KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2009/2010 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF COMPUTER SCIENCE

COURSE CODE: PHYS 110

COURSE TITLE: ELECTRICITY & MAGNETISM

STREAM: Y1S1

DAY: TUESDAY

TIME: 2:00 – 4:00P.M.

DATE: 23/03/2010

INSTRUCTIONS:

Instructions

- *Answer question 1 and ANY other TWO*
- *You may need the following constants where necessary:*
  $\pi = 3.14$ *;* , $\varepsilon_0 = 8.8541878176 \times 10\text{-}12$ F/m , g *=9.81* ms^{-2},
  $\mu_0 = 4\pi \times 10^{-7}$ N·A^{-2}.

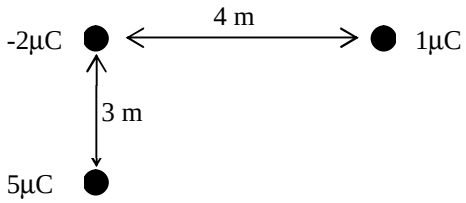
PLEASE TURN OVER

QUESTION 1 (30 MARKS)

(a) Briefly explain the origin of magnetism in materials (2 marks)

(b) (i) State coulomb's law of charges. (2 marks)

(ii) Three charges are distributed in a right angled manner as shown below.



Determine the force exerted on 5 μC by the other two charges. (5 marks)

(b) A proton with a charge of $1.6\text{x}10^{-19}$C is released from rest in a uniform electric field of magnitude 8×10^{4} V/m. After the proton has moved 0.5 meters, calculate

(i) The change in electric potential. (2 marks)

(ii) The change in potential energy. (2 marks)

(iii) The speed of the proton. (2 marks)

(e) Show that the potential energy of two point charges q_1 and q_2 can be expressed as

$U = k\dfrac{q_1 q_2}{r_{12}}$, where r_{12} is the distance separating the two charges. (3 marks)

(f) For the circuit in figure 1, determine,

(i) The time constant

(ii) The amount of current that would flow 20 ms after the switch is turned on. (5 marks)

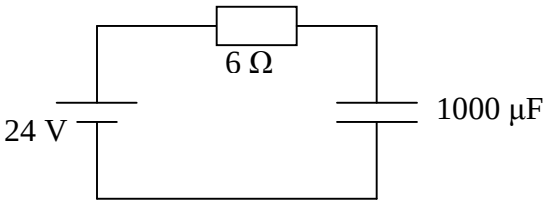


Figure 1

(g) Distinguish between hard and soft magnetic materials (2 marks)

(h) The earth's magnetic north pole is like the south pole of a magnet! Explain. (1 marks)

(i) From Ampere's law, show that the magnetic field of a wire loop of radius r and carrying a current *I* can be expresses as (3 marks)

$$B = \frac{\mu_o I}{2\pi r}$$

(j) Sketch the magnetic field pattern and direction for a thin straight conductor. (1 mark)

QUESTION 2 (20 MARKS)

(a) Compare the properties of gravitational forces with those of electrostatic forces. (8 marks)

(b) Two spheres separated by a distance d carry a charge of +46 μC and -30 μC.

(i) State what will happen to the charges on the sphere if they are made to touch each other and then returned to their original positions.

(ii) Determine the ratio $\frac{F_1}{F_2}$, where F_1 and F_2 are the forces between the two spheres before and after contact respectively. (6 marks)

(c) Four charges have been placed on the corners of a square 50 cm on each edge as shown in figure 2. Calculate the NET force on the +3 μC. (6 marks)

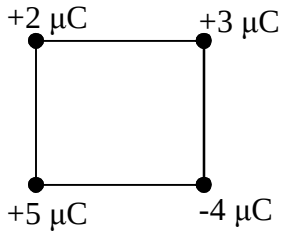


Figure 2.

QUESTION 3 (20 MARKS)

(a) Derive a general expression for the total resistance of a circuit for n resistors connected in parallel, hence determine the total power dissipated by a network of three parallel resistors of 4 Ω, 6 Ω and 10 Ω connected to a 12 V power supply. (8 marks)

(b) (i) State Kirchhoff's circuit laws (2 marks)

(ii) Find currents in all the resistors in figure 3. (10 marks)

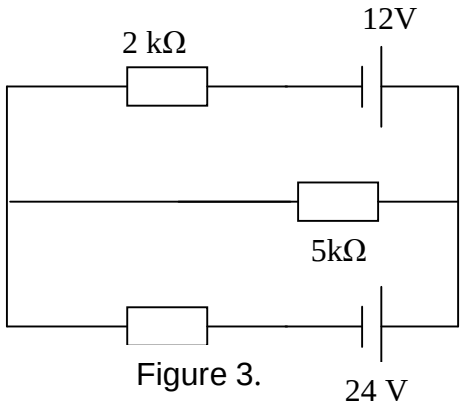


Figure 3.

Question 4 (20 marks)

(a) (i) Give four factors that affect the magnitude of induced magnetic flux in a coil. (4 marks)

(ii) Show that the emf induced by a rotating coil is of the form

$$E = E_0 \sin \omega t$$ (6 marks)

(b) (i) Explain why utility companies prefer to transport power over long distances at high voltages.

(ii) Why should AC be used on transformers and not DC?

(iii) Suppose 10 MW of power is being transported over a power line that has a resistance of 0.200 Ω. How much power is lost along the line if the voltage of the line is (a) 240 V, (b) 24,000 V? (10 marks)

QUESTION 5 (20 MARKS)

(a) Describe the operation of a Wheatstone Bridge (7 marks)

(b) Figure 4 shows a parallel plate capacitor with a conductor of thickness *a* inserted in between. Show for this arrangement, the capacitance can be expressed as

$C = \frac{\varepsilon_0 A}{d - a}$, where *A* is the area of the capacitor plates. (5 marks)

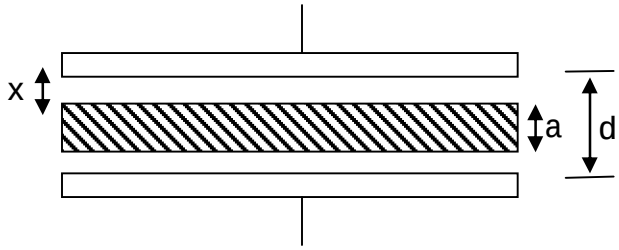


Figure 4.

(C) (i) State Thevenin's theorem. (2 marks)

(ii) Reduce the circuit below to Thevenin equivalent taking 20 Ω resistor as the load, hence find the current through the load. (6 marks)

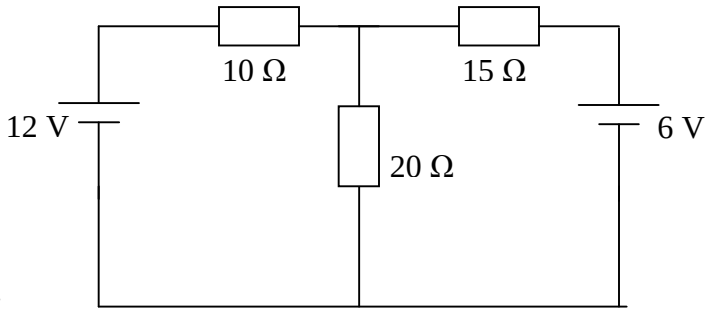


Figure 5.