INTERNATIONAL CENTRE FOR APPLIED SCIENCES
MAHE, MANIPAL

B.Sc. (Applied Sciences) in Engg.

End – Semester Theory Examinations – Nov./ Dec. 2020

II SEMESTER - PHYSICS-II (IPH 121)

(Branch: Common to all)

Time: 3 Hours **Date: 04 December 2020** **Max. Marks: 100**

- ✓ **Answer any FIVE full questions.**
- ✓ **Missing data, if any, may be suitably assumed**

PHYSICAL CONSTANTS

Elementary charge, e	:	1.602×10^{-19}C
Electron mass, m_e	:	9.11×10^{-31}kg
Proton mass, m_e	:	1.67×10^{-27}kg
Boltzmann constant	:	1.38×10^{-23}J/K
Planck's constant	:	6.626×10^{-34}J.s
Electric constant(permittivity) ϵ_o	:	8.85×10^{-8} F/m
Magnetic constant(permeability) μ_o	:	1.26×10^{-6} H/m
Speed of light in vacuum	:	3.0×10^{8}m/s

1A. Using Gauss' law find electric field near an infinite sheet of charge.

1B. Obtain an expression for the electric field at a point on the perpendicular bisector of an electric dipole.

1C. In a uniform electric field near the surface of the earth, a particle having a charge of -2.0×10^{-9} C is acted on by a downward electric force of 3.0×10^{-6} N. (a) Find the magnitude of the electric field. (b) What are the magnitude and direction of the electric force exerted on a proton placed in this field? (c) What is the gravitational force on the proton? (d) What is the ratio of the electric force to the gravitational force in this case?

1D. Two charged, concentric, thin, spherical shells have radii of 10.0 cm and 15.0 cm. The charge on the inner shell is 40.6 nC and that on the outer shell is 19.3 nC. Find the electric field **(a)** at r = 12.0 cm, **(b)** at r = 22.0 cm, and **(c)** at r = 8.18 cm from the centre of the shells.

[5+ 5+ 5+ 5]

2A. Find the equivalent capacitance of a parallel combination of two capacitors.

2B. Obtain an expression for the capacitance of a spherical capacitor.

2C. A 108 μF capacitor is charged to a potential difference of 52.4 V, then the charging battery is disconnected. The capacitor is then connected in parallel with a second (initially uncharged) capacitor. The measured capacitance drops to 35.8 V. Find the capacitance of this second capacitor.

2D. Two sheets of aluminum foil have a separation of 1.20 mm, a capacitance of 9.70 pF, and are charged to 13.0 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?

[4+ 6+ (5 + 5)]

3A. Calculate the change in potential energy when a charge q_2 moves from a point 'a' to point 'b' subject to the force due to another charge q_1 at rest and hence deduce the potential energy at a point.

3B. Find the potential due to a uniform line of positive charge at a distant point on its perpendicular bisector.

3C. Two conducting spheres, one of radius 5.88 cm and the other of radius 12.2 cm, each have a charge of 28.6 nC and are very far apart. If the spheres are subsequently connected by a conducting wire, find (a) the final charge on and (b) the potential of each sphere, assuming V = 0 at infinity.

3D. Two parallel, flat conducting surfaces of spacing d = 1.0 cm have a potential difference ΔV of 10.3 kV. An electron is projected from one plate directly toward the second. What is the initial velocity of the electron if it comes to rest just at the surface of the second plate? Ignore relativistic effects.

[4 + 6+ 6 + 4)]

4A. Obtain an expression for the charges present on the plates of a capacitor at any instant of time during its discharging process. What is the significance of RC time constant?

4B. State and explain Kirchhoff's rules.

4C. An electric heater is constructed by applying a potential difference of 120 V to a Nichrome wire that has a total resistance of 8.00 Ω. Find the current carried by the wire and the power rating of the heater.

4D. Copper and aluminum are being considered for a high-voltage transmission line that must carry a current of 62.3 A. The resistance per unit length is to be 0.152 Ω/km. Compute for each choice of cable material (a) the current density and (b) the mass of 1.00 m of the cable. The densities of copper and aluminum are 8960 and 2700 kg/m^3, respectively. Resistivity of copper and aluminum are 1.69×10^{-8} Ωm and 2.75×10^{-8} Ωm respectively.

[6+ 4 + (4 + 6)]

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

5B. 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.

5C. An electron is accelerated from rest by a potential difference of 350 V. It then enters a uniform magnetic field of magnitude 200 mT, its velocity at right angles to this field. Calculate (a) the speed of the electron and (b) the radius of its path in the magnetic field.

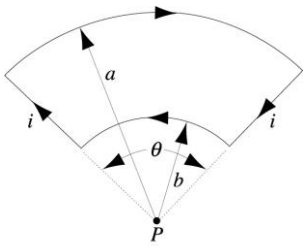
5D. A wire of length 62.0 cm and mass 13.0 g is suspended by a pair of flexible leads in a magnetic field of 440 mT. Find the magnitude of the current in the wire required to remove the tension in the supporting leads. **[4+6+ 5+ 5]**

6A. State Ampere's law. Using it find magnetic fields at external points of a long straight wire.

6B. Obtain an expression for the magnetic force between two parallel conductors carrying parallel current.

6C. A solenoid 95.6 cm long has a radius of 1.90 cm, a winding of 1230 turns, and carries a current of 3.58 A. Calculate the strength of the magnetic field inside the solenoid.

6D. Consider the circuit given below. The curved segments are arcs of circles of radii a and b. The straight segments are along the radii. Find the magnetic field at P. Assuming current I in the circuit.



[5+5+ 5+ 5]

7A. Define eddy current. Mention the advantages and disadvantages of eddy currents.

7B. State and explain Faraday's and Lenz's law.

7C. An electric generator consists of a rectangular loop of dimensions 8.4 cm by 15.4 cm. It rotates in a uniform magnetic field of 0.126 T at a frequency of 60 Hz about an axis perpendicular to the field direction. What is the maximum emf generated by the loop?

7D. The inductance of a closely wound N-turn coil is such that an emf of 3.0 mV is induced when the current changes at a rate of 5.0 A/s. A steady current of 8.0 A produces a magnetic flux of 40 μWb through each turn. (a) Calculate the inductance of the coil. (b) How many turns does the coil have?

[5+5+5+5]

8A. Derive an expression for the energy stored in the magnetic field of an inductor of inductance '*L*' carrying a current '*i*' and hence obtain an expression for the energy density in a magnetic field.

8B. Show for a sinusoidal applied voltage, the current in an inductor always lags behind the voltage across the inductor by ninety degree

8C. In a series LCR circuit let R = 160 Ω, C = 15 μF, L = 230 mH, f = 60 Hz, and E_m = 36 V. Find (a) the inductive reactance X_L, (b) the capacitive reactance X_C, (c) the impedance Z for the circuit, (d) the phase constant ϕ (e) the resonance frequency in Hz .

8D. An air conditioner connected to a 120V, rms ac line is equivalent to a 12.2Ω resistance and a 2.3Ω inductive reactance in series. (a)Calculate the impedance of the conditioner. (b) Find the average power supplied to the appliance. (c) What is the value of the rms current?

[5+5 + 5+5]

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