Reg.No.									

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION – APRIL/ MAY 2017

SUBJECT: PHYSICS - II (PH 121)

(COMMON TO ALL BRANCHES)

Saturday, 22 April 2017

Time: 3 Hours **Max. Marks: 100**

PHYSICAL CONSTANTS

Elementary charge, e	:	1.60×10^{-19} C
Electric constant [permittivity], ε_0	:	8.85×10^{-12} F/m
Magnetic constant [permeability], μ_0	:	1.26×10^{-6} H/m
Electron mass, m_e	:	9.11×10^{-31} kg
Proton mass, m_p	:	1.67×10^{-27} kg
Neutron mass, m_p	:	1.67×10^{-27} kg
Avogadro constant, N_A	:	6.02×10^{23} mol^{-1}
Unified atomic mass unit, 1u	:	1.66×10^{-27} kg
Speed of light in a vacuum, c	:	3.00×10^{8} m/s

- ✓ **Answer ANY FIVE full Questions. Each question carry 20 marks.**
- ✓ **Missing data, if any, may be suitably assumed**

1A. (a) What is charging by induction? Can an insulator be charged by induction?

(b) Calculate the force between the proton and the electron of a normal hydrogen atom. Take the radius of hydrogen atom to be 0.5 Å.

1B. Arrive at an expression for the electric field at a point just on the (i) outer surface of a charged conductor and (ii) near an infinite non conducting sheet of charge using Gauss' Law.

1C. (a) A uniformly charged conducting sphere of 1.22 m radius has a surface charge density of 8.13 $\mu C/m^2$. (i) Find the charge on the sphere. (ii) What is the total electric flux leaving the surface of the sphere? (iii) Calculate the electric field at the surface of the sphere.

(b) A 115-keV electron is fired directly toward a large, flat, plastic sheet that has a surface charge density of –2.08 $\mu C/m^2$. From what distance must the electron be fired if it is just fail to strike the sheet? (Ignore relativistic effects).

[4+8+8]

2A. Derive an expression for the electric potential at a point due to an electric dipole.

2B. Find the electric potential due to a uniformly charged ring at a point on its axis and hence derive the expression for electric potential due to a charged disk at a point on its axis.

2C. (a) An electric charge of –9.12 nC is uniformly distributed around a ring of radius 1.48 m that lies in the yz plane with its center at the origin. A particle carrying a charge of –5.93 pC is located on the x axis at x = 3.07 m. Calculate the work done by an external agent in moving the point charge to the origin.

(b) In the rectangle shown in Figure1, the sides have lengths 5.0 cm and 15 cm, q_1 = –5.0 μC, and q_2 = +2.0 μC. (i) What are the electric potentials at corner B and corner A?

(Assume V = 0 at infinity.) (ii) How much external work is required to move a third charge q_3 = +3.0 μC from B to A along a diagonal of the rectangle? (iii) In this process, is the external work converted into electrostatic potential energy or vice versa? Explain.

Figure 1

. **[4+8+8]**

3A. What are ohmic materials? State ohm's law and show that the resistance of a conductor varies directly as its length and inversely as cross-sectional area.

3B. (a) Discuss the effect of filling the capacitor with dielectric, the battery remains connected as the capacitor is filled with a dielectric.

(b) Derive the expression for the energy stored and energy density in a parallel plate capacitor.

3C. (a) An electrical cable consists of 125 strands of fine wire, each having 2.65-μΩ resistance. The same potential difference is applied between the ends of each strand and results in a total current of 750 mA. (i) What is the current in each strand? (ii) What is the applied potential difference? (iii) What is the resistance of the cable?

(b) A parallel plate capacitor has a capacitance of 112 pF, a plate area of 96.5 cm^2, and a mica dielectric (κ_e = 5.40). At a 55.0-V potential difference, calculate the magnitudes of (i) the electric field in the mica, (ii) the free charge on the plates, and (iii) the induced surface charge.

[**4+8+8]**

4A. State Kirchoff's laws in DC circuits. Obtain expressions for power delivered by the ideal source of emf '$\mathscr{E}$'.

4B. Arrive at an expression for the instantaneous charge and current through a circuit containing R and C in series with an emf source when the capacitor is in the process of charging. Draw the relevant graphs indicating the variation of potential difference across the circuit components with time. Write the significance of RC time constant in a circuit.

