Reg.No.									

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION – NOV. / DEC. 2016

SUBJECT: PHYSICS - II (PH 121)

(OLD SCHEME)

(BRANCH: COMMEN TO ALL)

Friday, 9 December 2016

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

Speed of light in vacuum= 3.00×10^8 m/s,
Mass of proton / neutron= 1.6726×10^{-27}kg,
Boltzmann constant= 1.38×10^{-23} J/ K,
Permittivity of vacuum = 8.85×10^{-12} F/m,
Permeability of vacuum = $4\pi \times 10^{-7}$ H/m,
Stefan's constant=5.669×10^{-8} $Wm^{-2}K^{-4}$

Electron charge = 1.60×10^{-19} C,
Electron mass = 9.1094×10^{-31} kg,
Planck's constant = 6.63×10^{-34} J-s,
Rydberg constant = 1.10×10^7/m,
Avogadro constant = 6.02×10^{23} /mol

- ✓ **Answer any FIVE FULL questions. Each question carries 20 marks.**
- ✓ **Any missing data may suitably be assumed**
- ✓ **Write the correct question nos. at the margin clearly.**

1A. (a) An electric dipole placed in a uniform electric field experience a torque and no net force. Justify this statement.

(b) Prove that the number of electrons in one coulomb of negative charge is 6.25×10^{18}.

1B. Prove that the electric field at a point just on the (i) just out side the outer surface of a charged conductor is = σ/ε_o and (ii) and near a non-conducting infinite sheet of charge is = $\sigma/2\varepsilon_o$ using Gauss' Law.

1C. (a) The average distance between an electron and a proton in a hydrogen atom is 5.3×10^{-11}m. Calculate (i) the magnitude of the average electrostatic force between the charges and (ii) average gravitational force between them. (Given: universal gravitational constant is 6.67×10^{-11} N-m^2/kg^2)

(b) A proton orbits with a speed 294×10^3 m/s just outside a charged sphere of radius 1.13cm. Find the charge on the sphere. **(4+8+8)**

2A. (a) A potential of zero at a point does not necessarily mean that the electrical force is zero at that point. Substantiate this statement with reasoning.

(b) Define the term "one volt" of potential at a point near a charged particle.

2B. Arrive at an expression for the potential at a point along the axis passing through the center and perpendicular to the plane of a uniformly charged disc. How this expression will be reduced if the point reaches the center of the disc?

2C. (a) An insulating disc of radius 4.8 cm carries a total charge q=+2.5 nC uniformly distributed over its surface and held fixed. An electron initially at rest is at a distance 30.0cm from the center of the disc along its perpendicular axis is released it strikes the surface with a speed. Calculate the speed of the electron.
(b) Two large parallel conducting pate are 12.0 cm apart and carry equal but opposite charges on their facing surfaces. An electron placed midway between them experience a force of 3.9 $x10^{-15}$N. Find (i) the electric field at the position of the electron and (ii) the potential difference between the plates. **(4+8+8)**

3A. (a) Write two difference between current and current density.

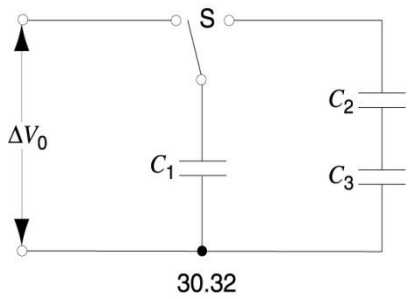
(b) Explain in brief any two ways one can increase the capacitance of a capacitor.

3B. (a) Arrive at an expression for the capacitance of a spherical capacitor.

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

3C. (a) A wire 10.0 m long and 3.0 mm in diameter has a resistance of 115 mΩ. A potential difference of 25.0 V is applied between the ends. (a) What is the current in the wire? (b) Calculate the current density. (c) Calculate the resistivity of the wire material?

(b) When switch S is thrown to the left (see Fig. below) the plates of the capacitor C_1 acquire a potential difference ΔV_0. C_2 and C_3 are initially uncharged. The switch is now thrown to the right. What are the final charges q_1, q_2, q_3 on the corresponding capacitors? (Given ΔV_0=25.0V, C_1=100μF, C_2=210μF, C_3=320μF). **(4+8+8)**



4A. (a) A 12.0 V battery with an internal resistance r = 5Ω is connected to an external load resistance R = 100 Ω. What is the voltage across the load 'R'?

