Question Paper

Exam Date & Time: 29-Nov-2018 (02:00 PM - 05:00 PM)



MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLED SCIENCES II SEMESTER B.S. ENGINEERING END SEMESTER EXAMINATION-NOVEMBER/DECEMBER 2018

Physics - II [IPH 121]

Marks: 100

Duration: 180 mins.

Answer 5 out of 8 questions. Any missing data may be assumed suitably

PHYSICAL CONSTANTS:

Elementary charge, $e = 1.6 \times 10^{-19}C$, mass of the electron = 9.1 x $10^{-31}kg$, mass of the proton = 1.67 x

 10^{-27} kg, permittivity of free space = 8.85 x 10^{-12} F/m, permeability = $4\pi x \ 10^{-7}$ H/m, Avogadro constant N_A = 6.02 x 10^{23} mol⁻¹, speed of light in air/vacuum = 3 x 10^{8} m/s

- Explain i) Coulomb's Law ii) Gauss's Law and iii) Electric ⁽⁴⁾
 A) field at a point. Give the pictorial representation of electric fields due to an isolated positive and a negative charges.
 - ^{B)} Arrive at an expression for the electric field near an infinite ⁽⁸⁾ line of charge and sheet of charge using Gauss's Law.
 - (i) The magnitude of the average electric field normally (8) present in the earth's atmosphere just above its surface is 200N/C directed downwards radially towards its centre. What is the total net surface charge carried by the earth, assuming the earth to be a conductor and having radius R = 6.3 x 10⁶m?
 (ii) A proton orbits with a speed 290 km/s just outside a charged sphere of radius 1.13cm. Find the charge on the sphere.
- Distinguish between potential and potential energy in an ⁽⁴⁾ electric field. What is the change in the potential energy if a nucleus having 4 protons moves through a potential difference of 20 kV?
 - ^{B)} Derive an expression for the potential at a point on the axis ⁽⁸⁾

of a uniformly charged disc.What is the potential at the centre of the disc?

- ^{C)} (i) Two flat parallel conducting plane surfaces are spaced d ⁽⁸⁾ = 1.0cm apart and have a potential difference 10.3kV. An electron is projected from one plate towards the other. What is the initial velocity of the electron if it comes to rest just at the surface of the second plate? (ii) Calculate (a) the electric potential established by the nucleus of a hydrogen atom at the average distance of the circulating electron ($r = 5.29 \times 10^{-11}$ m): (b) the electric potential energy of the atom when the electron is at this radius; and (c) the kinetic energy of the electron, assuming it to be moving in a circular orbit of this radius centered on the nucleus. (d) How much energy is required to ionize the hydrogen atom? Express all energies in electron-volts, and take V = 0 at infinity
- - (ii) Write any two uses of capacitors in electrical/electronic circuits.
 - ^{B)} Derive the expression for the (i) capacity of a parallel plate ⁽⁸⁾ capacitor and (ii) effective resistance of two resistances in parallel. (iii) Define the term current density and write a relation between current density and drift speed.

(i) Two sheets of aluminum foil have a separation of 1.40 (8) mm, a capacitance of 10.70 pF, and are charged to 15.0 V.
 (a) Calculate the plate area. (b) The separation is now decreased by 0.10 mm with the charge held constant. Find the new capacitance. (c) By how much does the potential difference change?
 (ii) A parallel-plate, air-filled capacitor having area 42.0 cm² and spacing of 1.30 mm is charged to a potential

difference of 625 V. Find (a) the capacitance, (b) the magnitude of the charge on each plate, (c) the stored energy, (d) the electric field between the plates, and (e) the energy density between the plates.

(i) When two or more resistances are connected in series (4) the total resistance increases. Justify your answer with relevant reasoning.
 (ii) State Kirchhoff's Laws in electrical circuits

B) Derive the expressions for the instantaneous charges on ⁽⁸⁾ the capacitor and instantaneous current through the circuit containing C and R in series with an emf source is connected and the capacitor is discharged through a resistor.

