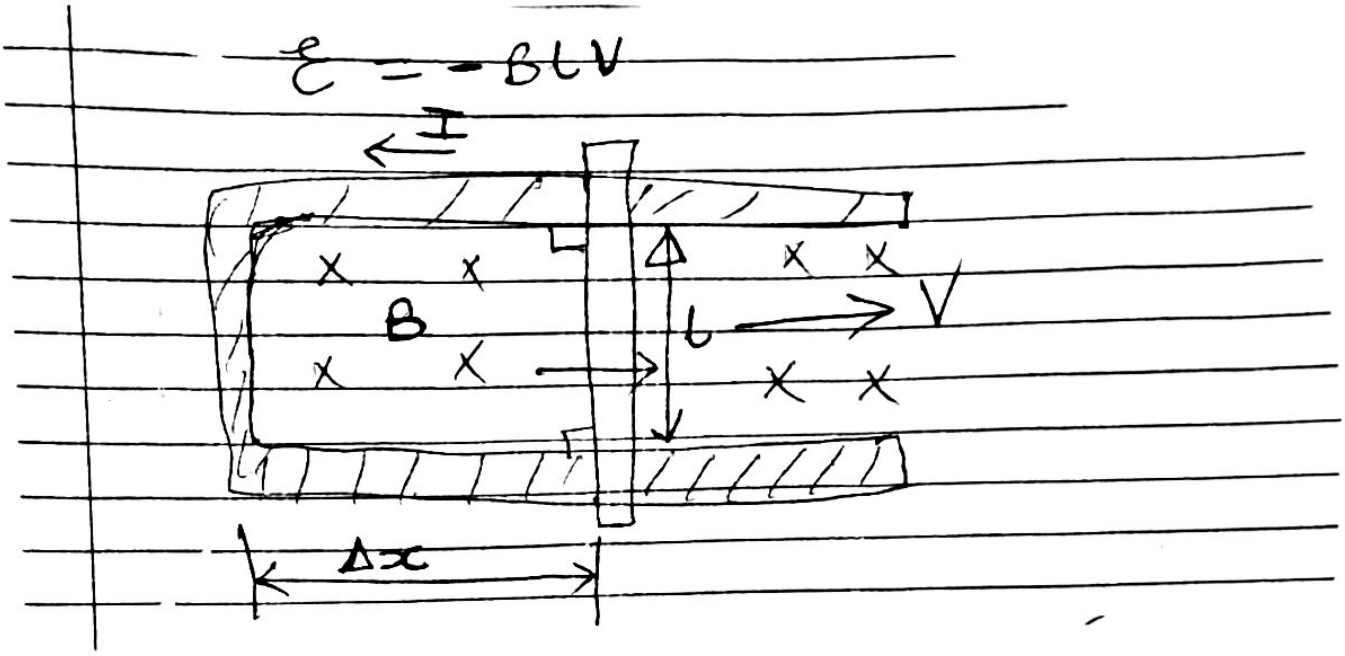
Question 6

a) i) Define "electromagnetic" induction. (4 marks)

ii) Write an expression for induced emf, ξ in a closely packed coil of N turns that emanates from a changing magnetic flux, ϕ_B in time t and explain why this emf has a negative sign. (4 marks)

b) Suppose a conductor of length, L is connected across a U-shaped conductor that is perpendicular to magnetic field, B, as shown in the figure. If the conductor moves with steady velocity, V in *x*-direction,
Show that,

$$\varepsilon = -BLV$$



(5 marks)

Figure: U-shaped conductor with rod of length, L across it in magnetic field that is into and perpendicular to plane of the paper.

c) i) Calculate the inductance of an air-core solenoid containing 300 turns if the length of the solenoid is 25 cm and its cross-sectional area is 4 cm^2. (4 marks)

ii) Calculate the induced emf in the solenoid in c(i) if the current it carries is decreasing at a rate of 50A/s. (3 marks)