Question Paper

Exam Date & Time: 13-Jun-2023 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATION - MAY 2023
II SEMESTER B.Sc (Applied Sciences) in Engg.

Physics - II [IPH 121]

Marks: 50 **Duration: 180 mins.**

Answer all the questions.

Missing data, if any, may be suitably assumed

✓ **Useful constants**

Speed of light in vacuum= 3.00×10^8 m/s
Electron mass = 9.11×10^{-31} kg
Permittivity of vacuum = 8.85×10^{-12} F/m
Avogadro constant = 6.02×10^{23} /mol

Electron charge = 1.60×10^{-19} C
Boltzmann constant= 1.38×10^{-23} J/ K
Rydberg constant = 1.10×10^7/m

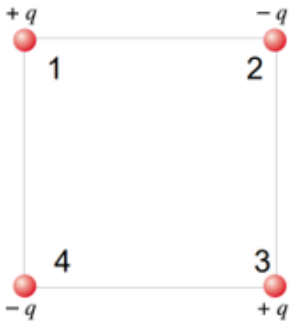
Mass of proton / neutron= 1.67×10^{-27}kg
Planck's constant = 6.63×10^{-34} J-s
Permeability of vacuum = $4\pi \times 10^{-7}$ H/m

1) (5)

A) Obtain an expression for the electric field at a point on the perpendicular bisector of a uniform line of charge. Show that the expression reduces to electric field due to point charge at a faraway point from this charge distribution.

B) (3)

Derive an expression for the work required by an external agent to put the four charges together as indicated in Fig. Each side of the square has a length a = 5 cm and take q = 10 μC (3)



C) (2)

What are equipotential surfaces? Draw an equipotential surface for a point charge and an infinite sheet of charge.

2) (4)

A) When do you say that a conductor is in an electrostatic equilibrium? List all the properties of a conductor which is in an electrostatic equilibrium.

B) (4)

Two capacitors, C_1 = 25.0 μF and C_2 = 5.0 μF are connected in parallel and charged with a 100-V power supply. (i) Draw a circuit diagram and calculate the energy stored in each of the two

diagram and calculate the energy stored in each of the two capacitors. (ii) What potential difference would be required across the same two capacitors connected in series for the combination to store the same amount of energy as in part (i)?

C) (2)

An electric heater is constructed by applying a potential difference of 120 V across a Nichrome wire that has a total resistance of 8.00 Ω. Find the power rating of the heater.

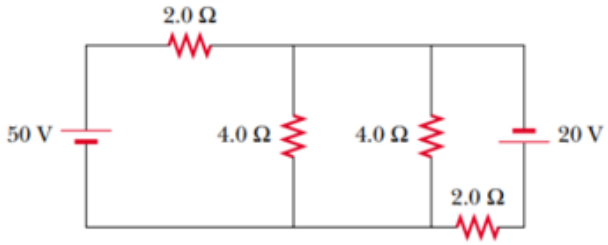
3) (3)

Derive an expression for current density J, in terms of drift velocity.

A)

B) (4)

Use Kirchhoff's rule to calculate the power delivered to each resistor shown in Figure below.



C) (3)

An alpha particle (q = +2e, m = 4.0 u) travels in a circular path of radius 4.5 cm in a magnetic field with B = 1.2 T. Calculate (i) its speed, (ii) its period of revolution, (iii) its kinetic energy in eV.

4) (2)

Discuss the phenomenon of Hall effect.

A)

B) (4)

(i) A loosely wound solenoid that has 1000 turns uniformly distributed over a length of 0.400 m produces a magnetic field of magnitude $1X10^{-4}$ T at its center. What current is required in the windings for that to occur? (ii) Suppose if the magnetic field strength needs to be increased to 2.2×10^{-4} T, how many more turns needs to be added, keeping the same length and current in the solenoid?

C) (4)

List all four Maxwell's equations and discuss their significance.

5) (3)

A) Discuss the case of a LR circuit and arrive at an expression for the current as a function of time. What is the physical significance of inductive time constant.

B) (4)

A series RLC circuit has R= 250 Ω, L= 3.25 H, and C=5.0 μF. It is connected to an AC source with f = 50.0 Hz and ΔV_{max} = 120 V. Determine the inductive reactance, the capacitive reactance, and the impedance of the circuit. Also, find the maximum voltage across the capacitor and inductor.

C) (3)

Show that the instantaneous current i_L in the inductor and the