BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT: ENGINEERING AND PHYSICS

PROGRAMME BSc HONOURS DEGREE IN COMPUTER SCIENCE / BSc EDUCATION HONOURS DEGREE IN COMPUTER SCIENCE

COURSE CODE PH107 (2): PHYSICS FOR COMPUTER SCIENCE

DURATION: 3 HOURS TOTAL MARKS: 100

JUN 2025

INSTRUCTIONS TO CANDIDATES

Answer **question one** in Section A and **any three** questions from Section B. Section A carries 40 marks and each question in Section B carries 20 marks.

Physical constants

Electronic charge, $e = 1.6 \times 10^{-19}\ C$
Boltzmann's constant, $k = 1.38 \times 10^{-23}\ JK^{-1}$
Mass of an electron, $m_e = 9.11 \times 10^{-31}\ kg$
Permittivity of free space, $\varepsilon_o = 8.85 \times 10^{-12}\ Fm^{-1}$
Permeability of free space, $\mu_o = 4\pi \times 10^{-7}\ Hm^{-1}$
Velocity of light in vacuum, $c = 3.00 \times 10^{8}\ ms^{-1}$
Universal Gravitational Constant, $G = 6.7 \times 10^{-11}\ Nm^2kg^{-2}$
Acceleration due to gravity, $g = 9.81\ ms^{-2}$
Electric potential at infinity, $V_\infty = 0$

SECTION A

1 (a) It is given that $\vec{L}$ and $\vec{M}$ are such that $\vec{L} = \vec{\imath} - 3\vec{\jmath} + 5\vec{k}$ and $\vec{M} = 3\vec{\imath} + 3\vec{\jmath} - 4\vec{k}$. Find $\vec{L} \times \vec{M}$ and verify that this vector is orthogonal to both $\vec{L}$ and $\vec{M}$. [6]

(b) A van travelling at a velocity of 10 ms^{-1} accelerates uniformly for 5 s at a rate of 2.5 ms^{-2}. Calculate the distance travelled during this time. [3]

(c) A positive charge of $+40\ \mu C$ is fixed at the origin and another charge of $-20\ \mu C$ is fixed to the x-axis at $x = 2\ m$. Find along the x-axis only one possible location where the electric field due to the two charges is zero. [6]

(d) If 200 J is required to carry a 10 C charge from point P to point Q what is the potential difference between the two points? [2]

(e) A 1500 μF capacitor is charged to a p.d. of 25 V. Calculate the charge acquired by the capacitor. [2]

(f) In an experiment to study capacitors, a capacitor of capacitance C discharges through a resistor of resistance R. Show that the time t when the charge on the capacitor become half of the initial value is given by $t = CRln2$. [5]

(g) A student has available some resistors, each of resistance 100 Ω. Draw circuit diagrams, one in each case, to show how a number of these resistors may be connected to produce a combined resistance of;

(1) 200 Ω (2) 50 Ω (3) 40 Ω [3]

(h) A charged particle carrying twice the magnitude of the basic charge moves with velocity $\vec{v} = \vec{\imath} - 5\vec{\jmath} + 2\vec{k}\ ms^{-1}$ in a region where the magnetic field is $\vec{B} = 4\vec{\imath} - \vec{\jmath} - 6\vec{k}\ T$.

(1) Calculate the magnitude of the magnetic force $\vec{F}$ on this particle. [5]
(2) Verify that $\vec{F}$ is centripetal in nature. [3]

(i) What do you understand by inductive reactance? [1]

(j) A resistor of resistance 500 Ω is connected in series with an inductor of inductive reactance 150 Ω and a 230 V supply. Calculate the current flowing in the circuit. [4]

SECTION B

2 (a) A particle is moving in two dimensions. Its position vector is given by;

$$r = (4 + 3t - 2t^2)\hat{x} + (5 + t)\hat{y}.$$

Distances are in metres and the time t in seconds.
(i) What is the velocity vector after 2 seconds. [3]
(ii) Evaluate the speed in ms^{-1} after 2 seconds. [3]
(iii) Determine the acceleration vector and its magnitude in ms^{-2} after 2 seconds. [6]

(b) Find the resultant and direction of the forces given in Fig. 1. [8]

