



SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING
END OF SEMESTER II 2025/2026 EXAMINATION
PHY1201: PHYSICS II

Date: 23rd March 2026

Time: 16.00 - 19.00 hours

Instruction:

1. This paper consists of **FIVE** questions.
2. Answer question 1 (**Compulsory**) and **ANY** other **TWO** questions
3. Show all your working in a systematic manner, where necessary, use diagrams to illustrate your concepts.
4. You may use your calculator

Important constants

$$\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A (Permeability of free space)}$$

$$\pi = 3.142$$

$$h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s (Planck's constant)}$$

$$c = 3.0 \times 10^8 \text{ m/s (speed of light in vacuum)}$$

$$m_e = 9.11 \times 10^{-31} \text{ kg (mass of electron)}$$

$$e = 1.6 \times 10^{-19} \text{ C (electron charge)}$$

$$\hbar = h/2\pi = 1.055 \times 10^{-34} \text{ J} \cdot \text{s (reduced Planck's constant)}$$

QUESTION 1 (30 MARKS)

- (a)** (i) State the Biot-Savart law and explain the physical significance of each term in the equation. [3 marks]
- (ii) A long straight wire carries a current of 8 A. Calculate the magnetic field strength at a perpendicular distance of 5 cm from the wire. [3 marks]

(b) A metal sphere is initially uncharged and is to be given a positive charge without direct contact with a charged object. With the aid of a clearly labeled diagram, describe step-by-step how the metal sphere can be charged positively by the method of electrostatic induction. (5 marks)

(c) (i) State Ampère's law and explain when it is most useful for calculating magnetic fields. [2 marks]

(ii) A solenoid of length 40 cm has 800 turns and carries a current of 3 A. Calculate the magnetic field strength inside the solenoid. [2 marks]

(iii) Explain why the magnetic field outside an ideal solenoid is approximately zero. [2 marks]

(d) (i) State Faraday's law of electromagnetic induction. [2 marks]

(ii) A conductor of length 25 cm moves at a velocity of 12 m/s at right angles to a uniform magnetic field of flux density 0.8 T. Calculate the induced e.m.f. in the conductor. [2 marks]

(iii) A rectangular coil of sides 10 cm and 6 cm with 100 turns rotates at 1800 rev/min in a magnetic field of flux density 1.2 T. The longer sides cut the magnetic field. Calculate the maximum generated e.m.f. [3 marks]

(e) Electric field lines are a useful tool for visualizing electric fields in space. State and explain four (4) properties of electric field lines, illustrating your answer with appropriate diagrams where necessary. (4 marks)

(f) Define the term electric flux and state its SI unit. (2 marks)

QUESTION 2 (15 MARKS)

(a) Show that the e.m.f. equation of a transformer is given by:

$$E = 4.44 f N \Phi_m$$

where all symbols have their usual meanings. [4 marks]

(b) A single-phase, core-type transformer is rated at 100 kVA with a voltage ratio of 11000 V / 550 V and operates at a frequency of 50 Hz. The core has a square cross-section of 20 cm $\times$ 20 cm, a maximum allowable core flux density of 1.3 Tesla, and a stacking factor of 0.9.

- Using the given core dimensions and stacking factor, calculate the net effective cross-sectional area of the core and hence determine the maximum flux (Φ_m) in the core. [3 marks]
- Determine the number of turns on the High Voltage (H.V.) winding & Low Voltage (L.V.) winding [4 marks]
- Calculate the e.m.f. per turn for this transformer and comment on its relationship to both the H.V. and L.V. windings. [4 marks]

QUESTION 3 (15 MARKS)

- State ohms law [2 marks]
- Determine the currents I_1 , I_2 and I_3 in Figure 1 shown below. [6 marks]

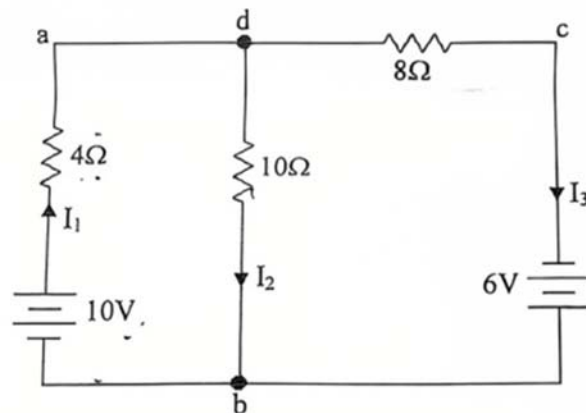


Figure 1

- In an experiment designed to measure the Earth's magnetic field using the Hall effect, a copper bar 0.500 cm thick is positioned along an east–west direction. If a current of 8.00 A in the conductor results in a Hall voltage of 5.10×10^{-12} V, determine the magnitude of the Earth's magnetic field? (Assume $n = 8.46 \times 10^{28}$ electrons/m³ and the plane of the bar is rotated to be perpendicular to the direction of the magnetic field) [7 marks]

QUESTION 4 (15 MARKS)

- (i) Explain the wave-particle duality principle. [2 marks]

(ii) State the de Broglie wavelength equation and explain the significance of each term.

[2 marks]

(b) An electron is accelerated through a potential difference of 150 V. Calculate:

- the kinetic energy of the electron in joules [2 marks]
- the momentum of the electron [2 marks]
- the de Broglie wavelength of the electron [2 marks]

(c) (i) State the Heisenberg Uncertainty Principle for position and momentum. [2 marks]

(ii) An electron is confined to a region of space of width 1.0×10^{-10} m. Calculate the minimum uncertainty in the electron's momentum. [2 marks]

(iii) Using your answer from part (c)(ii), estimate the minimum kinetic energy of the electron in electron volts (eV). [1 mark]

QUESTION 5 (15 MARKS)

(a) A transistor has $\alpha = 0.99$. If the transistor is configured in Common Emitter (CE) mode, calculate the change in collector current (ΔI_C) corresponding to a change of $10 \mu\text{A}$ in the base current (ΔI_B). [5 mark]

(b) A transistor circuit as shown in Fig. 5 has $\beta = 100$ and $I_{CBO} = 20 \text{ nA}$. Determine I_B , I_C , and V_{CE} , and use these values to identify the operating region of the transistor. Assume the following threshold voltages: $V_{BE(\text{active})} = 0.7 \text{ V}$, $V_{BE(\text{sat})} = 0.8 \text{ V}$, and $V_{CE(\text{sat})} = 0.2 \text{ V}$.

[10 marks]

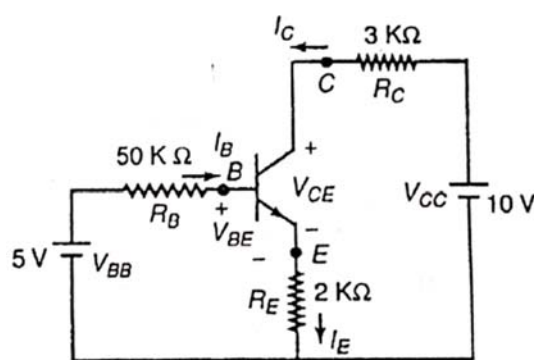


Fig. 5