INTERNATIONAL CENTRE FOR APPLIED SCIENCES
MAHE, MANIPAL

B.Sc. (Applied Sciences) in Engg.

End – Semester Theory Examinations – MAY 2021

II SEMESTER - PHYSICS - II (IPH 121)

(Branch: Common to all)

Time: 3 Hours **Date: 13 May 2021** **Max. Marks: 50**

- ✓ **Answer ALL the questions.**
- ✓ **Missing data, if any, may be suitably assumed**

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 of free space = 8.85 x 10^{-12} F/m,
Permeability free space = 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

1A. State and derive Gauss' law. Show that Coulomb's law can be deduced from Gauss's law. **(3)**

1B. Derive an expression for the electric field at an axial point of a uniformly charged ring. **(3)**

1C. (a) The drum of the photocopying machine has surface charge density 2μC/m^2 and it has a length of 42 cm and a diameter of 12 cm. What is the total charge on the drum? (b) The manufacturer wishes to produce a desktop version of the machine. This requires reducing the size of the drum to a length of 28 cm and a diameter of 8.0 cm. The electric field at the drum surface must remain unchanged. What must be the charge on this new drum? **(2)**

1D. An electric dipole consists of charges +2e and –2e separated by 0.78 nm. It is in an electric field of strength 3.4 × 10^6 N/C. Calculate the magnitude of the torque on the dipole when the dipole moment is (a) parallel, (b) at right angle, and (c) opposite to the electric field. **(2)**

2A. Derive an expression for the potential at a point due to i) a point charge ii) due to an electric dipole. **(3)**

2B. Derive the expression for the (i) capacity of a cylindrical capacitor (ii) Equivalent capacitance of three capacitors connected in series. **(3)**

2C. Three charges of +122 mC each are placed on the corners of an equilateral triangle, 1.72 m on a side. If energy is supplied at the rate of 831 W, how many days would be required to move one of the charges onto the midpoint of the line joining the other two? **(2)**

2D. A parallel plate capacitor has circular plates of 8.22cm radius and 1.31mm separation. (a) Calculate the capacitance (b) What charge will appear on the plates if a potential difference of 116V is applied? **(2)**

3A. Explain the terms – i) Electric current ii) emf of a source iii) potential difference in a circuit and iv) resistivity of a material. **(2)**

3B. Derive an expression for the force acting on a current carrying conductor kept in a uniform magnetic field. **(3)**

3C. A 1.22 keV electron is circulating in a plane at right angles to a uniform magnetic field. The orbit radius is 24.7 cm. Calculate (a) the speed of the electron, (b) the magnetic field, (c) the frequency of revolution, and (d) the period of the motion. **(2)**

3D. A 1.0-μF capacitor with an initial stored energy of 0.50 J is discharged through a 1.0-MΩ resistor. (a) What is the initial charge on the capacitor? (b) What is the current through the resistor when the discharge starts? (c) Determine ΔV_C, the voltage across the capacitor, and ΔV_R, the voltage across the resistor, as functions of time. (d) Express the rate of generation of internal energy in the resistor as a function of time. **(3)**

4A. Explain - i) Biot- Savart law ii) Ampere's law. **(2)**

4B. Using Biot- Savart law, obtain an expression for the magnetic field produced due to a current carrying straight infinitely long conducting wire. **(3)**

4C. A single turn current loop, carrying a current of 4.00 A, is in the shape of a right triangle with sides 50 cm, 120 cm, and 130 cm. The loop is in the uniform magnetic field of magnitude 75.0 mT whose direction is parallel to the current in the 130-cm side of the loop. (a) Find the magnetic force on each of the three sides of the loop. (b) Show that the total magnetic force on the loop is zero. **(3)**

4D. In the lowest energy state of the hydrogen atom, the most probable distance between the single orbiting electron and the central proton is 5.29×10^{-11} m. Calculate (a) the electric field and (b) the magnetic field set up by the proton at this distance, measured along the proton's axis of spin. The magnetic moment of the proton ($= 1.41 \times 10^{-26}$J/T) **(2)**

5A. What is motional emf? Obtain an expression for the motional emf. Show that the rate at which work is done in creating motional emf is equal to the internal energy produced in the circuit. **(3)**

5B. i) Explain Self-inductance and hence define Henry ii) Mention the advantages and disadvantages of eddy currents. **(3)**

5C. A single loop circuit consists of a 7.22 Ω resistor, a 12.3H inductor, and a 3.18μF capacitor. Initially, the capacitor has a charge of 6.31 μC and the current is zero. Calculate the charge on the capacitor N complete cycles later for N =5, 10 and 100. **(2)**

5C. At a certain place, the Earth's magnetic field has magnitude B = 59 μT and is inclined downward at an angle of 70° to the horizontal. A flat, horizontal, circular coil of wire with a radius of 13 cm has 950 turns and a total resistance of 85Ω. The coil is flipped through a half revolution about a diameter, so it is again horizontal. How much charge flows through the coil during the flip? **(2)**

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