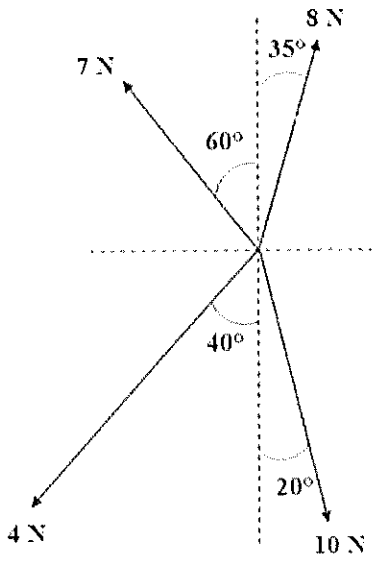

Fig. 1

3 Three point charges are located at the corners of an equilateral triangle as shown in Fig. 2.

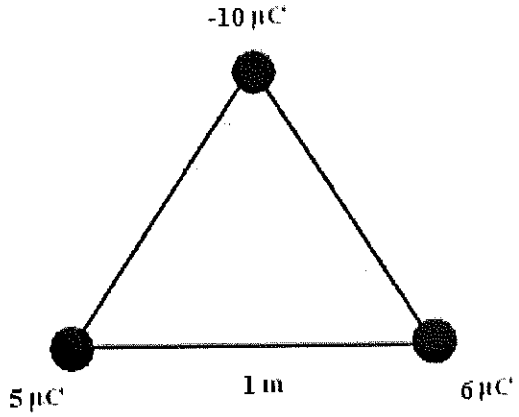

Fig. 2

(a) Calculate the electric potential at the centre of the triangle. [18]

(b) How much work is required to move a charge of 15 μC from infinity to the centre of the triangle? [2]

4 Fig. 3 shows a network containing two cells and some resistors.

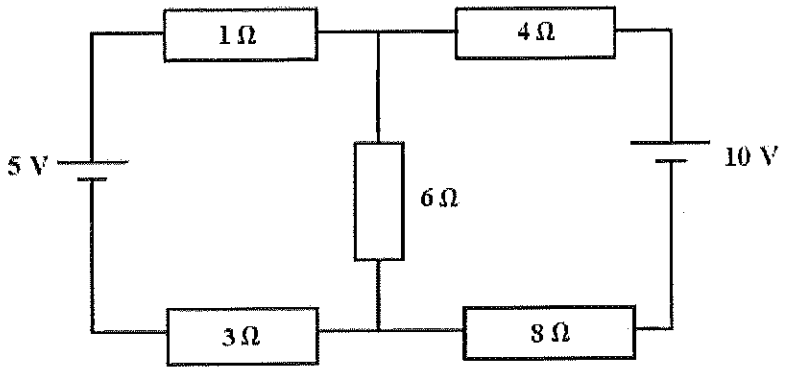

Fig. 3

(a) Use Kirchhoff's rules to determine the value of the current through the 6 Ω resistor. [18]

(b) Hence calculate the potential difference across the 6 Ω resistor. [2]

5 Fig. 4 shows a network of capacitors connected to a 20 *V* source.

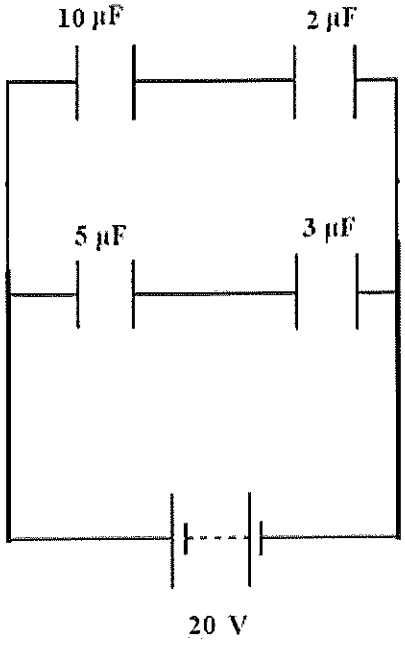

Fig. 4

Calculate

(a) the equivalent capacitance of the capacitors. [5]
(b) the charge on each capacitor. [5]
(c) the potential difference across each capacitor. [5]
(d) the energy stored in each capacitor. [5]

6 A resistor of resistance 60 Ω and a capacitor of capacitive reactance 80 Ω are connected in series with a 60 V a.c. generator.

(a) Draw a circuit diagram showing how the components are connected. [5]

(b) Draw the phasor diagram for V_R and V_C. [4]

(c) Calculate the following.

(i) impedance [3]
(ii) total current [2]
(iii) potential drop across the resistor [2]
(iv) potential drop across the capacitor [2]
(v) the phase angle [2]