(i) Internal energy is to be generated in a 108-m Ω resistor ⁽⁸⁾ at the rate of 9.88 W by connecting it to a battery whose emf is 1.50 V. (a) What is the internal resistance of the battery? (b) What potential difference exists across the resistor?
 (ii) A resistor 8.0 merge Ohm and a capacitor C = 5.2 µE are

(ii) A resistor 8.0 mega Ohm and a capacitor $C = 5.2 \ \mu$ F are connected in series and a 12.0 V battery of negligible internal resistance is connected across the combination. Calculate the capacitive time constant of the circuit? At what time after the battery is connected does the potential difference across the capacitor is equal to 6.0 V?

- ⁵⁾ Explain the various factors affecting the force on a charge ⁽⁴⁾
 ^{A)} in a magnetic field? Does a magnetic monopole exists?
 Does a static electric charge produce magnetic field?
 - i) Obtain expressions for the Hall voltage developed and ⁽⁸⁾ hence Hall coefficient of a specimen placed in a transverse uniform magnetic field. (ii) Write a note on magnetic mirror.
 - (i) A 1.22keV electron circulating in a plane right angle to a ⁽⁸⁾ magnetic field In a radius 24.7cm what is the a) speed of the electron, b) magnetic field, c) frequency of revolution, d) period of the motion.
 (ii) In a Hall Effect experiment, a current i = 3.2A length wise, of a wire 1.2cm width, 4.cm long, 9.5micrometer thick, a Hall voltage developed is 40µVolt, when a magnetic field B=1.4T perpendicular to it. Calculate the a) drift speed of career charges, b) number density/charge career density.
- ⁶⁾ State Biot-Savart Law and Ampere's Law and give their ⁽⁴⁾ _{A)} mathematically?
 - ^{B)} Arrive at an expression for the magnetic field on the axial ⁽⁸⁾ point of a current carrying circular loop.

(i) A solenoid 1.33 m long and 2.60 cm in diameter carries a current of 17.8 A . The magnetic field inside it is 22.4 mT. Find the length of the wire forming the solenoid.
(ii) A uniform magnetic field is perpendicular to the plane of a circular loop 10.4cm in diameter made of copper wire of diameter2.5mm. a) Calculate the resistance of the wire, b) at what rate the magnetic field should change with time to induce a current of 9.66A to appear in the loop? (Resistivity of copper is 1.69x10⁻⁸ ohm-m)

(i) What is a motional emf? Write one advantage and one (4) disadvantage of a motional emf.
 A)

 ii) Write the mathematical expression for the power dissipated in a coil moving transverse to a uniform magnetic field.

- ^{B)} Show that the inductance of a solenoid depends upon its geometrical factors. Arrive at an expression for the magnetic energy inside a current carrying solenoid.
- ^{C)} (i) A solenoid 110cm long is formed from 2000 turns of ⁽⁸⁾ windings carry current 4.36A. The core is filled with iron of permeability constant 968. What is the inductance of the solenoid if its diameter is 5.45 cm? (ii) The number of flux linkage through a certain coil of 800 m Ω resistance is 20.2 mWb when there is a current of 6.4A

in it. a) Calculate the inductance of the coil b) If a 6.0 V battery is suddenly connected across the coil, how long will it take for the current to rise from zero to 2.52A?

- ⁸⁾ What is the electrostatic force of attraction between a (4) proton and an electron separated by a distance 10nm? If the distance is increased twice what will be the force?
 - ^{B)} Arrive at an expression for the instantaneous current ⁽⁸⁾ through a circuit containing L, C and R in series with an AC source. Arrive at the condition for resonance.

^{C)} (i) The output of an AC generator $\xi = \xi \sigma \sin \omega t$ with $\xi \sigma =$ ⁽⁸⁾ 25.0V and $\omega = 377 rads/s$. It is connected to a 12.7 H inductor. a) What is the maximum current? b) When the current is maximum, what is the emf of the generator? c) When the emf of the generator is -13.8 V and increasing in magnitude, what is the current? (ii) A circuit containing R = 200 Ohm, C = 10 micro Farad and L = 10milli Henry are connected in series. An AC source having peak emf = 36.0 V and frequency 50Hz is connected to it in series. Calculate the capacitive reactance, inductive reactance, impedance and the maximum current through the circuit. What is the resonance frequency of the circuit?

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