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 [PH 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 x 10^{-19}C, mass of the electron = 9.1 x 10^{-31}kg, mass of the proton = 1.67 x 10^{-27}kg, permittivity = 8.85 x 10^{-12} F/m, permeability = 4π 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

1) A) Define the term "potential at a point" in an electric field. Write the expression for the same due to a point charge. What is the change in the potential energy if a helium nucleus having 2 protons moves through a potential difference of 100Kv? (4)

B) Derive an expression for the potential at an axial point of a ring with positive charges uniformly distributed on it.What is the potential at the centre of the ring? (8)

C) (i) Two flat parallel conducting plane surfaces are spaced d = 1.2 cm apart and have a potential difference 15.0kV. 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) A proton orbits with a speed 320 Km/s just outside a charged sphere of radius 2.0cm. Find the charge on the sphere. (8)

2) A) (i) Write the expressions for the capacity of a spherical capacitor and that of a parallel plate capacitor with dielectrics.
(ii) Write any two uses of capacitors in electrical circuits. (4)

B) (8)

Derive the expression for the (i) capacity of a cylindrical capacitor (ii) energy stored in the electric field of a parallel plate capacitor

C) (i) Two sheets of aluminum foil have a separation of 1.10 mm, a capacitance of 12.0 pF, and are charged to 16.0 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? (8)

(ii) A parallel-plate, air-filled capacitor having area 50.0 cm^2 and spacing of 1.10 mm is charged to a potential difference of 600 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.

3) A) Write the mathematical form of Coulomb's Law and Gauss's Law. Compare their merits. (4)

B) Arrive at an expression for the electric field (using Gauss's Law) near a spherical shell of charge and a sheet of charge. (8)

C) (i) The magnitude of the average electric field normally present in the earth's atmosphere just above its surface is 250N/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 having radius $R=6.37 \times 10^6$ m? (8)

(ii) Calculate (a) the electric potential established by the nucleus of a hydrogen atom at the average distance of the circulating electron ($r = 5.4 \times 10^{-11}$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 (assume potential is zero at infinity).

4) A) What is Hall Effect? Explain the principle involved in the development of Hall voltage. (4)

B) With a neat diagram explain the principle and construction of a cyclotron. Arrive at an expression for the kinetic energy of a proton accelerated using a cyclotron. Write a note on magnetic bottling/magnetic mirror. (8)

C) (i) A 1.5keV electron circulating in a plane right angle to a magnetic field In a radius 25.0cm what is the a) speed of the electron, b) magnetic field, c) frequency of revolution, d) period of the motion. (8)
(ii) In a Hall Effect experiment, a current I = 2.9A length wise, of a wire 1.3cm width, 4.1.cm long, 9.5micrometer thick, a Hall voltage developed is 40μVolt, when a magnetic field B=1.5T perpendicular to it. Calculate the a) drift speed of career charges, b) number density/charge career density.

5) A) State Biot -Savart Law and Ampere's Law. Why Ampere's Law is more useful in electrical appliances compared to Biot -Savart Law? (4)

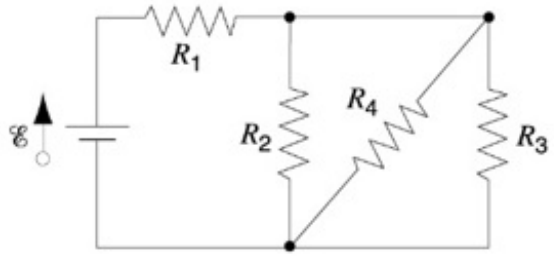
B) Using Biot -Savart Law, arrive at an expression for the magnetic field along a line perpendicular to current carrying thin wire. (8)

C) (i) A solenoid 1.4 m long and 2.50 cm in diameter carries a current of 18.0 A . The magnetic field inside it is 25.0 mT. Find the length of the wire forming the solenoid. (8)
(ii) The number of flux linkage through a certain coil of 1.0 Ω resistance is 20.0 m Wb when there is a current of 6.0A in it. a) Calculate the inductance of the coil b) If a 6.2 V battery is suddenly connected across the coil, how long will it take for the current to rise from zero to 2.0A?

6) A) Justify the statements (i) when two or more resistances are connected in parallel the total resistance decreases. (ii) parallel currents attract. (4)

B) Derive the expressions for the instantaneous charges on the capacitor and instantaneous current through the circuit containing C and R in series with a DC emf source while charging. (8)

C) (i) Find the equivalent resistance of the network shown in the circuit below. Calculate the current in each resistor. Given: R1=112 Ohms,R2 = 42 Ohms,R3 = 61 Ohms and R4=75 Ohms and the supply voltage from the battery 6.22V. (8)



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ii)A resistor 9.0 mega Ohm and a capacitor C = 6.2 μF are connected in series and a 10.0 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 5.0 V?

7) What is the electrostatic force of repulsion between two protons separated by a distance 8.0nm? If the distance is decreased to half the original distance, what will be the force of repulsion? (4)

A)

B) Arrive at an expression for the instantaneous current through a circuit containing L,C and R in series with an AC source connected to it in series.. What is the condition for resonance. (8)

C) (i) The output of an AC generator $\xi = \xi o \sin \omega t$ with ξo = 20.0V and ω=300rads/s. It is connected to a 12.0 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? (8)
(ii) A circuit containing R = 300 Ohm, C = 11 μF and L = 15mH are connected in series. An AC source having peak emf = 40.0 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?

8) (i) Write the mathematical expression for the power dissipated in a coil moving transverse to a uniform magnetic field. Write one advantage and one disadvantage of motional emf. (4)
(ii) State Kirchhoff's laws in electrical circuits.

A)

B) (i) Arrive at an expression for the magnetic field inside a (8)

current carrying solenoid using Ampere's Law. Plot the graph of magnetic field verses the length of an ideal solenoid.
(ii) Show that the magnetic energy inside a current carrying solenoid is U_B = Â½ Li^2 .

C) (i) A solenoid 100cm long is formed from 1800 turns of windings carry current 4.5A The core is filled with iron of permeability constant 968. What is the inductance of the solenoid if its diameter is 6.0cm. (8)
(ii) A uniform magnetic field is perpendicular to the plane of a circular loop 10.0cm in diameter made of copper wire of diameter2.0mm. a) Calculate the resistance of the wire, b) at what rate the magnetic field should change with time to induce a current of 10.0A to appear in the loop? (Resistivity of copper is $1.69x10^{-8}$ ohm-m)

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