4C. (a) In an RC series circuit an emf, $\mathscr{E}$ = 11.0 V, a resistor R = 1.42 MΩ, and a capacitor C = 1.80 μF. (i) Calculate the time constant. (ii) Find the maximum charge that will appear on the capacitor during charging. (iii) How long does it take for the charge to build up to 15.5 μC?

(b) Internal energy is to be generated in a 108-mΩ resistor at the rate of 9.88 W by connecting it to a battery whose emf is 1.50 V. (i) What is the internal resistance of the battery? (ii) What potential difference exists across the resistor?

[4+8+8]

5A. a) Explain the action of crossed electric and magnetic fields as a velocity selector.

b) What is the basic principle of magnetic mirror?

5B. a) What is Hall effect? Obtain an expression for the charge carrier density in a material in terms of Hall-Voltage, magnetic field and thickness of the material.

b) Derive an expression for the torque acting on a current carrying rectangular loop placed in a uniform magnetic field.

5C. (a) 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, and (iv) the potential difference through which it would have to be accelerated to achieve this energy.

b) An electron is accelerated through a potential difference of 1.0 kV and is directed into a region between two parallel plates separated by 20 mm with a potential difference of 100 V between them. If the electron enters moving perpendicular to the electric field between the plates, what magnetic field is necessary perpendicular to both the electron path and the electric field so that the electron travels in a straight line?

[4+8+8]

6A. a) State Ampere's law. Using this law find the magnetic field at interior points (inside toroid) of a toroid.

b) Why two parallel conductors carrying currents in the same direction attract each other? Give reasons with relevant mathematical expression.

6B. State Biot-Savart's law. Using it, find magnetic field at an axial point of a circular current loop. What is the magnetic field at the center of the loop? What is the magnetic field if current flows not in a complete circle but in an arc of the circle?

6C. (a) A long hairpin is formed by bending a piece of wire as shown in Figure 2. If the wire carries a current i = 11.5 A, (i) what are the magnitude and direction of B at point a? (ii) At point b, very far from a? Take R = 5.20 mm.

Figure 2

b) A circular loop of radius 12 cm carries a current of 13 A. A second loop of radius 0.82 cm, having 50 turns and a current of 1.3 A, is at the center of the first loop. (i) What magnetic field does the large loop set up at its center? (ii) Calculate the torque that acts on the small loop. Assume that the planes of the two loops are at right angles and that the magnetic field due to large loop is essentially uniform throughout the volume occupied by the small loop.

[4+8+8]

7A. (a) State (i) Faraday's law of induction (ii) Lenz' law.

(b) Write any two applications of eddy currents.

7B. State Faraday's law of induction in terms of magnetic flux. Mention any four methods for changing flux. Obtain an expression for the power required to withdraw a closed conducting loop from a transverse magnetic field. Show that the work done by the external agent is dissipated as Joule heating of the loop.

7C a) The number of flux linkages through a certain coil of 745-mΩ resistance is 26.2 mWb when there is a current of 5.48 A in it. (i) Calculate the inductance of the coil. (ii) If a 6.0 V battery is suddenly connected across the coil, how long will it take for the current to rise from 0 to 2.53 A?

b) A uniform magnetic field is perpendicular to the plane of a circular loop 10.4 cm in diameter and is made up of copper wire of diameter 2.5 mm. (i) Calculate the resistance of the wire (resistivity is 1.69×10^{-8} Ω-m.) (ii) At what rate must the magnetic field change with time if an induced current of 9.66 A is to appear in the loop?

[4+8+8]

8A. a) In a LR circuit with battery connected, show graphically the variation of (a) voltage across the inductor versus time (b) Voltage across the resistor versus time

(b) What is the resonance frequency of a circuit containing L = 20 mH and C = 10 pF?

8B. (a) Show the current and voltage relationship by the phasor diagrams for the following circuit elements in the series alternating current circuit. (a) A resistive element (b) An inductive element and (c) A capacitive element.

(b) Obtain an expression for average power in series RLC alternating current circuit in terms of power factor and hence the condition for maximum power delivered to the circuit by the source of emf.

8C. (a) An air conditioner connected to a 120 V, rms AC line is equivalent to a 12.2 Ω resistance and 2.30 Ω inductive reactance in series. (i) Calculate the impedance of the air conditioner. (ii) Find the average power supplied to the appliance. (iii) What is the value of the rms current?

(b) For a certain RLC circuit the maximum generator emf is 125 V and maximum current is 3.20. If the current leads the generator emf by 56.3°, (i) what is the impedance and (ii) what is the resistance of the circuit? (iii) Is the circuit predominantly capacitive or inductive?

[4+8+8]