(b) Three resistances 100 Ω, 200 Ω and 30 Ω are connected to each other. Calculate the effective resistance when they are in series (Rs) and parallel (Rp).

4B. Arrive at an expression for the instantaneous charge and current through a circuit containing R and C in series with am emf source when the capacitor is in the process of discharging. 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) One end of an aluminum wire of diameter 2.5 mm is welded to one end of a copper wire of diameter 1.8mm. The composite wire carries a current of 1.3A. (i) What is the current densities in of these two wires? (ii) What is the drift speed of electrons in the copper wire (the number of free electrons per volume in copper = $8.5 \times 10^{28}/m^3$)?

(b) When a potential difference of 115 V is applied between the ends of a 9.66 m long wire, the current density is 1.42 A/cm^2. Calculate the conductivity of the material. **(4+8+8)**

5A. a) There is no magnetic potential energy associated with a moving charge in a uniform magnetic field. Justify your statement.

b) What happens to a charge moving (i) parallel (i) perpendicular to an external magnetic field?

5B. a) State Hall Effect. With a necessary diagram explain the concept of Hall Effect and arrive at an expression for the carrier charge density in a semiconductor.
(b) Write in brief the principle of cyclotron.

5C. a) A proton travelling at 32.0° with respect a magnetic field of strength 5.63 mT experience a magnetic force 16.48×10^{-17}N. Calculate the (i) the speed and (ii) the kinetic energy of the proton in electron volt.

b)In a Hall effect experiment, a current of 3.2 A length in a conductor 1.2 cm wide and 4.0cm long and 9.5μm thick produces a transverse Hall voltage across its width of 40.0μV when a magnetic field of 1.4T acts perpendicular to the thin conductor. Calculate the (i) drift velocity and (ii) density of charge carriers.

(4+8+8)

6A. (a) State Biot-Savart Law and write an expression for the magnetic field at the center of a circular current loop.

(b) What is a toroid? Write an expression for the magnetic field inside a toroid.

6B. a) Using Ampere's Law, arrive at an expression for the magnetic field due to a) a long straight wire both at a point out side and at its interior. Plot a graph of 'B' verses 'r' the radial distance.

b) Using Biot-Savart Law, arrive at an expression for the force between two current carrying conductors and write when they repel and attract and why?

6C. (a) The 25.0 KV electron gun in a TV tube fires an electron beam 0.22 mm in diameter at the screen, 5.6×10^{14} electrons arriving each second. Calculate the magnetic field produced by the beam at a point 1.5 mm from the axis of the beam.

b) A long solenoid 1.33m long and 2.6cm in diameter carries a current 17.8 A. The magnetic field inside the solenoid is 22.4mT. Find the length of the wire forming the solenoid. **(4+8+8)**

7A. (a) State Faraday's Laws on electromagnetic induction.

(b) Write two difference between ferromagnetic an diamagnetic materials

7B. (a) With a neat diagram arrive at the expressions for the motional emf and the joule heating produced when a current carrying closed loop is moved in a transverse magnetic field.

(b) Prove that the self-inductance of a solenoid $L=\mu_0 n^2 lA$ (symbols have usual meanings).

7C. (a) A coil has an inductance 83.0 mH and resistance 0.55 Ω. If a 16.0V emf is applied, How much energy is stored in the magnetic field after the current is built up to its maximum value?

b) At what angular frequency would 6.23mH inductor and a 11.4 μF capacitor have the same reactance? Calculate the reactance of these circuit components.

(4+8+8)

8A. (a) State coulomb's Law in electrostatics and write its mathematical form.

(b) What is the force between two protons separated by a distance 1.0μm?

8B. (a) Arrive at an expression for the electric field at a point on the perpendicular bisector of an electrical dipole.

(b) Prove that the current density, $j = nev_d$, symbols have usual meanings.

8C. (a) Calculate the dipole moment of an electron and a proton separated by a distance 4.3 nm. What is the electric field at a point 20.0 mm on the perpendicular bisector axis from the center of the line joining the charges?

(b) In a uniform electric field near the surface of the earth, a particle having charge q = -6.0 nC is acted upon by a downward electric force 5.0 μN (neglecting the gravitational force). (i) Calculate the electric field. (ii) Instead, if a proton is placed, what is the electric force and gravitational force on it? ``` **(4+8+8)**